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3.3.1 RESEARCH PAPERS PUBLISHED

2018-19

SL NO	PUBLICATION	NAME	SUBJECT
1	“Keral Ke Kavi O.N.V. Kurup ka Kavitha Sansaar”	Dr A Priya	Hindi
2	“Cinema Ke Kshetru Mein Anuvarthithu Hindi Sahitya Aur Sanskrithi Ka Apasi Sarokar”	Dr A Priya	Hindi
3	“Kumvar Narayan Ki Kavitha Mein Manaveey Sankat Ki Abhivyakthi”	Dr A Priya	Hindi
4	“Keral Ki Pathrakaritha Ke Samajik Sarokar”	Dr A Priya	Hindi
5	“Kedarnath Singh Ki Kavitha Mein Gaanv Banam Shahar Ki Sanskrithik Samrachana”	Dr A Priya	Hindi
6	“Premchand Ki Kahaniyoon Mein Grameena Jeevan Ke Aayam”	Dr A Priya	Hindi

7	“Bazaar Mein Ramdhan Aur Manikyan Mein Chithrith Kisani Jeevan Ki Thulanatmak Samrachana”	Dr A Priya	Hindi
8	“Samakaleen Hindi Kavitha Mein Aadivasi Jeevan Ki Karunik Dasthan ”	Dr A Priya	Hindi
9	Effect of size of company on CSR practices	Dr Berly Sebastian	Commerce
10	Corporate Social Responsibility and Firm Performance	Dr Berly Sebastian	Commerce
11	Corporate social responsibility practices of public sector and private sector companies in India	Dr Berly Sebastian	Commerce
12	Banking strategy in the era of economic slowdown in India: need for a thrust on ICT integration and housing finance	Dr Mini Joseph	Commerce
13	Promotion of retail banking with a focus on housing finance: an imperative	Dr Mini Joseph	Commerce

	for banks in India and also the whole economy		
14	Factors affecting the work-life balance of the employees of Public and Private sector banks in Kerala	Dr Vipin K Varughese	Commerce
15	Food and Feeding Habit of Heteropneustes Fossils (BLOCH) of Vellayani Lake, Kerala,India	Dr Anila Kumari	Zoology
16	Community Structure of Benthic Foraminifera in the Adimalathura Estuary, Southwest coast of India	Dr Anila Kumari	Zoology
17	Length-Weight Relationship and Condition of Heteropneustes Fossilis (BLOCH) of Vellayani Lake, Kerala, India	Dr Anila Kumari	Zoology
18	Community Structure of Benthic Foraminifera in the Poonthura Estuary, Thiruvananthapuram, Kerala	Dr Anila Kumari	Zoology

19	Customer Experience of Internet and Mobile Banking Services of SBI	Dr Wilson C Thomas	Commerce
20	Nonlinear optical studies of calcium tartarate crystals	Dr Anit Elizabeth	Physics
21	SBI_SBT Merger and its impact on the Banking Industry	Dr Suma P Annie Mathew	Economics
22	Application of Laser Bio speckle Technique for the Analysis of Artificially Introduced Local Dynamics in Apple Fruit	Retheesh R	Electronics
23	Application of Qualitative Bio speckle Methods for the Identification of Scar Region in a Green Orange	Retheesh R	Electronics

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शब्दप्रणि निष्णात: परम् ब्रह्माधिगच्छति

(यू.जी.सी. से अनुमोदित मासिक पत्रिका)

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ओ.एन.वी.कुरुप

ज्ञानपीठ पुरस्कार विजेता ओ.एन.वी.कुरुप का कविता संसार

डॉ.प्रिया.ए.

[मयिलप्पीली (मोरपंख) और ओरुतुल्लि वेलिच्चं (एक बूंद प्रकाश) काव्य-संकलनों के अध्ययन के संदर्भ में]

मलयाळम काव्य-साहित्य को समग्र देन के लिए सन् २००७ में मलयाळम के प्रिय कवि ओ.एन.वी. कुरुप को ज्ञानपीठ पुरस्कार से सम्मानित किया गया था। उनका जन्म केरल राज्य के कोल्लम जिले के चवरा गाँव में २७ मई १९३१ को हुआ। उनका पूरा नाम ओट्टप्लाक्कल नीलकंठ वेलुकुरुप था। वे 'महाराजास कॉलेज' एरणाकुळम में सन् १९५७ में मलयाळम विभाग के प्राध्यापक नियुक्त हुए। सन् १९५८ से सन् १९८३ तक पच्चीस वर्ष यूनिवर्सिटी कॉलेज तिरुवनन्तपुरम में प्राध्यापक रहे। वनिता कॉलेज, तिरुवनन्तपुरम, आर्ट्स एंड साइंस कॉलेज कोषिक्कोड, ब्रण्णन कॉलेज, तलश्शेरी आदि सरकारी कॉलेजों में मलयाळम विभाग के अध्यक्ष रहे। सन् १९८६ में सरकारी वनिता कॉलेज तिरुवनन्तपुरम में सेवा करते वक्त अध्यापक-वृत्ति से सेवानिवृत्त हुए। सेवानिवृत्त होने के बाद भी साहित्यिक एवं सांस्कृतिक कार्यों के लिए उन्होंने अपना जीवन समर्पित किया।

कविता के प्रति ओ.एन.वी. की विशेष रुचि थी। उनकी पहली प्रकाशित कविता है मुन्नोट्ट (आगे की ओर) जो कोल्लम से प्रकाशित एक स्थानीय साप्ताहिक पत्रिका 'मलयाळा राज्यम' में प्रकाशित हुई। उनका पहला प्रकाशित काव्य-संकलन है सन् १९५१ में प्रकाशित 'पोरुतुन्न पालस्तीन' (संघर्षशील पलस्तीन) जो १३ कविताओं का संग्रह है। गत छः दशकों से वे काव्य-साधना में निरंतर सृजनरत रहे।

जिसके तहत तत्कालीन समाज की उलझनों का हल निकालने की कोशिश हुई थी। प्रेमचन्द शोषित मानव की आवाज़ बनने के लिए, उसके हकों की लड़ाई लड़ने के लिए, उसके हित में एक स्वस्थ सुन्दर मानवीय समाज व्यवस्था की गुहार लगाने के लिए, साहित्य के क्षेत्र में उतरे थे। प्रेमचन्द की परंपरा और उनकी विरासत को पुष्ट करनेवाली, कथाकारों की एक नयी पीढ़ी १९३६ के प्रगतिशील आन्दोलन का अंग बनते हुए उभर आयी है। राहुल सांकृत्यायन, अमृतराय रांगेय राघव, यशपाल, भैरवप्रसाद गुप्त, नागार्जुन, रेणु आदि इस श्रेणी में आते हैं।

सहायक आचार्य
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केरल।

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सिनेमा के क्षेत्र में अनुवर्तित हिन्दी साहित्य और संस्कृति का आपसी सरोकार

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सिनेमा और साहित्य का सरोकार बहुत पुराना है। साहित्य के गहरे अध्ययन से ही सैद्धांतिकों ने सिनेमा का आविष्कार किया था। सामाजिक मूल्यों एवं मानसिक संबन्धों की उदात्तता को दर्शाने के लिए समाज हमेशा साहित्योन्मुख होता है। साहित्य और समाज की आधारशिला संस्कृति ही होती है। भारतीय साहित्य द्वारा समाज में सांस्कृतिक मूल्यों का संप्रेषण होता है। ऐसे साहित्य की चर्चा जब दृश्यपट पर होती है तो साहित्य लोकप्रिय बन जाता है। इस प्रकार सिनेमा द्वारा साहित्य का दायरा सांस्कृतिक पहलुओं को संप्रेषित करते हुए विस्तृत बन जाता है। सिनेमा के क्षेत्र में अनपढ़ लोग भी आसानी से, आराम से पदार्पण कर सकते हैं। अतः साहित्य की तुलना में सिनेमा आस्वादकों पर ज़्यादा प्रभाव डाल सकता है। जब एक साहित्य रचना सिनेमा का रूप धारण करती है तो उस रचना का संदेश जनता तक संप्रेषित होता है। इसप्रकार साहित्य और समाज का आपसी संबन्ध सिनेमा के द्वारा सार्थक बनता है।

सिनेमा ने अपने आरंभिक चरण में अपना भविष्य संवारने के लिए साहित्य से ही प्राण तत्व ग्रहण किया। साहित्य के पास सिनेमा की ज़रूरतों को पूरा करने के लिए विपुल भंड़ार भी था। इस मायने में देखा जाए तो हिन्दी सिनेमा का इतिहास काफी पुष्ट दिखाई देता है। गौर से विश्लेषण करें तो उस समय सिनेमा की दिलचस्पी या झुकाव दो तथ्यों पर टिका हुआ था। एक तो यह है कि लोकप्रिय साहित्य रचनाओं को सिनेमा बनाने की प्रक्रिया। इस प्रक्रिया को फिल्मी जगत में 'अनुवर्त्तन' कहा जाता है। अंग्रेजी में इसके लिए 'adaptation' शब्द प्रचलित है। एक माध्यम से दूसरे माध्यम में रचना का रूपान्तरण ही अनुवर्तन है। ऐसी प्रक्रिया की शुरुवात तो सन उन्नीस सौ तीस से पायी जाती है। आगे-आगे साठोत्तरी फिल्मी दुनिया में यह श्रम काफी हद तक बलवत् हो गया। दूसरी बात यह थी कि हिन्दी के लेखक का सिनेमा जगत से गहरा संबन्ध।

सिनेमा ने अपने आरंभिक चरण में और अपना भविष्य - संवारने के लिए साहित्य से ही प्राण तत्व ग्रहण किया। साहित्य के पास सिनेमा की जरूरतों को पूरा करने के लिए विपुल भंडार है। साहित्य, सिनेमा, संगीत, गीत या अन्य ललित कलाएँ अपने समय के जीवन का केवल तस्वीर मात्र नहीं होती है। वे जीवन को उन्नत और शिक्षित बनाती हैं। यही उनकी सामाजिक भूमिका भी है। मिथक और लोक विद्या अपने समय, अपनी भूमि और मनुष्य को प्रस्तुत करती है। जब इनका संदर्भरहित इस्तेमाल किया जाता है तो यह हानिकारक और अशिष्ट हो जाती है।

सिनेमा अपने में पेंटिंग, शिल्प, संगीत, मूर्ति और तकनीकी को एक साथ समेटे हुए हैं। साहित्य और सिनेमा के मुहावरे अलग-अलग हैं। सिनेमा और साहित्य दोनों ही अभिव्यक्ति के माध्यम है, लेकिन साहित्य में केवल भाषा को ही गूंथा जाता है। साहित्य में अलंकार, अतिशयोक्ति का आधार लेकर साधारण वस्तु को भी भव्य बनाने की रीति हैं। उदाहरण के लिए - गुलाब का वर्णन साहित्य में हजारों तरीके से हो सकता है, लेकिन कैमरे की आंख से वह स्थूल गुलाब है। कैमरा बहुत शक्तिशाली माध्यम है। साहित्य की परंपरा सैकड़ों साल पुरानी है। सिनेमा की उम्र अभी बहुत कम है। साहित्य बहुत समृद्ध है और उससे सिनेमा के गीत, चरित्र, माहोल भाषा जैसी बहुत सी जरूरतें पूरी हुई हैं।

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कुंवरनारायण की कविता में मानवीय संकट की अभिव्यक्ति

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असिस्टेंट प्रोफेसर, हिन्दी विभाग, के.जी. कॉलेजट पाम्पाडी, कोट्टयम-केरल

समाज में सबसे अहम मूल्य-मानवीयता का है। वही मनुष्य को मनुष्य से जोड़ती है। इसी आपसी सरोकार से समाज की वास्तविक प्रगति संभव है। ऐसे में मानवीय मूल्यों की अपनी भूमिका असंदिग्ध है। ये मूल्य ही समाज को मानवीय संवेदनाओं से संपृक्त करते हैं। पर वर्तमान दौर में इन मूल्यों का लगातार विरूपीकरण हो रहा है। आपसी विश्वास, ईमानदारी, संवेदनशीलता व नैतिकता सरीखे मूल्य अपने अर्थ से अपदस्थ हो रहे हैं। इस प्रकार मनुष्यता का निरन्तर अवमूल्यन हो रहा है। हर रोज़ भिन्न प्रकार से मनुष्य के साथ संवेदनाघात और विश्वासघात हो रहे हैं। छद्म सामाजिकता के कारण मनुष्य असुरक्षित हालात में दमघुटकर जीने के लिए अभिशप्त बनता जा रहा है। मानवीय संकट की यह स्थिति हर काल की वास्तविकता रही है।

सार्थक कविता मनुष्योन्मुखी होती है। यह कविता में उपस्थित सक्रिय जीवंतता है। कविता में मनुष्योन्मुखता का पक्ष जीवंत और गतिशील होकर उत्तरोत्तर विकसित होता है। मनुष्योन्मुखता के विविध जीवन पक्ष कविता में बहुविध छवियों में अभिव्यंजित होते हैं। संवेदनशील कवि मनुष्य की मूल संवेदना की ओर, अन्तर्जगत की ओर निरन्तर यात्रा करते हुए समाज के हृदय की अन्दरूनी हलचल को मापने की लगातार कोशिश करता है। आधुनिक कवि कुंवर नारायण ने अपने समकालीन समय से संवाद करने का कार्य किया है। उन्होंने अपनी रचनाओं में मानवीय संकट को विभिन्न परिप्रेक्ष्य में आँकने का प्रयास किया है। आज की दुनिया में समाज के सामने मानवीय संकट की असुरक्षित हालत भिन्न-भिन्न कारणों से प्रकट होती है। इसकी अभिव्यक्ति कुंवर नारायण की कविता प्रकट करती है।

आज के माहौल में मानवीयता संकटों से ग्रस्त है। इस दुस्समय में इन्सानियत को बनाए रखने का उपक्रम कविता का बुनियादी धर्म बन जाता है। अपने समय की मनुष्य विरोधी परिवेश को वह दर्ज करती हुई समाज को सही दिशाबोध प्रदान करती है। सामाजिक संकट को दर्शाते हुए कुंवर नारायण कहते हैं कि - "कविता वक्तव्य नहीं गवाह है/कभी हमारे सामने/कभी हमारे पहले/कभी हमारे बाद/कोई चाहे भी तो रोक नहीं सकता/भाषा में उसका बयान/जिसका पूरा मतलब है सचाई/जिसकी पूरी कोशिश है बेहतर इन्सानी।"[1]

कविता भाषा में सच्चाई का बयान है। विरोधी साजिशों के खिलाफ कविता तनकर पूरे दृढ़ संकल्प के साथ खड़ी है; जिसके मूल में मनुष्य की चिन्ता ही मुख्य है। मानवीयता को हर कीमत पर बनाए रखने की कसावट कविता की अपनी पहचान है।

मनुष्य के साँस्कृतिक विकास की सहज परिणति है - कविता। ऐसे में कविता और संस्कृति का अन्तर्संबन्ध भी स्पष्ट है। संस्कृति समाज में मानवीयता को बरकरार रखती है। संस्कृति के प्रतीक-चिह्न के रूप में व्यक्ति का अपना महत्व असंदिग्ध है। हमारे साँस्कृतिक वातावरण में आई गिरावट या संकट का और हिन्दुस्थान की बदलती तस्वीर को कुंवरनारायण प्रस्तुत कविता में रूपायित करते हैं - 'एक जले हुए मकान के सामने' नामक कविता की पंक्तियाँ "भूल गया है रास्ता/कि ऐसे शहर में/जो सैकड़ों साल पहले था/दरअसल कही नहीं है वह/फिर भी लगता है कि हर जगह वही है/नया-सा लगता कोई बहुत पुराना आदमी/गुमनाम गली में/एक जले हुए मकान के सामने/खड़ा हैरान/कि क्या यही है उसका हिन्दुस्थान?"[2]

भारतीय समाज, उसके जीवन यथार्थ और आज की कविता ये तीनों बदल रहे हैं। 'जला हुआ मकान' या 'खंडहर' हमारी पुरानी संस्कृति ही है। समकालीन समय मानवीय संकट के दौर से गुज़र रहा है। नयी पीढ़ी को भी मूल्य या संस्कृति के साथ-साथ ही चलना है। पर विद्रूपात्मक सच्चाई यह है कि आजकल मूल्य का क्षरण हो रहा है। हमारा हिन्दुस्थान मानवीय मूल्य की च्युति के कगार पर खड़ा है। इसी हकीकत को, अपसंस्कृति के माहौल को प्रस्तुत कविता की पंक्तियाँ ज़ाहिर करती हैं।

जनतंत्र के मूल को उखाड़नेवाली मूल्यहीनता आज सत्ता पर पूरी तरह से हावी है। अवाम की नियति इसी मूल्यहीन व्यवस्था द्वारा निर्धारित हो रही है। मूल्यहीनता से जन्मी अराजकता हमारी न्यायसत्ता पर भी कब्ज़ा कर रही है। कुंवरनारायण की कविता 'सफलता की कुंजी' सत्ता की नशा में बहरी हुई पूरी सामाजिक व्यवस्था पर व्यंग्य का प्रहार करती है। यहाँ शासकों की पूरी कार्यवाही अन्याय पर टिकी रहती है। यहाँ व्यंग्य प्रकारान्तर से विडम्बना की ओर संकेत करता है। पंक्तियाँ यों हैं - "दोनों के हाथों में भरी पिस्तौलें थीं/दोनों एक दूसरे से डरे हुए थे/दोनों के दिल एक दूसरे के लिए/पुरानी नफरतों से भरे हुए थे/उस वक्त वहाँ वे दो ही थे/लेकिन जब गोलियाँ चली/मारा गया एक तीसरा जो वहाँ नहीं/चाय की दूकान पर था..../पकड़ा गया एक चौथा/जो चाय की दूकान पर भी नहीं/अपने मकान पर था, उसकी गवाही पर/रगड़ा गया एक पाँचवाँ जिसे किसी छठे ने/फँसवा दिया था - सातवें की शिनाख्त पर/मुकदमा जिस आठवें पर चला, उसके फलस्वरूप/सज़ा नवें को हुई/और जो दसवाँ बिल्कुल साफ़ छूट कर/एक ग्यारहवें के सामने गिड़गिड़ाने लगा/उसकी मार्फ़त/एक नयी सफलता तक पहुँचने की कुंजी को/उँगलियों पर नचाने लगा...."[3]

राजनीति के मुखौटाधर्मी शक्ल के तहत दबनेवाले मनुष्य के जीवन यथार्थ को कुंवरनारायण की प्रस्तुत कविता शब्दबद्ध करती है। समूची आम जनता की यह विडम्बना हमारे साँस्कृतिक विकास के खोखलेपन को अनावृत करती है। चालाकों पर पूरी

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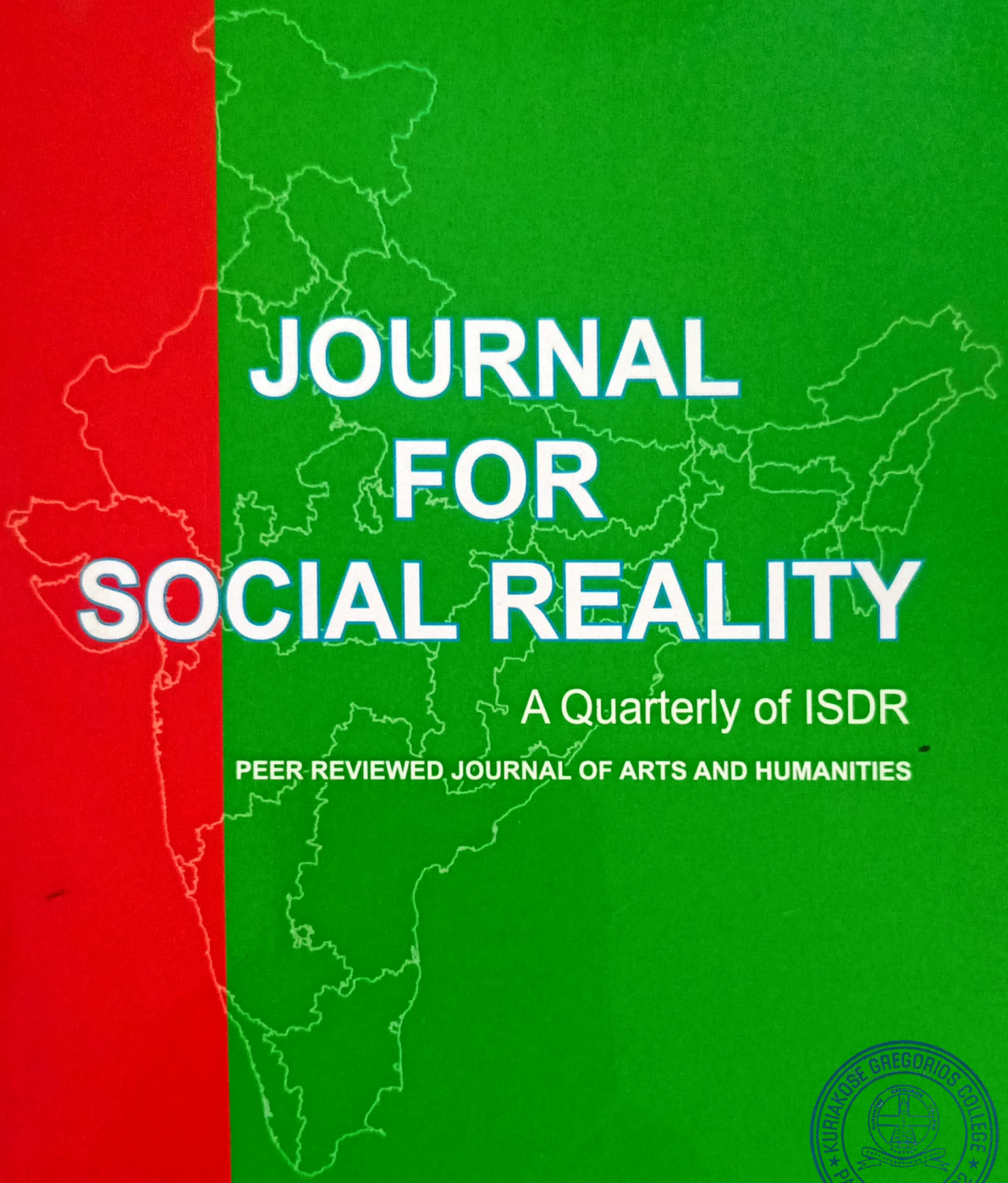

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केरल की पत्रकारिता के सामाजिक सरोकार

डॉ. प्रिया ए.

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'पत्रकारिता' शब्द अंग्रेजी के जरनलिज्म का हिन्दी रूपान्तर है। शब्दार्थ की दृष्टि से 'जर्नलिज्म' शब्द 'जर्नल' से निर्मित है और इसका आशय है- दैनिक; जिसमें दैनिक कार्यों का विवरण होता है। वर्तमान समय में 'जर्णल' शब्द मैगजीन का द्योतक भी है। पत्रकारिता को एक बहुआयामी ढंग से देखने का एवं उसके सामाजिक सरोकार को परखने का प्रयास इस आलेख द्वारा किया गया है।

साहित्य की तरह पत्रकारिता भी समाज में चलनेवाली गतिविधियों एवं हलचलों का दर्पण है। पत्रकारिता के माध्यम से मानव परिवेश में घट रही प्रत्येक सूचना हम तक पहुँचती है। आज की पत्रकारिता सूचनाओं और समाचारों का संकलन मात्र न होकर मानव जीवन के व्यापक परिदृश्य का आकलन प्रस्तुत करती है। जिस प्रकार साहित्य, समाज को मार्ग दिखाने का, सूचना देने का एवं जागरूक बनाने का दायित्व निभाता है, उसी प्रकार पत्रकारिता भी जनता एवं सत्ता के बीच एक संवाद सेतु का कार्य निभाती है। साहित्य हो या पत्रकारिता इन दोनों का धर्म अन्याय के विरूद्ध प्रतिरोध दर्ज करना है। यह समय की माँग भी है। ऐसे में उसकी जिम्मेदारी एवं जवाबदेही बढ़ जाती है।[1]

आधुनिक केरल के सामाजिक-सांस्कृतिक निर्माण में पत्रकारिता ने निर्णयात्मक भूमिका अदा की है। पत्रकारिता एवं साहित्य ने मलयालम भाषा का विकास, मुद्रण कला का विकास एवं नागरिकाधिकार बोध का पथ प्रशस्त किया। वास्तविक अर्थ में समाचार पत्र का प्रारंभ 1860 के बाद ही हुआ। केरल पताका, दीपिका, केरलमित्रम, केरल पत्रिका, केरल संचारी आदि पत्रों को उदाहरण के रूप में लिया जा सकता है। मलयाल मनोरमा का प्रारंभ 1890 में हुआ, जिसने मलयालम पत्रकारिता में नया मार्ग प्रशस्त किया। प्रारंभकालीन पत्रों का उद्देश्य

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१४. केदार सिंह की कविता में गाँव बनाम शहर की साँस्कृतिक संरचना

डॉ. प्रिया ए.
असिस्टेंट प्रोफेसर, हिन्दी विभाग, के. जी. कॉलेज, पाम्पाडी, कोट्टयम, केरल.

केदारनाथ सिंह का जन्म उत्तर प्रदेश के बलिया जिले के चकिया गाँव में 20 नवंबर 1934 को हुआ था। 198 में उन्हें 'अकाल में सारस' काव्य संकलन के लिए साहित्य अकादमी पुरस्कार प्राप्त हुआ था। 2013 में वे 49वाँ ज्ञानपी पुरस्कार के विजेता थे। 1959 में तीसरे सप्तक से उनकी काव्य रचना की यात्रा शुरू होती है। उसके बाद आठ काव्य संकलनों का प्रकाशन हुआ। अभी बिलकुल अभी (1960), ज़मीन पक रही है (1980), यहाँ से देखो (1983), अकाल में सारस (1988), उत्तर कबीर और अन्य कविताएँ (1995), बाघ (1996), तालस्ताय और साइकिल (2005) औ अंतिम काव्य संकलन - सृष्टि पर पहरा (2014) आदि।

केदारनाथ सिंह समकालीन हिन्दी कविता के प्रमुख हस्ताक्षर के रूप में विख्यात हैं। 'तीसरे सप्तक' से शु होकर 'सृष्टि पर पहरा' तक व्याप्त उनकी काव्य-यात्रा जनपदीय चेतना से संपृक्त है। अपने चारों ओर के जीवन क स्वीकृति एवं अभिव्यक्ति उनकी कविता की विशेषता है। समय, समाज, सौंदर्य, लोक तथा मानवता को अत्यंत सजीव ढं से वे अपनी कविताओं में दर्ज करते हैं। उनकी रचनाएँ भारतीयता की अनमोल धरोहर है। उनकी कविताओं का अध्ययन करते वक्त हम इस बात से अवगत हो जाते हैं कि उनकी कविता की आधारशिला गाँव व गाँव से जुड़ी संस्कृति है ज भारतीय संस्कृति को पोषित करती है। उनके काव्य संवेदना का दायरा गाँव से शहर तक परिव्याप्त है।

केदारनाथ सिंह की रचनाओं में बार-बार गाँवों की ओर लौटने की उनकी बेचैनी को देख सकते हैं। क्योंकि व एक आधुनिक कवि होते हुए भी जीवन-विरोधी, आततायी आधुनिकता के विरोध में खड़े हैं। उनका मन सदा ग्रामीणता के वातावरण में, अपनी जड़ों की ओर ही आकृष्ट होता है। 'गाँव आने पर' शीर्षक कविता शहर से गाँव आने पर उनकी मानसिकता को यों प्रस्तुत करती है-

"अब आ तो गया हूँ/पर क्या करूँ मैं?
एक बूढ़े पक्षी की तरह लौट-लौटकर
मैं क्यों यहाँ चला आता हूँ बार-बार?

छू लूँ किसी को?/लिपट जाऊँ किसी से?
मिलूँ/पर किस तरह मिलूँ
कि बस मैं ही मिलूँ/और दिल्ली न आए बीच में"।

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वार्षिक चन्दा : दो सौ रुपये मात्र

प्रेमचंद की कहानियों में ग्रामीण जीवन के आयाम

डॉ. प्रिया ए.

भारतीयता का संपूर्ण प्रस्फुटन गाँव से, ग्रामीण संस्कृति से ही संभव है। गाँव ही हमारे राष्ट्र की रीढ़ है। भारतवर्ष 'गाँवों का देश' कहलाता है। 'भारत की आत्मा गाँवों में बसती है' महात्मा गाँधी की यह उक्ति एक आर्ष-वाक्य जैसी है। जिस दिन यह आत्मा सबल, निर्मल और सतेज होगी उसी दिन हमारा देश सुखी होगा। प्रेमचंद की कहानियों में ग्रामीण जीवन की संस्कृति के विभिन्न पहलुओं को हम देख सकते हैं। ग्रामीण संस्कृति को संप्रेषित करने में प्रेमचंद की कहानियाँ बहुत ही सक्षम सिद्ध हुई हैं। गाँव के किसान, पर्व, खेल, विश्वास, पशु-पालन एवं गाँव की सामाजिक कुरीतियों एवं छुआछूत संबन्धी समस्याओं के प्रति भी प्रेमचंद जागरूक रहे। इन सभी मुद्दों के आकलन से प्रेमचंद का साहित्य भारतीय संस्कृति के मूल्यों का संवाहक बनता है।

प्रेमचंद की कहानियों में गाँवों का किसान जीवन

प्रेमचंद ने अपनी रचनाओं में भारतीय किसान के समग्र जीवन-यथार्थ का चित्रण किया है। वे किसान को समाज का आधारभूत उत्पादन वर्ग मानते हैं। उनके लिए किसान की उन्नति ही देश की उन्नति है और किसान की बदहाली ही देश की बदहाली है। अतः किसान का जीवन-क्रम ही सारे देश के अन्य वर्गों के जीवन को निर्धारित करता है। इसलिए उन्होंने अपनी रचनाओं में किसान को केन्द्र बनाकर सारे समाज का चित्रण किया है। प्रेमचंद की कहानी 'अलग्योझा' का केन्द्र पात्र 'रग्घू' द्वारा संपूर्ण किसानी चेतना का चित्रण उन्होंने किया है। 'रग्घू' गाँव का किसान था, उसकी मृत्यु हुई उसके बाद उसका पूरा परिवार अकेला पड़ गया। पूरे परिवार में गरीबी का अंधकार छा गया। उन्होंने इस प्रकार उस घर की विपन्नता को चित्रित किया है - "अब इस घर में कैसे निबाह होगा? वह किसके सहारे रहेगी? किसके बल पर खेती होगी। बेचारा रग्घू बीमार था, दुर्बल था; पर जब तक जीता रहा, अपना काम करता रहा। मारे कमजोरी के कभी-कभी सिर पकड़कर बैठ जाता, और जरा दम लेकर फिर हाथ चलाने लगता था। सारी खेती तहस-नहस हो रही थी, उसे कौन सँभालेगा? अनाज की डाँठें खलियान में पड़ी थीं, ऊख अलग सूख रही थी। वह अकेली क्या-क्या करेगी? फिर सिंचाई अकेले आदमी का तो काम नहीं। तीन-तीन मजूरों को कहाँ से लाये? गाँव में मजूर थे ही कितने? आदमियों के लिए खींचातानी हो रही थी। क्या करे, क्या न करे?"[१]

इस कहानी में 'रग्घू' पूरे किसान वर्ग का प्रतिनिधि बनकर हमारे सामने

१. प्रेमचंद - मानसरोवर, भाग-१ - पृ. २३

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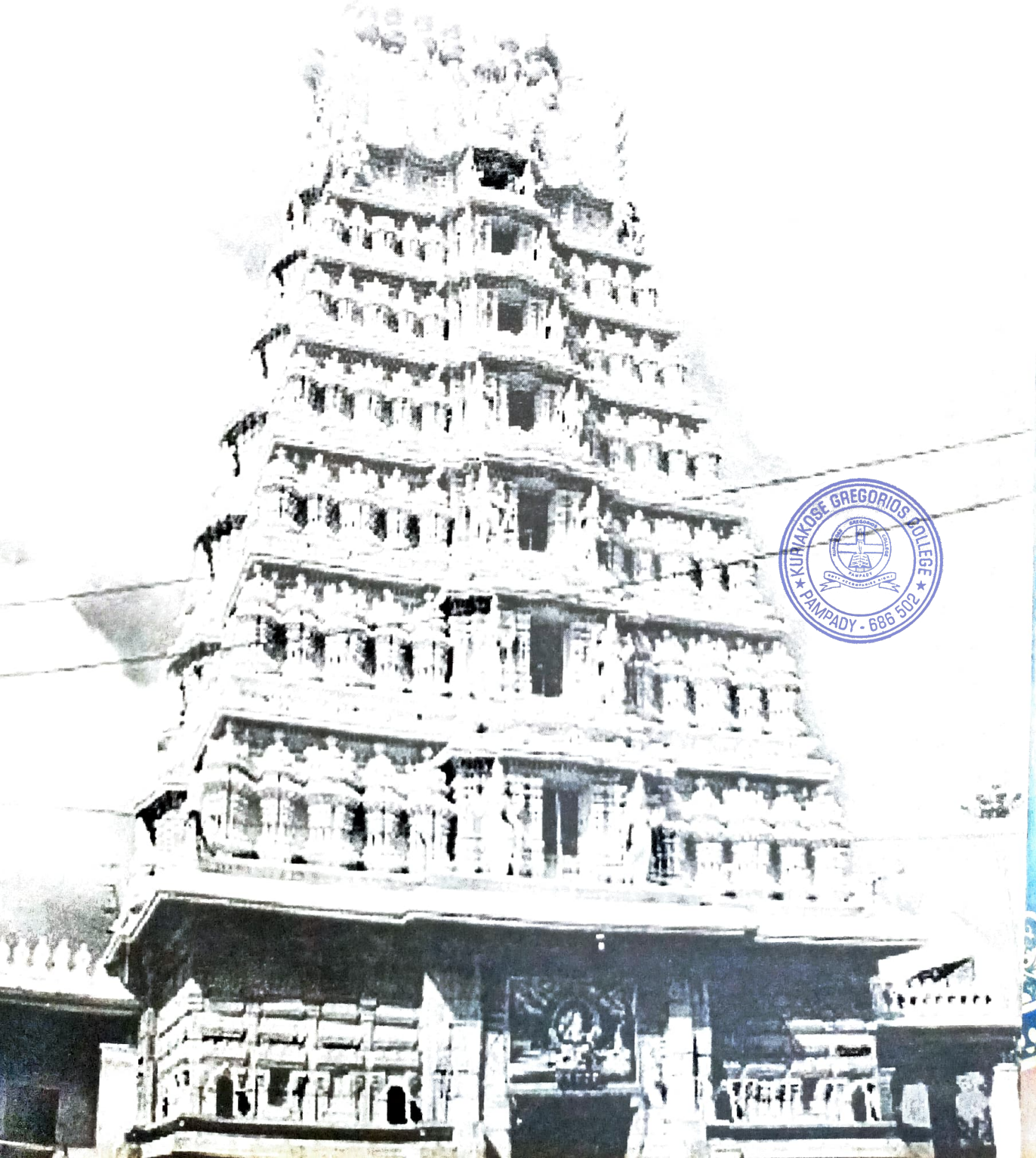
समन्वय दक्षिण

दक्षिण भारत की साहित्य एवं संस्कृति केंद्रित पत्रिका

समन्वय दक्षिण

दक्षिण भारत की साहित्य एवं संस्कृति केंद्रित पत्रिका



'बाज़ार में रामधन' और 'मणिक्कन' में चित्रित किसानी जीवन की तुलनात्मक संरचना

डॉ. प्रिया ए.

तुलनात्मक साहित्य की सर्वमान्य स्थूल परिभाषा यही हो सकती है कि यह साहित्यिक समस्याओं का अध्ययन है, जहाँ एक से अधिक भाषाओं का उपयोग किया जाता है। भारत एक तुलनात्मक साहित्य क्षेत्र है। बहुभाषिकता इस देश की विशेषता है। इसी विशेषता के कारण भारतीय साहित्य का अध्ययन एकक साहित्य के रूप में हम नहीं कर सकते। यहाँ किसी भी एक भाषा के साहित्य का अध्ययन और विश्लेषण एक दूसरी भाषा में रचित साहित्य के अध्ययन के लिए रास्ता दिखाता है। इस प्रकार एक संपूर्ण भारतीय साहित्य की जानकारी मिल जाती है।

भारतीय साहित्य भारतीय जनता की स्मरणीय अभिव्यक्तियों का समाहार है। भारतीय साहित्य में विषयवस्तु की एकता मिलती है। भारतीय साहित्य की एकता भाषागत एकता नहीं, लेखकों के विचारों और भावनाओं की एकता है। भारत एक ऐसे क्षेत्र का प्रतिनिधित्व करता है, जहाँ नाना प्रकार के जीवन रूप तथा जीवन के चुनाव उपलब्ध हैं। कैलाश बनवासी और ललितांबिका अंतर्जन्म जैसे कहानीकारों ने अलग-अलग स्थानों पर रहते हुए भी एक ही विषय पर बल दिया है। अपनी रचनाओं में किसान वर्ग के विभिन्न आयामों को स्थान दिया है।

समकालीन हिंदी कहानीकार कैलाश बनवासी की कहानी 'बाज़ार में रामधन' में और मलयालम कहानीकार ललितांबिका अंतर्जनम की कहानी 'माणिक्कन' में भारतीय किसान वर्ग की जीवन पद्धति को निर्धारित किया है। भारतीय किसान का समग्र जीवन इन कहानियों में प्रतिबिंबित हुआ है। किसान के भिन्न-भिन्न जीवन पहलुओं को उभारकर कहानीकार ने हमारे सामने रखा है। बाज़ार में रामधन और माणिक्कन-ये दोनों कहानियाँ किसान की जीवन गाथा को प्रस्तुत करती हैं। दोनों कहानियों को पढ़ते वक्त समान रूप से कुछ विशेषताएँ दृष्टव्य होती हैं। वे हैं-

(1) **दोनों कहानियों में कृषक संस्कृति का सन्निवेश :**

भारतीय संस्कृति की नींव कृषि संस्कृति है। भारतीय कृषक का कृषि के साथ अटूट संबंध है। भारतीय संस्कृति में भूमि एवं गाय का बड़ा महत्व होता है क्योंकि ये दोनों कृषक संस्कृति की आधार शिलाएँ हैं। 'माणिक्कन' और 'बाज़ार में रामधन' नामक कहानियों में अपने बैलों से, कृषक जीवन से गहरी संवेदना रखने वाले 'अषकन' और 'रामधन' को हम देख सकते हैं। दोनों कहानियों के आरंभ से लेकर अंत तक किसानी जीवन का परिदृश्य संगुंफित रहता है।

(2) **दोनों कहानियों में किसानों को अपने बैलों के प्रति संवेदना की झलक :**

'रामधन' अपने मन की संवेदना को यों शब्दबद्ध करता है-"बैल हमारे घर की इज्जत है... घर की शोभा है। और इससे बढ़कर हमारे पिता की धरोहर है। उस किसान का भी कोई मान है समाज में, जिसके घर एक जोड़ी बैल नहीं है।

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ता. येवला. जि. नाशिक.

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मराठी विभाग : डॉ. व्ही. एस. लव्हाळे व डॉ. एस. के. माळी
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डॉ. प्रिया ए.
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पाम्पाडी, कोट्टयम
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'आदिवासी' देश के मूल निवासी माने जानेवाले तमाम आदिम समुदायों का सामूहिक नाम है। वर्तमान समय में देश के किसी भी आदिवासी बसाहटों का गाँव या शहर हो, बाज़ारवाद और सरकारी नीतियों के कारण संकटों से ग्रस्त है। साम्राज्यवादी ताकतों ने जल-जंगल-ज़मीन से उन्हें विस्थापित कर दिया गया है। इक्कीसवीं सदी की नई आर्थिक नीतियों से हमारी सरकारों और उद्योगपतियों को विकास के नाम पर आदिवासियों को लूटने की खुली छूट मिल गई। ऐसे यथार्थ का प्रभाव देश के सभी आदिवासी इलाकों में दृष्टिगत होता है। उनके रोज़गार, भाषा, जीवन शैली एवं संस्कृति पर खतरे मँडरा रहे हैं। अपने अस्तित्व को सुरक्षित रखने के लिए आदिवासी वर्ग को मुख्यधारा समाज से जूझना पड़ा। इस प्रकार अब वह गुलामी की चुप्पी को तोड़कर बोलने लगा है। पहचान के संकटों से बचने के लिए आदिवासी वर्ग अब विद्रोह करने लगा है। इसके फलस्वरूप हिन्दी भाषा में आदिवासी लेखन प्रक्रिया भी हुई है।

समकालीन आदिवासी लेखन आदिवासी समाज और जीवन में हो रहे बदलाओं से पाठकों को रू-ब-रू कराता है। रोज केरकेट्टा, सरोज केरकेट्टा और ग्लैडसन डुंगडुंग झारखंड़ के बहुचर्चित कवियों में प्रमुख हैं। ये तीनों खड़िया भाषी कवि हैं। पर इन तीनों कवियों ने हिन्दी भाषा में अपनी रचनाओं को प्रस्तुत किया है। इनकी कविताओं के माध्यम से पूरे देश के आदिवासी समाज का जीवन यथार्थ प्रस्तुत होता है।

रोज केरकेट्टा खड़िया भाषी है, वे झारखंड की सब से पुराने हस्ताक्षरों में से हैं। उनकी कविताएँ स्त्री, आदिवासी जीवन में आई चेतना को शब्दबद्ध करती हैं। पूँजीपति वर्ग द्वारा आदिवासी स्त्रीयों पर होनेवाले बलात्कार एवं शोषण को 'पहरेदार' नामक कविता यों व्यक्त करती है-

"स्त्री / पहरे में गर्भवती होती है
जनती भी / पहरेदारी में ही है
दूध भी पहरेदारी में ही पिलाती है
और फेंक भी आती है / पहरेदारी में ही बच्चा

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The Effect of Size of the Company on CSR Practices

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ABSTRACT

Corporate Social Responsibility (CSR) is the responsibility of corporates for their impact on society. The Companies Act, 2013 mandated companies to spend 2% of their profits on CSR activities. CSR activities are influenced by several factors like size of company, type of industry and nature of ownership among other things. The present study is conducted to analyse the effect of size of the company on CSR practices. Data of 36 companies for three years from 2014-15 to 2017-18 are collected from the annual reports. The analysis is made with SPSS and hypotheses are tested by using one-way ANOVA and chi-square. The study found that the size of the company has no impact on the amount of CSR spending, implementation strategy or type of CSR activities. The study also found that CSR spending has increased over the years, though all the companies are not fully complying.

1. Introduction

Indian business houses have a very long tradition of philanthropy as a sign of social commitment and as part of thanks giving for using societal resources. It was in the form of providing money or goods or developing infrastructure. The Companies Act, 2013 made it mandatory for companies to spend on CSR activities from 2014-15 onwards.

Corporate Social Responsibility (CSR) is "the commitment of business to contribute to sustainable economic development, working with employees, their families, the local community and society at large to improve their quality of life."

CSR spending was made mandatory for companies in India. Under Section 135 of The Companies Act 2013, every company having a net worth of Rs.500 crores or more, or a turnover of Rs.1000 crores or more, or net profit of Rs.5 crores or more during any financial year has to spend at least 2% of its average net profits made during the three immediately preceding financial years on CSR activities.

Companies can do the CSR activities mentioned in Schedule VII of the Act. It includes hunger and poverty eradication, education, health, sports, environment, skill development, infrastructure development, disaster relief and so on. These activities can be done under the scrutiny of the CSR committee formed specifically for the purpose through setting up foundations or through tie-ups with governmental and non-governmental organisations. The paper looks into the CSR practices of companies such as how far the new rule is followed, how the implementation is carried on and which are the CSR activities undertaken.

2. Review of Literature

Sharma and Mani (2013) studied the CSR practices of banks prior to the mandatory CSR rule and found that the highest contribution is done by public sector banks while the lowest contribution is by the foreign banks.

Rai and Bansal (2014) studied the CSR activities undertaken by top 200 companies and found that companies are doing their CSR activities in the areas where they affect negatively. Companies which pollute environment spends more on environment. Top companies set up own foundations/trusts rather than depending on implementing agencies. Community development, education and health are the major areas of CSR spending by companies.

Shah (2018) stated CSR activities undertaken in different countries are in accordance with their prevailing socio-economic conditions. Companies in European countries which have excellent social security systems focussed their CSR activities on sustainability and environment protection. Chinese companies are focussing on environmental protection and reduction of pollution as their CSR activities. Companies in capitalist country like USA donate billions of dollars for charitable and philanthropic activities every year mostly through their own foundations. Companies in Latin American countries like Argentina, Venezuela and Uruguay concentrated their CSR activities in the areas of poverty reduction and environment protection.

The Economic Times (March 22, 2018) reported that the CSR spending of Indian corporates have increased 14 percent in 2016-17 from the earlier year, and 74% of the eligible companies are using NGOs for implementing CSR activities.

3. Statement of the Problem

The Companies Act made CSR spending mandatory. Before the rule also, the companies were making voluntary charitable activities. After the passing of the Act, there is an increase in the spending on CSR activities. The large companies having huge financial resources may be spending more than medium and small companies. They can afford creation of own foundations. There may not be much difference in the type of CSR activities of large companies. Some companies do the CSR activities through own employees and foundations. Others prefer tie-ups with governmental and non-governmental organisations. Companies do CSR activities in

various sectors like health, environment, infrastructure development, education, skill development and so on.

There is a need to know whether there is any relation between CSR practices and size of company. Size of the company may have an impact on the amount of spending, implementation strategy and type of activities.

4. Objective of the study

To study whether there is an impact of size of company on CSR practices of large, medium and small companies.

5. Hypothesis of the study

There is no significant difference in the CSR practices of large, medium and small companies.

6. Methodology of the study

The study uses secondary data. It requires information relating to CSR practices of large, medium and small companies. This information is collected from the business responsibility reports and annual reports published by the companies.

6.1. Units of Study

Purposive sampling method is adopted for the study. Thirty-six NSE listed companies are selected for the study, ie., twelve each from large, medium and small companies. Companies with a market cap of Rs 100,000 crores or more are treated as large cap companies, with a market cap between Rs 50,000 crores and 100,000 crores as mid cap companies and those less than Rs 50,000 crores market cap as small cap companies.

6.2. Tools of Analysis

The data analysis is done with SPSS and hypotheses are tested by using one-way ANOVA and chi-square. One-way ANOVA is done to analyse whether there is any significant relationship between CSR spending and size of company. Chi square test is done to analyse the association between size of company and CSR implementation strategy. It is also done to know whether there is association between size of company and CSR activities done by them.

7. Limitation of the Study

The information is collected from the annual reports and business responsibility reports of companies. No further verification on the accuracy of data is done. Only three years data are used for the study.

8. Analysis of Data

Analysis 1: CSR Spending of Companies after the mandatory law

CSR spending was made mandatory from 2014-15. The companies have to spend 2% of their profits on CSR activities. The study is done to analyse whether the companies are following the mandatory rule and whether there is any difference in their spending on the basis of size of company. One-way ANOVA is done to analyse whether there is any difference in spending on the basis of size of company. Table 1 shows the CSR spending of large, medium and small companies.

Table - 1
CSR Spending of Companies (in %)

2017			2016			2015		
L	**M**	**S**	**L**	**M**	**S**	**L**	**M**	**S**
3.51	2.00	2.33	1.72	N.A	2.07	1.27	2.01	2.23
0.05	2.00	4.24	0.57	2.00	4.00	0.59	0.99	2.37
2.04	2.00	2.05	2.00	1.35	N.A	2.10	0.76	2.06
2.01	2.00	2.00	1.58	2.02	2.00	1.97	2.01	2.00
2.00	2.02	1.69	2.01	2.04	1.14	2.87	2.60	1.00
2.04	2.41	2.60	2.36	2.23	2.66	1.44	0.11	2.00
2.01	2.34	1.01	2.02	2.01	0.67	2.00	2.02	0
2.00	2.42	2.01	2.40	2.04	1.77	1.49	2.72	2.00
2.43	2.02	2.01	3.62	2.07	1.49	1.45	1.96	0.72
1.96	3.35	2.00	1.41	2.35	2.00	1.50	2.83	2.00
2.13	2.05	2.00	2.34	2.27	1.36	2.85	3.45	1.39
1.70	2.01	1.33	1.64	1.67	0.90	1.53	1.27	0.54
1.99*	**2.22***	**2.11***	**1.97***	**2.00***	**1.82***	**1.76***	**1.89***	**1.66***
F(2,33)=.345			F(2,31)=.212			F(2,32)=.261		
p value=.711			p value=.810			p value=.772		

Source: Annual reports of companies
** means average.*
Note 1: L, M and S stands for Large, Medium and Small companies
Note 2: Idea Cellular Ltd. did not do any CSR activities in 2015. Adani Ports and Ashok Leyland had negative net profits in 2016. So, they are not required to do mandatory CSR in 2016.

Table 1 shows that CSR spending has increased over the years, though all the companies are not fully complying even in the third year of implementation of the CSR rule. In 2015, 18 companies complied with the rule, which increased to 21 companies in 2016 and further increased to 30 companies. The average CSR spending of large, medium and small companies

were found out and there is a difference in their spending. To test whether the difference is statistically significant or not, one-way ANOVA is done taking the null hypothesis that:

H0: There is no difference in CSR spending of large, medium and small companies.

It was found that the result was not statistically significant. Hence, it can be concluded that size of company does not influence CSR spending.

Analysis 2: CSR Implementation Strategies of Companies

The Companies Act, 2013 states that companies can undertake CSR activities through a registered trust/foundation established by the company or through tie-ups with governmental and non-governmental organisations. They can also do the CSR activities using their own personnel. Table 2 shows the CSR implementation strategies adopted by large, medium and small companies.

Table - 2
CSR Implementation Strategy

Size of company	2017		2016		2015	
	Foundation, Direct, Employee	Implementing Agency	Foundation, Direct, Employee	Implementing Agency	Foundation, Direct, Employee	Implementing Agency
Large	12	12	12	10	12	10
Medium	12	12	12	12	12	12
Small	9	11	9	11	9	10
Test	chi square=0.141		chi square=0.382		chi square=0.219	
	p=0.932		p=0.826		p=0.896	

Source: Annual reports of companies

Table 2 shows the CSR implementation strategies of large, medium and small companies. Majority of the companies use a combination of their own foundation and tie-ups with governmental or non-governmental organisations. To analyse whether size of company affects CSR implementation strategies, chi-square test was done. It was found that there is no relationship between size of company and implementation strategy. The result was not statistically significant and it can be concluded that size of company does not influence CSR implementation strategy.

Analysis 3: Type of CSR activities

Section 135 of The Companies Act specifies the areas where CSR spending can be done by companies. The major CSR spending areas include education, environment, rural development, hunger and poverty eradication, health, skill enhancement, gender equality and women empowerment. Table 3 shows the type of CSR activities carried on by large, medium and small companies.

Table - 3
Sector-wise CSR interventions

CSR Activities	2017			2016			2015		
	L	M	S	L	M	S	L	M	S
Education	17	16	14	15	16	17	16	17	14
Health	12	10	12	12	9	13	9	9	13
Environment	11	13	9	13	10	10	14	13	11
Rural development	7	6	6	7	6	6	5	5	5
Gender equality	5	7	9	5	8	6	7	7	6
	52	**52**	**50**	**52**	**49**	**52**	**51**	**51**	**49**
chi square	2.47			2.175			1.768		
p value	0.963			0.975			0.987		

Source: Annual reports of companies

Note: L, M and S stands for Large, Medium and Small companies

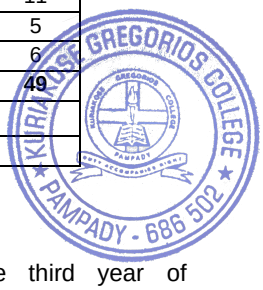

Table 5 shows the major CSR spending areas of large, medium and small companies. It was found that education is the most preferred CSR activity of all the companies. To analyze whether there is any relationship between size of company and CSR activities, chi-square test was done. It was found that there is no relationship between size of company and type of CSR activity. The result was not statistically significant and it can be concluded that size of company does not influence type of CSR activity.

9. Findings

- The CSR spending of companies has increased over the years though all the companies are not spending the mandatory 2% even in the third year of implementation of the CSR rule. There is no significant difference in CSR spending of large, medium and small companies.
- Companies do their CSR activities through own foundations, using own personnel and tie-ups with governmental and non-governmental organisations. There is no difference in the CSR strategies adopted by large, medium and small companies.
- The major CSR spending sector of companies is education, followed by health and environment. There

is no significant difference in the type of CSR activities undertaken by large, medium and small companies.

- The difference in CSR spending, implementation strategies and sectors of spending of large, medium and small companies are tested using chi-square test and one-way ANOVA and found that the size of company does not influence CSR practices.

10. Conclusion

The present study is conducted to know whether size of company influence CSR practices. It was found that CSR spending have increased from the earlier years of implementation, but even in the third year of implementation of mandatory CSR rule, all companies are not fully complying. There is no significant difference in the CSR practices of large, medium and small companies. That is, the size of company does not influence CSR practices.

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Appendix

List of Companies

Sl. No.	Name of the Company	Market capitalisation (Rs in crores)
	Large cap companies	
1	Asian Paints Ltd.	123,396.00
2	Bharti Airtel Ltd.	154,539.49
3	Hindustan Unilever Ltd.	325,566.77
4	Infosys Ltd.	257,890.81
5	I T C Ltd.	346,174.83
6	Larsen & Toubro Ltd.	194,452.99
7	Mahindra & Mahindra Ltd.	108,045.86
8	Maruti Suzuki India Ltd.	264,329.11
9	NTPC Ltd.	138,070.30
10	Oil & Natural Gas Corporation Ltd.	240,623.16
11	Reliance Industries Ltd.	626,736.66
12	Tata Consultancy Services Ltd.	661,759.65
	Mid cap companies	
1	Adani Ports and Special Economic Zone Ltd.	85,468.18
2	Bajaj Auto Ltd.	81,469.84
3	Bosch Ltd.	56,945.60
4	Dabur India Ltd.	64,550.92
5	Godrej Consumer Products Ltd.	73,529.08
6	Hero MotoCorp Ltd.	72,261.60
7	JSW Steel Ltd.	78,257.51
8	Pidilite Industries Ltd.	56,019.10
9	Shree Cement Ltd.	56,461.39
10	Tata Steel Ltd.	73,120.15
11	Tech Mahindra Ltd.	65,303.83
12	Titan Company Ltd.	84,876.80
	Small cap companies	
1	ACC Ltd.	27,623.51
2	Ambuja Cements Ltd.	43,118.29
3	Ashok Leyland Ltd.	47,375.18
4	Cadila Healthcare Ltd.	40,274.03
5	Cipla Ltd.	46,189.69
6	Hindustan Petroleum Corporation Ltd.	48,571.85
7	Idea Cellular Ltd.	22,429.21
8	Marico Ltd.	40,010.34
9	Oracle Financial Services Software Ltd.	35,176.86
10	Procter & Gamble Hygiene & HealthCare Ltd.	29,865.18
11	Siemens Ltd.	36,951.04
12	Sun TV Network Ltd.	34,226.25

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Corporate Social Responsibility and Firm Performance

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ABSTRACT

As part of their responsibility to the society, companies engage in activities that benefit employees, suppliers, customers and society at large. These activities reduce the present value of the cash flows generated by the firm and thus reduce the return available to the shareholders. However, these activities may give better image to the company in the society and the firm value may be increased. Further, by virtue of the good image, the company may be able to record a better performance. In this study, it is tried to establish a relation between CSR spending and firm performance. It is also examined whether there is any difference in the quantum of CSR spending by companies of different sectors. The study is conducted with reference to thirty companies listed on the National Stock Exchange. The study found that there is no significant relation between CSR spending and firm performance. It also found that there is no difference in the quantum of spending on CSR activities by consumer goods, industrial goods and service sector companies.

Keywords: CSR, Firm Performance, ROE, ROA, ROS.

INTRODUCTION:

Corporate Social Responsibility is the responsibility of business towards various stakeholders. It is defined as achieving commercial success in ways that honour ethical values and respect people, communities, and the natural environment. The CSR activities may give better image to the company in the society. However, these activities may reduce the present value of the cash flows generated by the firm. Paine (2002) states that companies should engage in activities that benefit employees, suppliers, customers and society at large, even if those activities reduce the present value of the cashflows generated by a firm.

In India, it is mandatory to spend a certain percentage of the profit of the company for CSR activities. Under section 135 of The Companies Act 2013, every company having a net worth of Rs.500 crores or more, or a turnover of Rs.1000 crores or more, or net profit of Rs.5 crores or more during any financial year has to spend at least 2% of its average net profit made during the three immediately preceding financial years on CSR activities.

A company spending on CSR will have good image and reputation, better financial performance, increased sales and customer loyalty, increased ability to attract and retain employees, reduced government interference, easier access to capital and so on. Different companies follow different CSR practices. The present study is conducted for examining whether CSR spending leads to better financial performance. A comparison of CSR spending of various sectors is also done.

STATEMENT OF THE PROBLEM:

Corporates all over the world are spending for social and community causes voluntarily. In India also even before the CSR spending made mandatory, companies have been undertaking several social projects for the benefit of the community as a whole. When the CSR spending was made mandatory even there were discontent among many corporates as they were spending more than what is specified as the statutory

minimum. However, at the same time there are corporates who earnestly believe that social spending is a breach of contract with the shareholders and the primary objective of a corporation is to increase the return to the shareholders.

The companies which spend more on CSR activities may have better acceptance from all stakeholders which ultimately may lead to better firm performance. Previous research has yielded mixed results regarding the relationship between CSR and financial performance of firm. Wright and Ferris (1997) identified a negative relationship; Posnikoff (1977) reported a positive relationship, while Siew, Ivo and Paul (1999) found no relationship between CSR and financial performance. One of the major factors that influence the CSR spending is the type of industry. The quantum of CSR spending by consumer goods companies, industrial goods companies and services may vary.

REVIEW OF LITERATURE:

Cornell and Shapiro (1987) found that firms with an image of high CSR may find that they have more low-cost implicit claims than other firms and thus have higher financial performance.

Stanwick and Stanwick (1998) examined 125 firms to study the relationship between corporate social performance and the three variables, viz., financial performance, environmental performance and organizational size. It was found that corporate social performance has a positive relationship with profitability and firm size, and an inverse relationship with the pollution created by the firm.

Amrousy, Gavious and Yosef (2012) studied whether the adoption of CSR influence the financial performance of companies by taking 78 listed firms in Israel. Financial performance was measured using the variables ROA and ROE. It was found that there is no significant difference in financial performance of CSR firms and non-CSR firms.

Flammer (2013) views CSR as a valuable resource for the company and argue that it leads to superior financial performance.

Kanwal et al. (2013) found that there is a considerable positive relationship between the CSR and financial performance of the firm, and firms spending on CSR not only benefits from continuous long-term sustainable development but also enjoy enhanced financial performance.

Kapoor (2014) in his study of India's top 100 companies in fifteen sectors found that cement, metal and FMCG companies have disclosed CSR initiatives undertaken better than other industry sectors.

Musau (2015) found that there is significant improvement on the performance of banks, improvement in bank profitability, customer satisfaction, customer retention and improved service delivery after the introduction of CSR in the financial sector.

OBJECTIVE OF THE STUDY:

The objectives of the study are:

1. To examine whether there is any relationship between CSR spending and firm performance.
2. To examine whether there is any difference in CSR spending of consumer goods, industrial goods and service sector companies.

HYPOTHESES OF THE STUDY:

1. There is no relationship between CSR spending of companies and firm performance.
2. There is no difference in CSR spending of consumer goods, industrial goods and service sector companies.

METHODOLOGY OF THE STUDY:

The study is conducted with secondary data. Data were collected from annual reports and business responsibility reports. For the purpose of the study, thirty companies listed on the National Stock Exchange are selected, ie., ten each from consumer goods, industrial goods and service sector.

In this study, accounting measures are used to investigate the relationship between CSR and firm performance. For measuring corporate performance, three variables have been used, viz., Return on Equity (ROE), Return on Assets (ROA) and Return on Sales (ROS).

Corporate performance and CSR spending of financial years 2015, 2016 and 2017 were used for the study. The data analysis is done in SPSS and the hypotheses are tested by using correlation and one-way ANOVA.

LIMITATIONS OF THE STUDY:

- The CSR spending of companies are studied only on the basis of published data. Further verification on the accuracy of data is not done.
- Since CSR spending is mandatory from 2014-15, and the data are available only for that period the study is conducted using data for three years only.

Analysis 1: Relation between CSR spending and firm performance

Firm performance is measured by three variables, viz., Return on Equity (ROE), Return on Assets (ROA) and Return on Sales (ROS). These variables were calculated using data from annual reports. CSR spending is taken as a percentage of its average net profit made during the three immediately preceding financial years. Correlation is done to test whether there is any relationship between CSR spending and firm performance. The results are given in tables1, 2 and 3 respectively for consumer goods, industrial goods and services sectors.

Table 1: Correlation between CSR spending and Firm Performance of Consumer Goods Companies

Particulars	2015	2016	2017
CSR and ROE	-0.2176	-0.3032	-0.1113
CSR and ROA	-0.1833	-0.5257	-0.102
CSR and ROS	0.3906	-0.0701	-0.1657

Source: Computed * significant at 5% p value

Table 2: Correlation between CSR spending and Firm Performance of Industrial Goods Companies

Particulars	2015	2016	2017
CSR and ROE	-0.6148	-0.5909	-0.9012*
CSR and ROA	-0.431	-0.5813	-0.7911*
CSR and ROS	0.2238	0.1433	0.0494

Source: Computed * significant at 5% p value

Table 3: Correlation between CSR spending and Firm Performance of Service sector

Particulars	2015	2016	2017
CSR and ROE	-0.4422	-0.2045	-0.083
CSR and ROA	-0.5416	-0.4464	-0.2975
CSR and ROS	-0.7026*	-0.6506*	-0.6063

Source: Computed * significant at 5% p value

It is found that CSR is negatively related to ROE, ROA and ROS in the case of consumer goods companies and service sector companies. In the case of industrial goods companies CSR is positively related to ROS.

The negative relationship of CSR spending with ROE and ROA implies that investors are not bothered about CSR spending or are against it. The positive correlation between CSR spending and ROS in the case of industrial goods may be due to the fact that the companies while purchasing industrial goods may give more preference to CSR driven companies than non-CSR companies.

Analysis 2: CSR Spending of Companies

The Companies Act, 2013 makes it obligatory for companies to spend at least 2% of its average net profit made during the three immediately preceding financial years on CSR activities. The sector to which the company belong to may have an influence on the amount of spending. Accordingly, CSR spending of the 30 selected companies classified into three sectors, namely, consumer goods (CG), industrial goods (IG) and service sector (S) are presented in table 4.

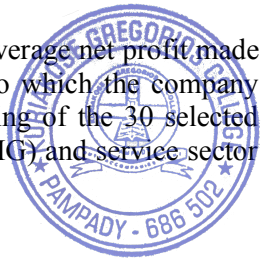


Table 4: CSR Spending of Companies (in percentage)

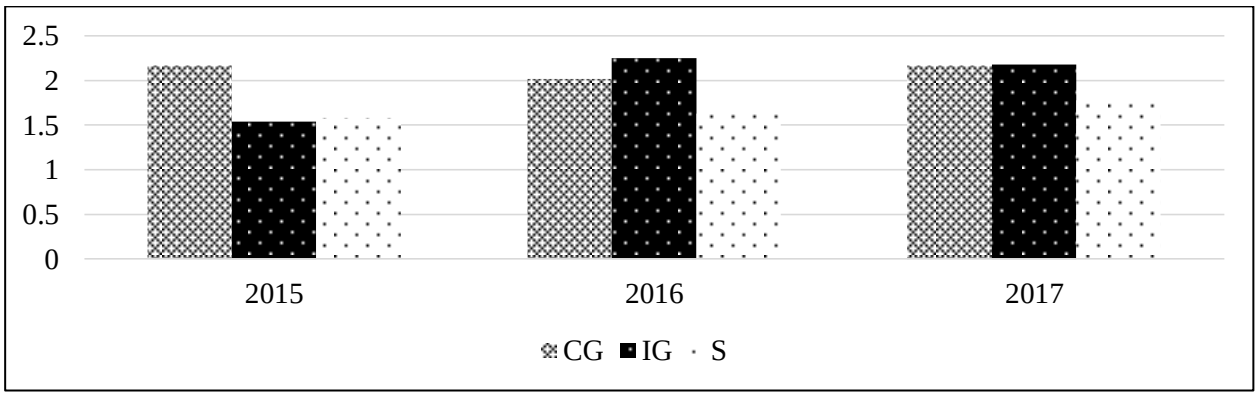
	2015			2016			2017		
	CG	IG	S	CG	IG	S	CG	IG	S
C1	1.27	2.23	1.8	2.04	2.07	1.64	3.51	2.33	1.05

	2015			2016			2017		
	CG	**IG**	**S**	**CG**	**IG**	**S**	**CG**	**IG**	**S**
C2	2	2.37	1.68	2.00	4.00	2.45	2.00	4.00	2.02
C3	2.02	0.41	0.16	2.02	0.63	0.20	2.02	0.78	0.63
C4	2.01	0.89	1.97	2.02	1.70	1.58	2.00	1.14	2.01
C5	2.6	1.02	0.72	2.04	1.71	1.49	2.02	1.49	2.01
C6	2.10	1.21	0.54	2.00	2.30	0.90	2.04	2.26	1.33
C7	2.87	0.78	1.53	2.01	0.74	1.64	2.00	0.56	1.70
C8	2	2.19	3.54	1.77	3.36	2.27	2.01	3.43	2.05
C9	2	1.45	2.07	2.00	3.62	2.05	2.00	2.43	2.90
C10	2.85	2.83	1.74	2.34	2.35	2.06	2.13	3.35	2.14
Avg	**2.17***	**1.54***	**1.58***	**2.02***	**2.25***	**1.63***	**2.17***	**2.18***	**1.78***
	F (2, 27) = 2.116			F (2, 27) = 1.671			F(2,27) = .758		
	p value = .140			p value= .207			p value= .478		

Source: Annual reports of companies
* means average.

CG means Consumer Goods, IG means Industrial Goods and S means Services.
Table 4 shows that there is an increasing trend in CSR spending of companies across sectors though all corporates are not spending the required amount even in the third year of implementation of the CSR rules. In the year 2017, all the companies in the consumer goods sector complied to the CSR rule. t is found that there is difference in the average CSR spending of consumer goods companies, industrial goods companies and services. On an average the consumer goods sector satisfies the mandatory limit in all the years. To test whether the difference is statistically significant or not one-way ANOVA is done taking the null hypothesis that: H0: There is no difference in CSR spending of consumer goods companies, industrial goods companies and services.
It was found that the result was not statistically significant. Hence, it can be concluded that type of industry does not influence CSR spending.

Chart1: CSR Spending of Companies



CG means Consumer Goods, IG means Industrial Goods and S means Services.
Chart 1 shows the average CSR spending of consumer goods companies, industrial goods companies and services for the three years 2015, 2016 and 2017. There is an increase in the spending of consumer goods and services while there is a slight decrease in the case of services.

FINDINGS:

- There is no relationship between CSR spending and corporate performance.
- There is no association between CSR spending and type of industry.

CONCLUSION:

The present study is conducted to know whether there is relationship between CSR spending and corporate performance and whether type of industry influence quantum of CSR spending.

The study found that there is no significant relation between CSR spending and firm performance. It is also found that there is no significant difference in the CSR spending of consumer goods companies, industrial goods companies and services. That is, the type of industry does not influence CSR spending.

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APPENDIX:

List of Companies

Consumer goods	Industrial goods	Services
Asian Paints Ltd.	ACC Ltd.	Bharti Infratel Ltd.
Britannia Industries Ltd.	Ambuja Cements Ltd.	Container Corporation Ltd.
Cipla Ltd.	Bharat Electronics Ltd.	HCL Technologies Ltd.
Colgate Palmolive Ltd.	BPCL	Infosys Ltd.
Dabur India Ltd.	Cummins India Ltd.	Oracle Ltd.
Godrej Ltd.	GAIL (India) Ltd.	Sun TV Ltd.
ITC Ltd.	Hindustan Zinc Ltd.	TCS Ltd.
Marico Ltd.	NHPC Ltd.	Tech Mahindra Ltd.
P & G Ltd.	NTPC Ltd.	Wipro Ltd.
Reliance Industries Ltd.	Tata Steel Ltd.	Zee Entertainment Ltd.

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CORPORATE SOCIAL RESPONSIBILITY PRACTICES OF PUBLIC SECTOR AND PRIVATE SECTOR COMPANIES IN INDIA

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Abstract

Spending on Corporate Social Responsibility (CSR) has been made mandatory, for companies, from the financial year 2014-15, in India. The Companies Act, 2013 has made it obligatory, for companies, to undertake CSR activities and to spend at least two percent of the average profits on CSR. The study was conducted, to know whether there was difference in CSR practices, between public sector and private sector companies. Spending on CSR activities, by the two groups, was compared. The number of independent and woman director in the CSR Committee and number of committee meetings, were studied. T-test and chi-square test were conducted and the results were found not significant. There was no difference in the CSR practices of public sector and private sector companies, i.e., ownership did not affect the CSR practices.

Keywords: *Corporate Social Responsibility, CSR Committee, Independent Director.*

JEL Code: *M140, G300.*

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1. Introduction

Corporate Social Responsibility (CSR) was considered as philanthropy in the early stages. **Carroll (1991)** defined that corporate social responsibility involves the conduct of a business so that it is economically profitable, law abiding, ethical and socially supportive. To be socially responsible means that profitability and obedience to the law are foremost conditions while discussing the firm's ethics and the extent to which it supports the society in which it exists, with contributions of money, time and talent. The Corporate Social Responsibility is considered as the continuing commitment, by business, to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large **(World Business Council of Sustainable Development, 2006).** The importance of CSR emerged significantly, in the last few years, with the introduction of CSR Rules in the Indian Companies Act, 2013. Under section 135 of the Act, "every company, having a net worth of Rs.500 crores or more, or a turnover of Rs.1000 crores or more, or net profit of Rs. five crores or more, during any financial year, has to spend at least two percent of its average net profit made during the three immediately preceding financial years, on CSR activities". There are contradictory views as to the relevance of compulsory spending on CSR. **Carroll (1991)** is of the view that corporations have a social responsibility beyond pure profit whereas **Friedman (1970)** was against the CSR principle, stating that the social responsibility of business is to increase its profits. The present study considers various aspects, related to CSR spending, such as amount of spending, activities undertaken and the CSR Committee.

2. Review of Literature

Melo (2009) found that corporate social responsibility has a long term impact on corporate performance and brand value. **Sharma and Mani (2013)** found that Indian banks are not undertaking much CSR activities. The public sector banks contribute more than private sector and foreign banks. **Jain and Jain (2014)** compared the views of employees of private sector and public-sector companies, regarding the various dimensions of CSR practices like environmental policies, societal policies, company values, human resource policies and market policies and found that employees want their companies to be socially responsible. CSR activities make the companies more sustainable in the long run. **Rai and Bansal (2014)** found that public companies spend more on CSR than private sector companies. Domestic firms spend more on CSR than foreign firms. There is a positive correlation between CSR and profit and the probability of higher spending on CSR increases as the firm becomes bigger. **Das and Pramanik (2015)** analysed the social responsibility disclosure practices of manufacturing companies, using social disclosure checklist, containing 49 items of social information and found that social information items, disclosed in annual reports, were mostly non-financial and descriptive in nature. **Pirzad and Naderi (2015)** examined the relationship between the determinants of CSR and corporate financial performance of listed companies, in Iran and found that only one of the CSR aspects, viz., community involvement, was positively related to the financial performance. **KPMG in India's Reporting Survey (2016)** found that CSR spending of PSU companies had gone up by 12% and that of non-PSU companies, had gone by 15% in 2016. In the sector wise focus of CSR spending, 90% of the companies have projects in the area of education and health, followed by environment and rural development. **Sehar, et al., (2017)** examined the relationship between CSR disclosure and its determinants of listed companies in FMCG sector, in Malaysia, by using CSR index and regression analysis and found that profits and independent directors did have significant influence on CSR disclosure.

3. Statement of the Problem

The Corporate Social Responsibility Rule, in the Companies Act, 2013, is to be followed by the companies, from the financial year 2014-15 onwards. Companies should have a CSR policy and should constitute a CSR Committee. CSR activities are to be disclosed, in the companies' annual report, in the format given in the Act. As there are structural differences between private sector and public sector companies as far as ownership is concerned, the CSR practices of these companies also may be different. Both public sector companies and private sector companies are spending on CSR activities. There may be difference in spending due to the structural differences in the ownership pattern. The public sector companies are more oriented to service rather than profit as compared to private sector companies. This orientation may affect the CSR practices also. Companies have to constitute a CSR Committee, with at least three independent directors. The CSR Committee should meet regularly to discuss CSR activities.

4. Need of the Study

Corporate Social Responsibility has, for the first time, been legally recognized in India. According to the provisions of the Companies Act, 2013, a company is required to spend 2% of average net profit, made during the three immediately preceding financial years on CSR. Before the introduction of mandatory provision for CSR in the Companies Act, many corporates in India contributed to CSR activities voluntarily and all companies followed different CSR strategies. This study is an effort to analyse the CSR practices of selected manufacturing companies.

5. Objective of the Study

The objective of the study was to find out, whether there was any difference in Corporate Social Responsibility practices of public sector and private sector companies, with regard to amount of spending, committees and the CSR activities.

6. Hypothesis of the Study

NH-1: There is no significant difference between the Corporate Social Responsibility practices of private sector and public-sector companies.

7. Methodology of the Study

7.1 Sample Selection

In this study, purposive sampling method was adopted. Twenty manufacturing companies were selected for the study, i.e., ten each from the public sector and the private sector. The manufacturing companies included textiles, telecommunication equipment, cement, automotive, chemicals, computer hardware, and agro-foods etc.

7.2 Sources of Data

The study required information, relating to Corporate Social Responsibility spending, committee and practices. This information was collected from the websites of companies and annual reports, published by the companies.

7.3 Period of the Study

One-year data (financial year 2015-16) were used, for studying Corporate Social Responsibility practices of private sector and public sector companies.

7.4 Tools used for the Study

T-test and Chi-square test were used in the study. T-test was used, for studying the Corporate Social Responsibility spending, number of members in the CSR committee, number of independent directors in the CSR committee and number of CSR committee meetings, held in a year, by public and private sector companies. Chi-square test was used for studying the number of women directors, in the public and private sector companies.

8. Data Analysis

In India, the Companies Act, 2013 made it obligatory, for eligible companies, to spend at

least two percent of its average net profit, on CSR activities. The CSR spending of the selected sample private and public sector companies, is given in **Table-1.** The descriptive statistics of CSR spending indicated that the spending of public sector (2.12%) was little less than that of the private sector (2.27%) manufacturing companies. However, the difference was not statistically significant (t = 0.43013, p = .672209) (**Table-2).** Companies undertake CSR activities, in the areas of education, health, environment, rural development, hunger and poverty eradication, infrastructure development, sports, livelihood and financial inclusion, skill development, disaster relief and so on. The focus area of each company may be different. Both public sector and private sector companies are contributing towards CSR activities. Various CSR activities, undertaken by the sample companies, are presented in **Table-3.** The major activities of CSR spending are education and health, followed by environment. The spending pattern of the companies, under both sectors, is almost the same. The selected companies did not involve themselves in the areas of financial inclusion, sustainability and disaster relief.

The Companies Act, 2013, made it mandatory that the companies must constitute a Corporate Social Responsibility Committee. This Committee has to formulate and suggest the CSR policy, to the Board of Directors, decide on the CSR activities to be undertaken and regularly monitor the CSR policy. There should be at least three directors, in the CSR Committee. The number of meetings of the Committee or the number of members in the Committee, is not a criterion to decide the efficiency of CSR implementation, but these disclosures are important from the angle of accountability and transparency. The disclosures, regarding the number of members in the CSR Committee, are given in **Table-4.** The descriptive statistics shows that the average number of members, in the CSR Committee, is higher in public sector companies (5.4) than that of private sector companies (4.6). However, the difference is not statistically significant (t= -1.97279, p=.06408) (**Table-5).** As per the Companies Act, there should be at least three directors in the CSR Committee in which at least one director shall be an Independent Director**. Table-6** shows the number of independent directors in the CSR Committee of selected sample companies. The descriptive statistics of independent directors, in the CSR Committee, is given in **Table-7**. All the companies have equal to or more than the prescribed number (which is one Independent Director) in the CSR Committee, which is a positive sign. The average number of independent directors was two, for both private sector and public sector companies. Thus there is no difference (t=0, p=1). This Section analyses the number of women members in the CSR Committee. The law does not make the presence of women directors, mandatory. **Table-8** depicts the presence of women directors in the CSR Committee. Presence of women directors was low, in both public sector and private sector companies. The private sector was better than public sector in this regard. The difference is not statistically significant (chi-square=0.9524, p=.329114).

The CSR law is silent with regard to the number of meetings of CSR Committee, in a year. It depends on the requirement of the company. **Table-9** shows the number of CSR committee meetings, held in a year. The descriptive statistics shows that the average number of meetings, held in a year, was higher in private sector companies (2.8) than that of public sector companies (2.2). However, the difference is not statistically significant (t=0.06422, p=.949587) (**Table-10).** On the basis of the results, the null hypothesis, **NH-1:** There is no significant difference in the CSR practices of private sector and public sector companies, is accepted.

9. Findings of the Study

There is no significant difference in the spending on Corporate Social Responsibility, under both public and private sector companies. There was no difference in the CSR activities of private sector and public-sector companies. The spending pattern of the companies, in both sectors, was almost the same. There was no significant difference, in the number of members or independent directors or women directors in the CSR Committees of the companies, in the public as well as private sectors. There was no significant difference, in the number of meetings held in companies, in the public as well as the private sector.

10. Suggestions

The spending of majority companies, irrespective of the sector, was around 2%. It would be better if the companies were to go beyond the statutory minimum. The focus area of CSR spending of these companies was education and health. It would be better if these companies were to do the CSR activities, in their own core area of operation. CSR activities should be built into their business. CSR Committee should undertake socially responsible activities, with their innovative ideas and management skills, instead of focussing on what other companies do.

11. Conclusion

The study was conducted to know whether there was any difference in the Corporate Social Responsibility practices of selected companies, on the basis of ownership. The study found that there was no difference in the CSR practices of public sector and private sector companies. Thus it can be stated that ownership did not affect the CSR practices.

12. Limitations of the Study

The spending on Corporate Social Responsibility of companies was studied, only on the basis of published data. The sample companies were selected only from the manufacturing sector and the study considered only one-year data (financial year 2015-16), for studying the CSR practices.

13. Scope for Further Research

The companies, which undertake Corporate Social Responsibility activities, may enhance the reputation and the financial performance of the company, leading to the enhancement of the firm value. Further research can be done, on establishing the relationship between CSR activity and the firm value.

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Table-1: CSR Spending of the Companies

Private Sector	Rs. (in crores)	%	Public Sector	Rs. (in crores)	%
Apollo Tyres	12.96	1.92	BEL	25.69	2.05
Asian Paints	34.44	1.72	BHEL	110.1	1.99
Bajaj Auto	86.72	2.00	Coal India	73.26	0.56
Cipla	31.88	1.78	GAIL	118.64	2.30
Dabur	17.44	2.02	Hindustan Copper	7.68	2.54
Godrej	5.33	4.51	IOC	156.68	1.99
HUL	92.12	1.71	National Aluminium	27.17	2.07
L & T	119.89	2.36	NTPC	491.8	3.62
Reliance Industries	652	2.34	ONGC	421	1.41
Tata Steel	204	2.35	SAIL	76.2	2.62
Average		2.27	Average		2.12

Source: Annual Reports of the Companies (2015-16)

Table-2: Descriptive Statistics of CSR Spending of the Companies

Descriptive Statistics	Private Sector	Public Sector
Minimum	1.71	0.56
Maximum	4.51	3.62
Range	2.8	3.06
Count	10	10
Sum	22.71	21.15
Mean	2.27	2.115
Median	2.01	2.06
Standard deviation	0.8267	0.7949
Variance	0.6835	0.6319
Mid Range	3.11	2.09
Standard Error of Mean	0.2614	0.2514
Skewness	2.101	-0.1093
Kurtosis	6.043	3.151
Relative Standard Deviation	36.4%	37.59%

Source: Annual Reports of the Companies (2015-16) using SPSS 16.

Table-3: Number of CSR Activities Undertaken by the Companies

Sector	Private Sector	Public Sector
Education & Skill development	10	10
Health & Sanitation	10	10
Environment	6	8
Heritage, art & culture	*	5
Rural development	4	7
Infrastructure development	*	3
Financial inclusion	*	*
Community development	4	*
Sustainability	*	*
Gender equality & women empowerment	4	*
Armed forces	2	*
Disaster relief	*	*
Sports	2	6
Government projects	3	*

Source: Annual Reports of the Companies (2015-16) Note: * - No Activity

Table-4: Number of Members in the CSR Committee

Private Sector	No.	Public Sector	No.
Apollo Tyres	4	BEL	5
Asian Paints	5	BHEL	7
Bajaj Auto	3	Coal India	5
Cipla	5	GAIL	5
Dabur	4	Hindustan Copper	6
Godrej	6	IOC	6
HUL	6	National Aluminium	6
L & T	4	NTPC	4
Reliance Industries	4	ONGC	5
Tata Steel	5	SAIL	5
Average	**4.6**	**Average**	**5.4**

Source: Annual Reports of the Companies (2015-16)

Table-5: Descriptive Statistics of Number of Members in the CSR Committee

Descriptive Statistics	Private Sector	Public Sector
Minimum	3	4
Maximum	6	7
Range	3	3
Count	10	10
Sum	46	54
Mean	4.6	5.4
Median	4.5	5
Standard deviation	0.9661	0.8433
Variance	0.9333	0.7111
Mid Range	4.5	5.5
Standard Error of Mean	0.3055	0.2667
Skewness	0.08872	0.3113
Kurtosis	1.892	2.398
Relative Standard Deviation	21%	15.62%

Source: Annual Reports of the Companies (2015-16) using SPSS 16.

Table-6: Number of Independent Directors in the CSR Committee

Private Sector	No.	Public Sector	No.
Apollo Tyres	2	BEL	1
Asian Paints	2	BHEL	1
Bajaj Auto	1	Coal India	3
Cipla	2	GAIL	2
Dabur	2	Hindustan Copper	4
Godrej	2	IOC	2
HUL	4	National Aluminium	3
L & T	1	NTPC	1
Reliance Industries	3	ONGC	1
Tata Steel	1	SAIL	2
Average	**2**	**Average**	**2**

Source: Annual Reports of the Companies (2015-16)

Table-7: Descriptive Statistics of Number of Independent Directors in the CSR Committee

Descriptive Statistics	Private Sector	Public Sector
Minimum	1	1
Maximum	4	4
Range	3	3
Count	10	10
Sum	20	20
Mean	2	2
Median	2	2
Standard deviation	0.9428	1.054
Variance	0.8889	1.111
Mid Range	2.5	2.5
Standard Error of Mean	0.2981	0.3333
Skewness	0.7955	0.5692
Kurtosis	2.813	1.98
Relative Standard Deviation	47.14%	52.7%

Source: Annual Reports of the Companies (2015-16) using SPSS 16.

Table-8: Presence of Women Directors in the CSR Committee

Sector	Present	Not Present
Private Sector	4	6
Public Sector	2	8
Total	6	14

Source: Annual Reports of the Companies (2015-16)

Table-9: CSR Committee Meetings held in the Year (2015-16)

Private Sector	No.	Public Sector	No.
Apollo Tyres	3	BEL	1
Asian Paints	1	BHEL	1
Bajaj Auto	1	Coal India	1
Cipla	4	GAIL	3
Dabur	4	Hindustan Copper	*No information
Godrej	2	IOC	*No information
HUL	3	National Aluminium	3
L & T	4	NTPC	4
Reliance Industries	4	ONGC	7
Tata Steel	2	SAIL	2
Average	**2.8**	**Average**	**2.2**

Source: Annual Reports of the Companies (2015-16)

Table-10: Descriptive Statistics of CSR Committee Meetings held in the Year (2015-16)

Descriptive statistics	Private Sector	Public Sector
Minimum	1	1
Maximum	4	7
Range	3	6
Count	10	8
Sum	28	22
Mean	2.8	2.75
Median	3	2.5
Standard deviation	1.229	2.053
Variance	1.511	4.214
Mid Range	2.5	4
Standard Error of Mean	0.3887	0.7258
Skewness	-0.3445	1.028
Kurtosis	1.465	2.873
Relative Standard Deviation	43.9%	74.65%

Source: Annual Reports of the Companies (2015-16) SPSS 16.

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BANKING STRATEGY IN THE ERA OF ECONOMIC SLOWDOWN IN INDIA: NEED FOR A THRUST ON ICT INTEGRATION AND HOUSING FINANCE

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Abstract
It is well recognized that at present India is passing through an era of acute economic slump. Hence, there is an urgent need for kick-starting the recession-hit Indian economy from the clutches of slowdown by way of appropriate revival strategies. Given the economic slump on the one hand and the unprecedented challenges faced by the financial system in the country, like, growing NPAs, declining profitability, eroding capital base and there is a marked fall in the growth of credit off-take also. At this crucial juncture, this paper looks into the vital need for a banking strategy that focuses on adoption of Information and Communication Technology (ICT) on the one hand and retail banking thrust with a focus on housing finance on the other hand. While ICT adoption ensures enhanced customer service and operational efficiency, retail banking thrust with a focus on housing finance ensures revival of the economy through linkage effects of housing investments, risk diversification etc. Retail banking is the only feasible strategy for public sector banks (PSBs) in the current era of PSB consolidation. This strategy suits well with the national goal of 'Affordable Housing for All by 2022'.

Keywords: ICT, Digital India, Retail Credit, Housing finance, Linkages, Risk diversification.

Introduction

It is well recognized that at present India is passing through an era of acute economic slump. Recent analyses by many a national and international agency has underscored this fact regarding Indian economy. This trend is in tune with the global economic slowdown also. In this scenario, there is an urgent need for kick-starting the recession-hit Indian economy from the clutches of slowdown This in turn necessitates the adoption of suitable macro level strategies that are capable of initiating an economic revival. Besides the general slowdown in Indian economy, financial system of the country is facing unprecedented challenges, like, mounting NPAs, falling profitability, eroding capital base. Moreover, there has been a marked fall in the growth of credit off-take also. At this crucial juncture, this paper looks into the vital need for a banking strategy that focuses on adoption of Information and Communication Technology (ICT) on the one hand and retail banking thrust with a focus on housing finance on the other hand. While ICT adoption ensures enhanced customer service and operational efficiency, retail banking thrust with a focus on housing finance ensures revival of the economy through the linkage effects of housing investments, risk diversification etc. Retail banking is the only feasible strategy for public sector banks (PSBs) in the current era of PSB consolidation. This strategy suits well with the national goal of 'Affordable Housing for All by 2022'. Better ICT integration augers well with the growing expectations of today's discerning customers; as ICT brings in the added benefit of enhancing the competitiveness of banking products and services, especially the retail banking products like housing finance.

Objectives of the Study

- To make a broad study of the present condition of Indian economy, the slowdown faced by the economy and its implications, and the need for remedial strategies;
- To study the significance of the adoption of Information and Communication Technology (ICT) in delivering retail banking products like housing finance in a competitive environment, and the macroeconomic implications of such a strategy; and
- To suggest strategies for the sustained growth of the retail credit portfolio of banks, especially the housing finance segment, and hence sustained growth of the economy.

Relevance and Significance of the Study

As waves of electronic revolution are sweeping across the globe, fast advances in the field of Information and Communication Technology (ICT), an outcome of the electronic revolution, are invading every facet of human life. ICT adoption is bringing about radical changes in the way in which organizations are being managed, business operations are being performed and state governance is being done. Indian economy is no exception to the above global trend and so also is the case of banking and financial services industry (BFSI) in India. 'Digital India' is a national goal of the country and the fast pace at which ICT advances are embraced by the BFSI sector in India has resulted in rapid growth of the Financial Technologies ('Fin-Tech') entities in India. On the one hand, there is fast-paced ICT integration and a boom in Fin-Tech units. On the other hand, Indian economy

ISSN 2394 - 7780

is facing an acute economic slump and this is reflected in all facets of the economy including the banking sector of the country. Focus on retail advances, particularly housing finance, enables banks to diversify risks, maintain asset quality, reduce bad debts, create employment avenues, and lure the new generation customers. Above all, this strategy helps to kick-start the recession-hit sectors of the economy because of the vast linkages of housing industry. The role of banks in meeting this key goal by fulfilling the housing finance needs of the masses will be more vital in the future, since the market share of housing finance companies (HFCs) that has already been falling.

Relevance and Significance of the Study

Kiran Keswani (1997) [11] in his paper, 'The contribution of building centres to low-cost housing in India' in *Building Research & Information* has studied the reasons for the slow growth in low-cost housing projects in India. The author has suggested that the Government should assume the role of a facilitator rather than a provider. A three-pronged strategy has been suggested for promoting low cost housing viz. (i) examining critically the archaic laws on housing, (ii) disseminating information on technical aspects of house building, and (ii) training in updated technologies on low-cost housing. Peer Smets (1999) [30], in his paper 'Housing Finance Trapped in a Dilemma of Perceptions: Affordability Criteria for the Urban Poor in India Questioned' in *Housing Studies* has argued that a definitional issue associated with formal housing finance and 'eligibility' for the same in terms of 'affordability criteria in one go' has resulted in exclusion of the vast majority of the urban poor from availing finance from formal sources of finance. The author has advocated the need for 'incremental housing' and also the need to assess the 'affordability in a phased in manner' and 'not in one go'. Manoj P. K. (2003) [13] in his research paper, 'Retail Banking: Strategies for Success in the Emerging Scenario' in *IBA Bulletin* has suggested strategies for the sustained growth of the retail credit portfolio of banks, that mainly comprises of housing finance, as a safer way of increasing business and also kick-starting the then recession-hit industry of India. 'Linkages' – both forward and backward – of housing with large number of other industries, and the positive effect of such linkages for bringing about faster economic growth have been pointed out in the paper. Manoj P. K. (2004) [14] in his another research paper, 'Dynamics of Housing Finance in India' in *Bank Quest* has pointed out the growing appetite of commercial banks (CBs) towards housing credit, the falling share of housing finance companies (HFCs) in the market, and allied aspects. Some macro level strategies for the sustained and balanced growth of housing finance in India are suggested. The relevance of promoting secondary mortgage market (like, RMBS), alternative models like Housing Micro Finance (HMF) etc. has been noted. In a Working Paper 19 titled, *Housing Microfinance: Designing a Product for the Rural Poor*, released by Institute for Finance Management and Research (IFMR) (2007)[7], has noted the utmost importance of promoting Housing Micro Finance (HMF) – an alternative model for housing finance for the poor – for addressing India's chronic housing problem, which in turn is primarily that of the poor and marginalized in the country, like the LIG (Low Income Group) and EWS (Economically Weaker Sections). Only models like HMF could cater to such deprived sections that are not served by the formal sector agencies. So, models like HMF are required to solve India's 'real housing problem'. The report seeks to design the suitable HMF model for the Indian poor. Manoj P. K. (2008) [15] in his paper, 'Learning from Cross-country Experiences in Housing Finance: A Microfinance Approach' in *Journal of Global Economy* has suggested suitable macro level strategies for promotion of housing micro finance (HMF) in the Indian scenario by appropriately replicating the successful and time-tested models like HMF or other similar alternative housing finance models prevalent elsewhere in the world. A research paper on HMF by Manoj P. K. (2010)[21], "Prospects and Problems of Housing Microfinance in India: Evidence from "Bhavanashree" Project in Kerala State" in *European Journal of Economics, Finance and Administrative Sciences* has studied in detail the utmost importance of HMF for balanced and equitable housing development in India, and hence rapid economic development of the country. Strategies for promotion of HMF in India have been suggested, along with specific and category-wise strategies for the HMF based in Kerala and sponsored by the state government namely 'Bhavanashree'. Manoj P. K. (2010) [18] in his paper, 'Benchmarking Housing Finance Companies in India: Strategies for Enhanced Operational Efficiency and Competitiveness' in *European Journal of Economics, Finance and Administrative Sciences* has made a detailed analysis of the relative competitive position of the leading housing finance companies (HFCs) in India and has suggested strategies for the enhanced operational efficiency and competitiveness of HFCs.

The management consultancy organization, KPMG (2010) [11], in its Industry Report (Advisory), '*Affordable Housing – A key growth driver in the real estate sector?*' has sought to discuss the immense growth prospects of real estate players in the affordable housing market in India, given the huge demand and grossly under-penetrated market, very favourable Governmental policies etc. The demand and supply constraints, the

ISSN 2394 - 7780

relevance of PPP in the real estate sector etc. have also been dealt in detail. In a paper by Manoj P. K., (2010) [19] 'Determinants of Successful Financial Performance of Housing Finance Companies in India and Strategies for Competitiveness: a Multivariate Discriminant Analysis' in *Middle Eastern Finance and Economics*, has attempted to find the determinants of superior financial performance of HFCs. Using the tool Multivariate Discriminant Analysis (MDA), Discriminant Function having five distinct parameters (selected from the total 21 parameters used for MDA) which significantly influence the financial performance of HFCs has been derived. Yet another paper by Manoj P. K. (2010) [17], 'Financial Soundness Housing Finance Companies in India and Determinants of Profitability: A 'CAMEL' Approach along with ROE Decomposition Analysis' published in *International Journal of Business Policy & Economics* has employed the methodology of 'CAMEL' ranking along with ROE decomposition analysis to identify the determinants of profitability of HFCs. A research paper by Manoj P. K. (2011) [22], 'Determinants of Profitability of Housing Finance Companies in India and Strategies for Competitiveness: a Multiple Partial Correlation Approach' in International Journal of Business Intelligence and Management has suggested competitive strategies for various groups of HFCs with the help of the basic parameters that significantly influence the respective groups of HFCs.

A joint research paper by Hrushikesh Mallick & Mantu Kumar Mahalik (2015)[5] 'Factors determining regional housing prices: evidence from major cities in India', in *Journal of Property Research* has sought to identify the factors determining the housing prices with respect to 15 major cities in India using data relating to 16 Quarters (4 years, 2010 to 2013). It has been noted that fundamental factors are more significant than speculative factors. In a research paper by Manoj P. K. (2015) [25], "Socio-Economic Impact of Housing Microfinance: Findings of a Field-based Study in Kerala, India", published in *International Research Journal of Finance and Economics*, the reasons for the failure of 'Bhavanashree' – the HMF initiative of the Government of Kerala have been studied in detail. The author suggests strategies for effective implementation of HMF projects based on the "learning from the failure of 'Bhavanashree' project" in Kerala. The research report by the agency IFMR (2015) [8] entitled as *Affordable Housing Finance Sector: Overview* makes a detailed analysis of the need, relevance and significance of affordable housing in India in the context when the national goal of 'Affordable Housing for All by 2022' is implemented by the Government of India. The crucial role that HFCs have to play in this context is specially noted in the IFMR report. The fact that there is a gradual re-emergence of HFCs since 2013, thus overtaking the CBs in growth rate and significantly improving their market share has been specifically pointed out. In a paper by Manoj P. K. (2015) [23], "Deterrents to the Housing Microfinance: Evidence from a Study of the Bankers to 'Bhavanashree' in Kerala, India", in *International Research Journal of Finance and Economics*, the major problems associated by the bankers in financing 'Bhavanashree', the HMF initiative of the Government of Kerala, has been dealt in detail. Various issues like the unclear land tenure, fragile institutional framework of the HMF and its parent (mentor) 'Kudumbashree' etc. have been studied in detail. Suggestions have been made to the Government based on the findings of the study, for the purpose of enabling more meaningfully implement HMF initiatives in the future, 'Bhavanashree' initiative being more or less a failure. In a research article by Manoj P K (2015) [24], "Housing Microfinance: A Study on Quality, Cost and Default Rate with Respect to 'Bhavanashree' in Kerala", in *International Research Journal of Finance and Economics*, a detailed and critical study of the asset quality, administrative (transaction) costs, and default rates in respect of the HMF initiative of the Government of Kerala ie. 'Bhavanashree' has been made. Suggestions are made for more effective implementation of HMF projects by the Government. Another paper by Manoj P. K. (2016) [26], "Real Estate Investment Trusts (REITs) for Faster Housing Development in India: An Analysis in the Context of the New Regulatory Policies of SEBI" in *International Journal of Advance Research in Computer Science and Management Studies* has made an exploratory study of the utmost relevance of REITs in a developing country like India for promotion of its housing and real estate sector and hence the whole economy. BCG (2018) [2] in its report, *Digital Lending* has sought to highlight the immense opportunity for digital lending in India. According to BCG, it is a USD 1 Trillion opportunity over the next 5 years and the stakeholders can utilize the same. Industry research agency, India Brand Equity Foundation (IBEF) (2018) [6] in its report on Real Estate industry in India has pointed out the tremendous growth prospects of the real estate industry in India which is estimated to attain the size of USD 1 Trillion by 2030. Its estimated size as of 2019 is 3.7 Million Square feet and it is the fourth largest sector in terms of FDI flows. Rapid urbanization, growing affordability, and Governmental commitment to attain 'Affordable Housing for All' etc. brighten the prospects of India's real estate sector.

In view of the foregoing discussions, it is noted that though there are a number of studies on housing finance, studies that focus on the need for ICT integration in the context of retail banking like housing finance are

ISSN 2394 - 7780

scarce. This study seeks to bridge this research gap and it studies the need for a banking strategy that focuses on ICT adoption and housing finance.

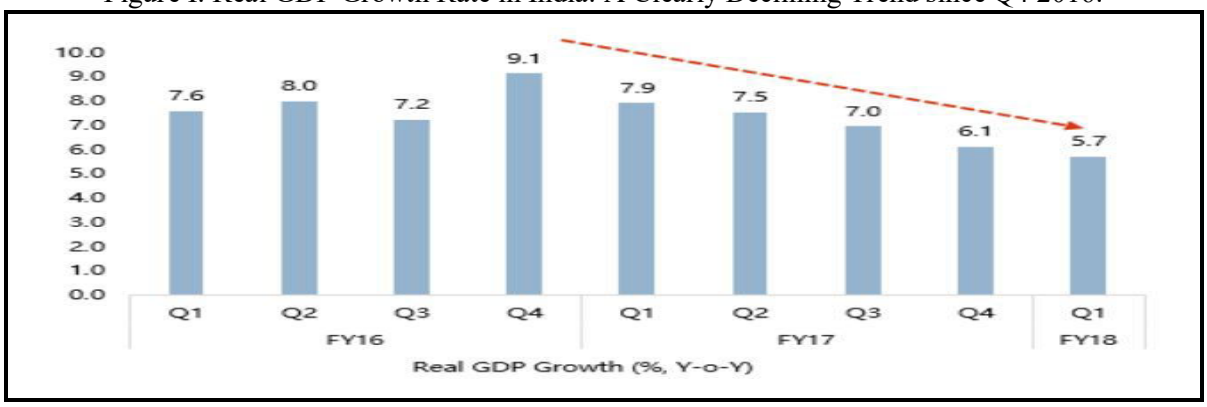
Methodology of the Study

The study is descriptive-analytical and exploratory in nature. It is descriptive as it describes the developments in the field of retail banking with a focus on housing finance. The paper is analytical too as it analyzes the relevance of a banking strategy that focuses ICT adoption and retail banking, for tiding over the present slump in the Indian economy. The present study is primarily based on secondary data from authentic sources like RBI, NHB, and CRISIL.

Current Status of the Economy, Banking System and Housing Situation in India

There is a steadily falling trend in respect of GDP of India over the last few quarters and this is very prominent since the fourth quarter of 2016 (Q4, 2016) (Figure I) and this falling trend is expected to continue in FY 2019 also.

Figure I: Real GDP Growth Rate in India: A Clearly Declining Trend since Q4 2016.



Source: CRISIL (Sept. 2018) [3]

It may be noted that there has been a declining trend in the financial stability of banks in India, particularly the public sector banks (PSBs) as is evident from the fast eroding capital base and also near-zero and negative return on assets (ROA) (Table I). This in turn points to the need for a revival in the banking sector, particularly among the PSBs which still the backbone of the Indian financial system in spite of their declining share in the banking business. Higher exposure to relatively less risky advances like housing finance ensures greater business growth and better profitability because of better asset quality or lower NPAs.

Table I: Return on Assets (ROA) of Major PSBs in India

Sl. No.	Names of Major PSBs in India	ROA (Percent)
01.	Allahabad Bank	-0.10
02.	Bank of Baroda	-0.41
03.	Bank of India	-0.52
04.	Central Bank of India	-0.24
05.	Corporation Bank	0.003
06.	Dena Bank	-0.66
07.	Indian Overseas Bank	-0.87
08.	IDBI Bank	-0.76
09.	Oriental Bank of Commerce	0.08
10.	Syndicate Bank	0.24
11.	UCO Bank	-0.63
12.	United Bank of India	0.14

Source: *Mathrubhumi,* Daily [Print], Kochi Ed., dt. 20.02.2018

Considering the housing finance segment of banks which is one of the major components of retail credit, it may be noted that there is enough scope for promoting it. In fact, the mortgage to GDP ratio in India is still at a very low level of about 9 percent (as of 2012, and it is about 10 percent as of 2018) and is one of the lowest in the whole world. This fact points to the scope for promoting the housing finance portfolio of banks. (Table II).

ISSN 2394 - 7780

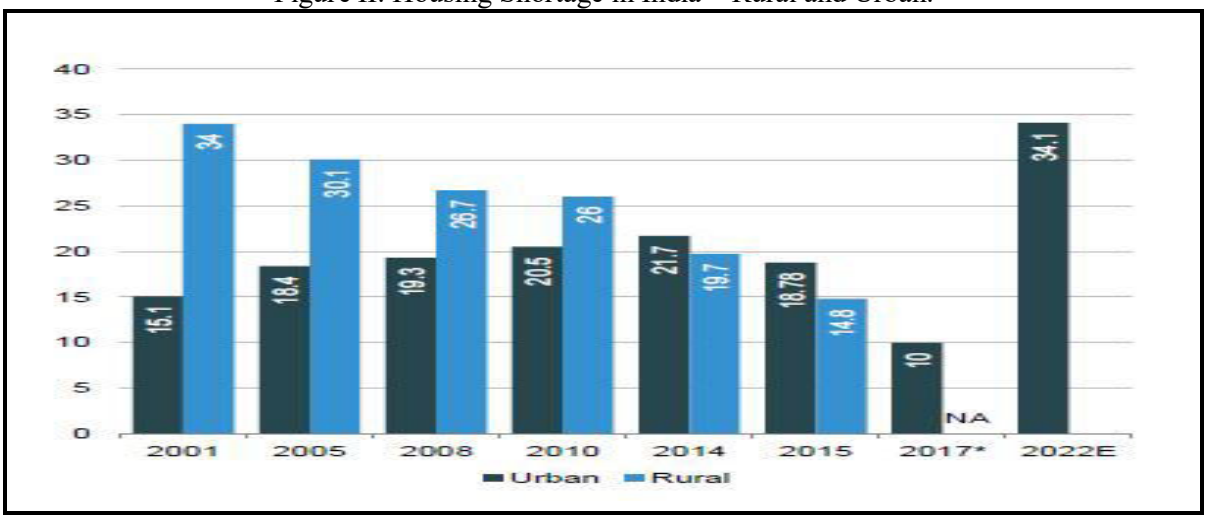
Table II: Mortgage to GDP Ratio of India vis-a-vis Selected Other Countries
(In Percentages)

India	China	Thailand	Korea	Malaysia	Singapore	Taiwan	Hong Kong	USA	UK
9.0*	12	17	26	29	32	39	41	80	86

Source: European Mortgage Federation (2007), Asian Development Bank (2007) & NHB (2013).
Note: * NHB, as of 2012 (approx.), Report on Trend and Progress of Housing in India, 2013, p.105.

Because, housing shortage is a reality in India even after 70 years of independence. Though there is a gradually falling trend in housing shortage in rural India, it is still acute in urban areas of the nation and is showing a generally growing trend over the years. (Figure II).

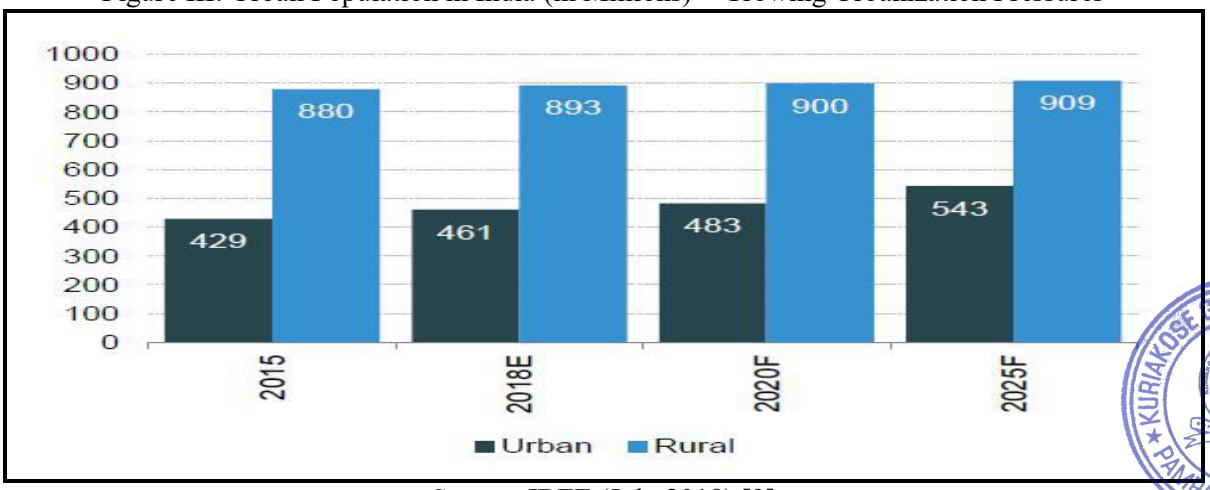
Figure II: Housing Shortage in India – Rural and Urban.



Source: IBEF (July 2018) [9]

Urban housing problem in India growing because of the growing urbanization in the country. The national goal of 'Affordable Housing for All by 2022' gives another dimension to the urgent need for solving the growing urban housing problem. Further, this fact points to the need for focusing on urban areas for housing finance because urban housing problem is more acute in India. (Figure II & Figure III).

Figure III: Urban Population in India (in Millions) – Growing Urbanization Pressures

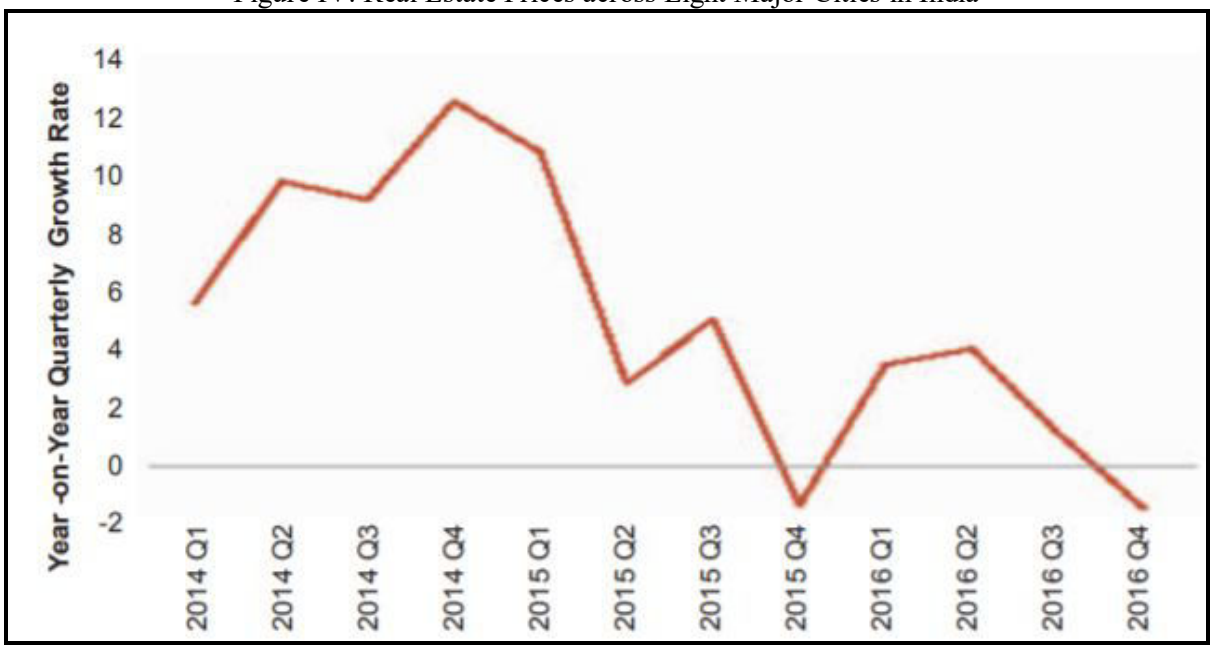


Source: IBEF (July 2018) [9]

There is only a constantly falling trend in the real estate prices across eight major cities in India (Figure IV). This suggests that major cities in India have almost saturated as far as housing and residential real estate development is concerned. While focusing on solving the housing finance needs of the urban populace, there is a need to pay more attention to the suburban areas (eg. Tier II and Tier III cities) where the scope for housing development is more, particularly the affordable housing segment which is a priority area in India, going by the national commitment of the Government of India viz. *Affordable Housing for All by 2022.*

ISSN 2394 - 7780

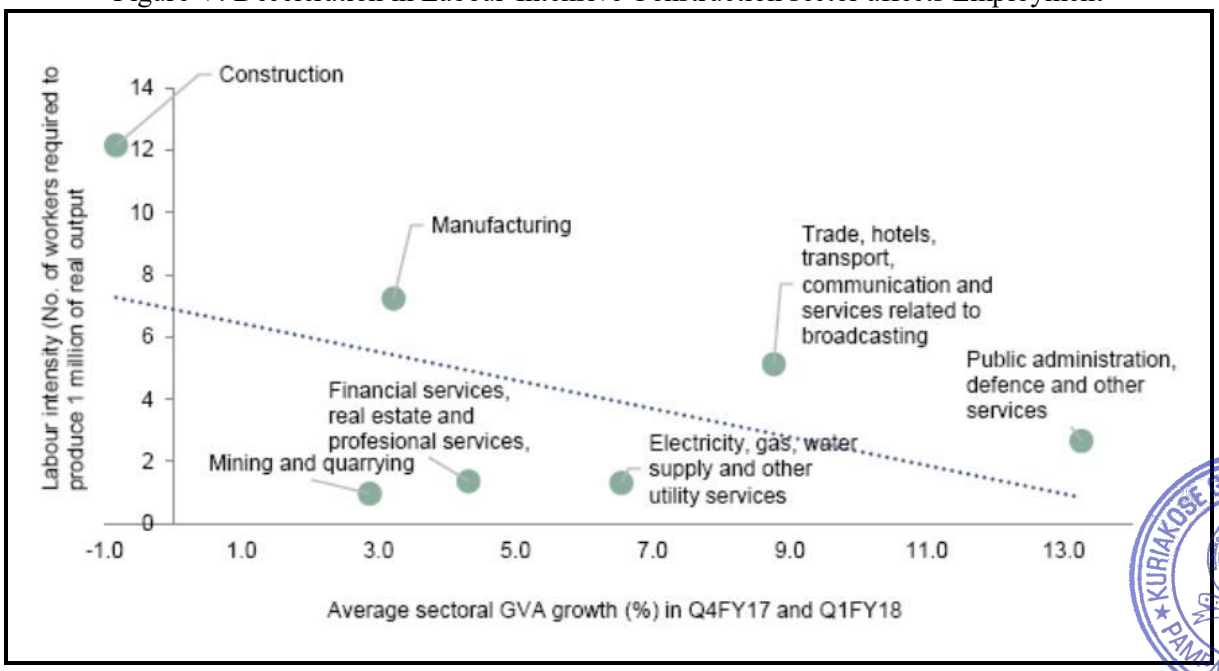
Figure IV: Real Estate Prices across Eight Major Cities in India



Source: *Knight Frank* and *Economic Survey 2016-17*; Adapted from, NHB (2017) [33]

The general slump in the construction industry in India, which includes primarily the housing construction industry affects the employment creation in the country because construction is one of the most labour-intensive sectors and it requires as high as 12 workers to produce Rs. 1 million worth output. Deceleration in housing construction sector hence would adversely influence the employment generated in the country. Or, in other words, promotion of housing construction in India has a vital role (Figure V).

Figure V: Deceleration in Labour-Intensive Construction sector affects Employment

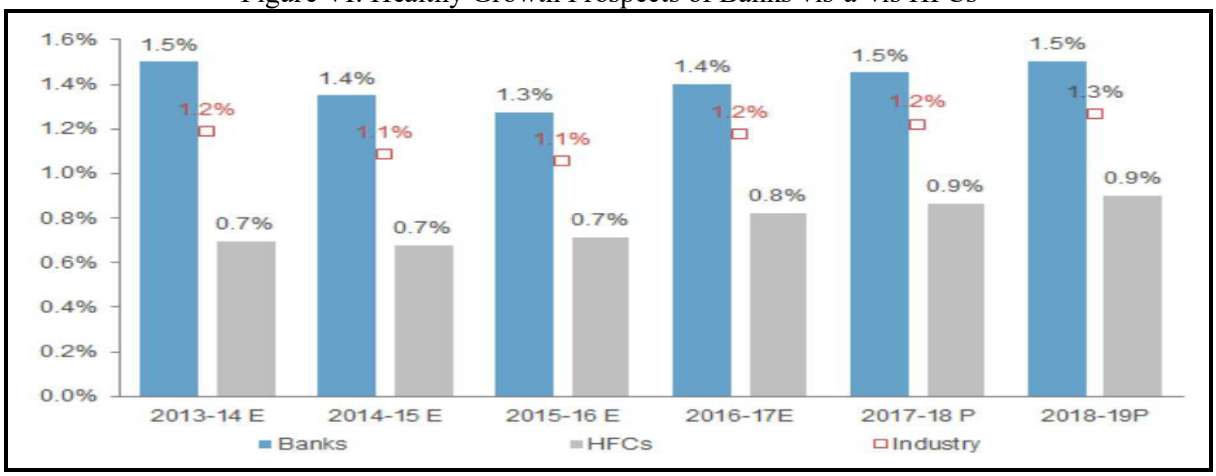


Source: CRISIL (Sept. 2018) [3]

The housing loan market in India has been growing over the years and the trend is likely to continue in the future also; the two major players in this market being Commercial Banks ('Banks' in short) and Housing Finance Companies ('HFCs', in short). In view of the liquidity issues of NBFCs (including HFCs), Banks will have a greater role in the housing finance market in the future. It is noted that banks would have higher growth prospects than the HFCs, because of a reversal in the growth rates of HFCs vis-à-vis Banks. (Figure VI).

ISSN 2394 - 7780

Figure VI: Healthy Growth Prospects of Banks vis-à-vis HFCs



Source: CRISIL (2018) [4]

Better ICT Integration by Banks in 'Digital India' Era: Need and Implications

Reforms initiated in Indian banking sector since 1992 has resulted in this sector, which was overwhelmingly dominated by the Government-controlled Public Sector Banks (PSBs) and significantly oriented towards fulfilling certain social obligations till then, to work on business lines. Like private sector banks and foreign banks, PSBs too started working on business lines, based on profitable business models. The pressures of 'LPG' (Liberalization, Privatization and Globalization) could succeed in injecting 'commercial sense' and 'profit orientation' in Indian banking sector, primarily the PSBs. LPG has brought about fierce competition too. To withstand competition and to maintain profitability and market share in the globalised markets it has become essential for banks to deliver high quality service at low cost. The real impetus towards ICT adoption in India was basically the banking sector deregulation measures initiated in 1992. A serious thrust on ICT adoption was given by the Reserve Bank of India (RBI) only in 1999-2000, because of two reasons. First, for the specific purpose of a smooth transition for the year 2000. Second, for the general purpose of ensuring overall technological upgradation of Indian banks essentially to facilitate payment and settlement, enhanced customer service and profitability. Of late, the Demonetisation (DeMo) drive since 08th Nov. 2016 by the Government of India has given another impetus for ICT adoption by banks. Modern customers being very discerning, customer centricity is a vital need for business success. So, ICT integration has become an imperative for survival and growth, particularly in respect of retail banking products. The growing trend of ICT adoption in the ongoing era of 'Digital India' has vital impact on the operations and business models of banks in India. The rapid pace of technological innovations would radically change their business models for retail banking including housing finance. Indian banking sector has been following the above global trend only since the 2000s. Of late, the ongoing consolidation process among the PSBs has given another need for ICT integration. Though, Indian banks have been quite late in adopting ICT and other technological innovations, of late, there has been growing adoption of digital banking by banks in India. (Figure VII). BCG's report (2018) [2] has noted that digital banking will exceed USD 1 Trillion over the next 5 years, and that retail banking portfolio of banks has witnessed a CAGR of about 16 percent over the last 5 years. It is noted that total retail loans that could be disbursed digitally in the next 5 years would be over USD 1 Trillion. Annual disbursements 5 years hence would be 5 times of current levels. (BCG, 2018)[2].

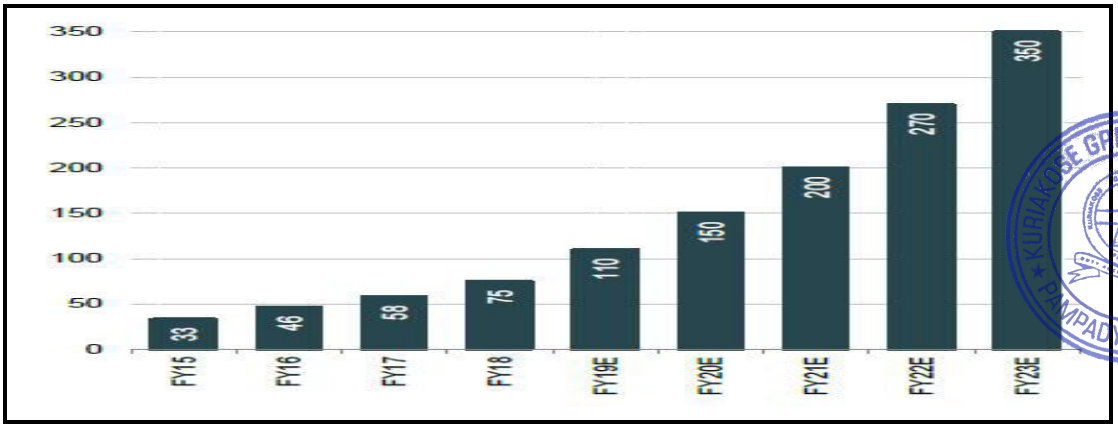


Figure VII: Digital Lending by Banks in India (USD Billion). (Source: IBEF, 2018)[9].

ISSN 2394 - 7780

BCG's study has noted that the digital footprint (i.e. access to internet) of customers in the financial services category is 50 percent. Of the customers with digital footprint, 55 percent have been noted to be digitally influenced. That is, 28 percent (i.e. 55 percent of 50 percent) of the total population are digitally influenced. Besides, of the customers with digital footprint, 47 percent are digital purchasers. Thus, 23 percent (i.e. 47 percent of 50 percent) of the total population are digital purchasers. That is, as high as 82 percent of the digitally influenced customers are digital purchasers. So, the drop-off is very less. (Figure VIII). (BCG, 2018) [2].

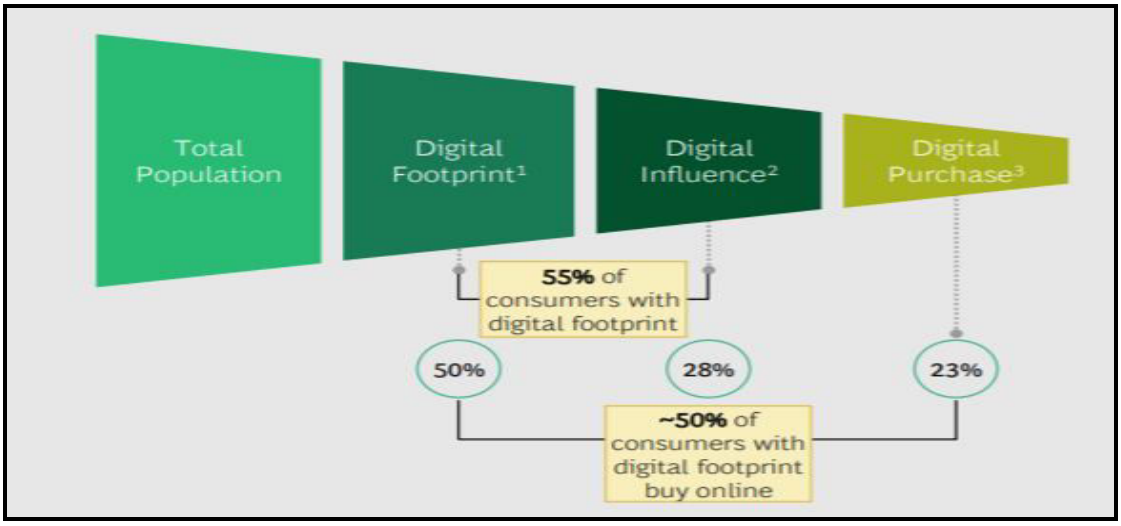


Figure VIII: Nearly one-fourth (23 percent) customers purchase retail loams digitally.
(Source: BCG Google 2018 Digital Lending Survey (N=2364)[2].

It is noted that there is a gradual but definite shift towards various digital channels from the traditional channels in the banking industry in India as is evident from the high positive growth rates over the years. At the same time, there is a gradual fall in the transactions by way of physical branches and this is reflected in the high negative growth rates year after year. Regarding the use of ATMs also, there has been a falling growth rates over the years and of late it is estimated as negative also for FY 2018. Hence, it may be inferred that there is clear and definite shift towards different transactions from the conventional 'brick and mortar' banking and even the transactions through ATMs are less preferred by the highly discerning modern customers. (Figure IX).

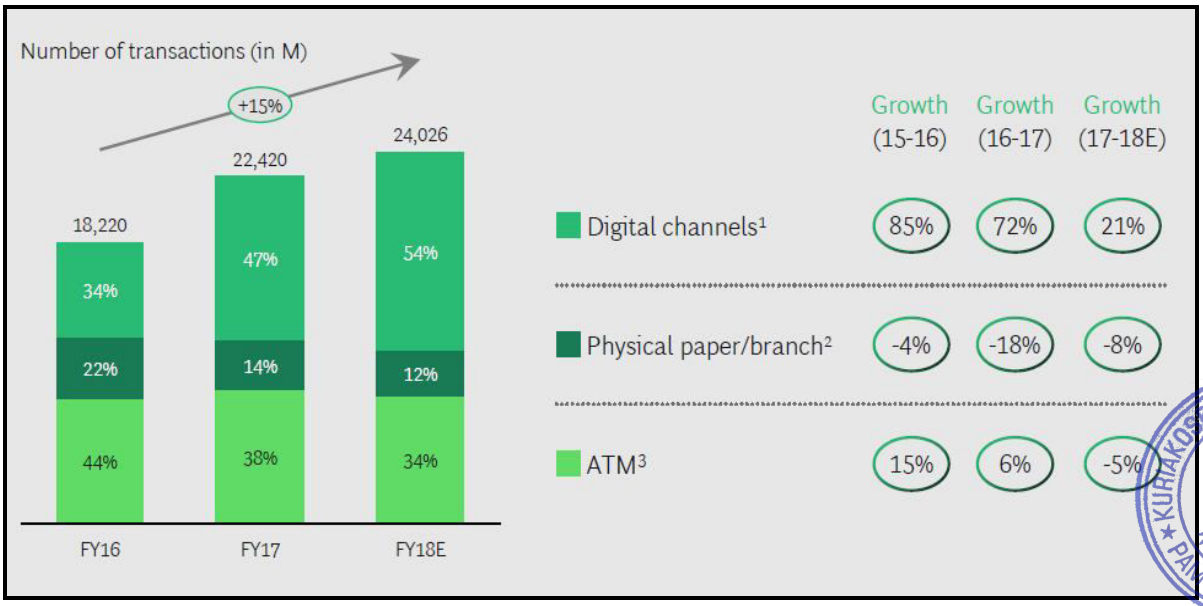


Figure IX: Fast Shift in Transaction Profile of Banks.
Source: BCG Google 2018 Digital Lending Survey (N=2364), p.15. [2].

Among the various digital channels for delivery of banking products, mobile banking is becoming more popular. This is particularly true in respect of rural customers because rural tele-density is constantly on the rise in India. Hence, for faster promotion of various retail banking products, the use of delivery channels like mobile banking makes good business sense; as the modern customers prefer such delivery channels.

ISSN 2394 - 7780

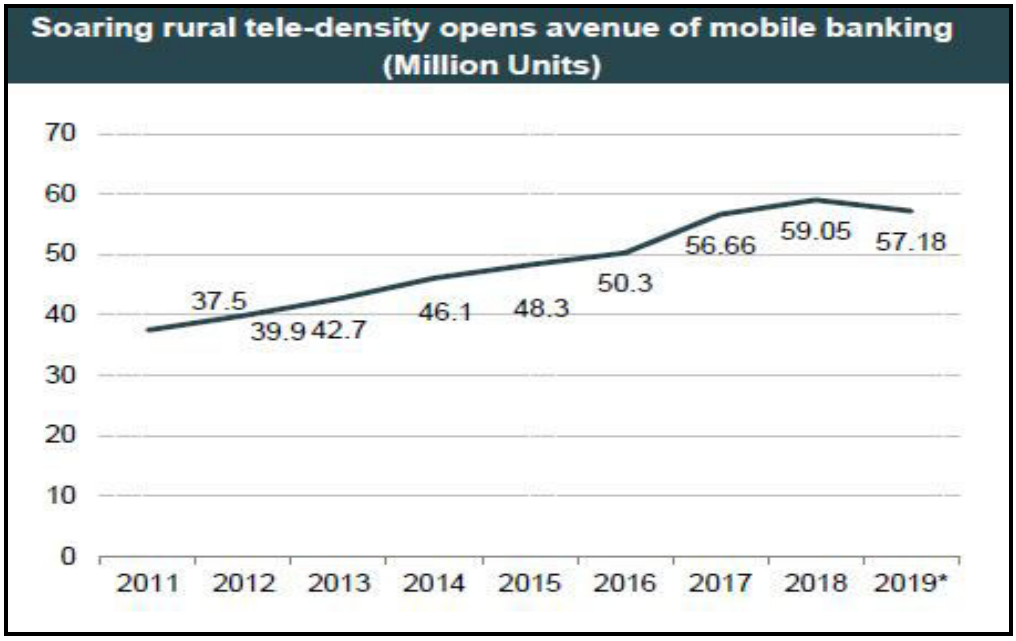


Figure X: Growing Rural Tele-density – Better Scope for Mobile Banking.
Source: IBEF, 2018 [9].

The disposable income and hence the purchasing power of the rural population is on the rise in rural areas. Hence, a focused approach towards promoting various retail banking products including housing loans in rural areas, is advisable. This approach ensures that economic activities in the country are of balanced and equitable nature. (Figure XI).

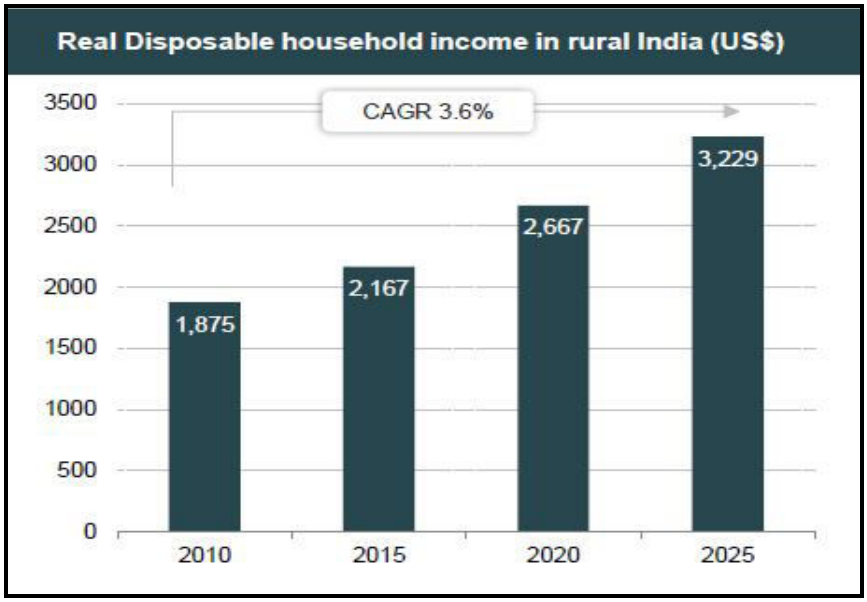


Figure XI: Rising Real Disposable Income in Rural India. (USD).
Source: IBEF, 2018 [9].

Medium Term Strategy for Banks in 'Digital India' Era: Some Suggestions

Taking into account the national goal of 'Affordable Housing for All by 2022' in India and also the 'Digital India' initiative, of the Government of India and hence having a pan-India presence, let us now try to design the medium term strategy for the banks that can take care of the national goals and at the same time help tide over the present situation of economic slowdown. Whether the economic slump is cyclical or structural in nature, investment in housing can act as a suitable remedial strategy. So, promotion of retail credit by banks, particularly housing credit is meaningful, especially when we consider the vast linkages of housing industry with not less than 269 allied industries. Investment in housing can kick-start many a recession-hit sector in the economy and is a top employment generator also. Hence, the medium term banking strategy should be that of 'retail credit with housing finance thrust'. Another vital need for the banking strategy is that of ICT integration. ICT ensures better competitiveness, significantly improve operational efficiency by reducing cost, and can

ISSN 2394 - 7780

enable better customer service also. Modern ICT-based tools like data mining can be of immense use because of their ability to generate relevant knowledge from large amounts of unorganized business data.

Another vital need for the banking strategy is that of ICT integration. ICT ensures better competitiveness, significantly improve operational efficiency by reducing cost, and can enable better customer service also. Modern ICT-based tools like data mining can be of immense use because of their ability to generate relevant knowledge from large amounts of unorganized business data. Moreover, given the imminent invasion by the financial technologies (Fin-Tech) companies and also the ever growing expectations of today's discerning customers, banks have to constantly innovate their products and services, particularly in respect of the retail banking portfolio. Here, ICT acts as the means (enabler) and also the end. So, from the viewpoint of competition too ICT integration at all levels, especially in respect of retail credit, is an imperative for the survival and growth of the banks.

Public sector banks (PSBs) and Old Private sector Banks (OPBs) have to pay more attention to ICT adoption because they often lag behind the New generation Private sector Banks (NPBs) and Foreign Banks (FBs) in ICT adoption. This in turn enables them to catch up with NPBs and FBs in customer service and operational efficiency; especially in respect of retail credit wherein customer service and control of operating costs are vitally significant.

There is another reason for the PSBs to take special interest in retail credit. As consolidation process is going on among the PSBs, the only feasible strategy that can 'keep them moving' in the short and medium terms is that of focusing on retail credit with due respect to ICT integration and constant product innovations. Focusing on large corporate or industrial advances or on project financing by these PSBs which are already heavily burdened with the issues of bad-debts (NPAs) and falling profitability and productivity will not at all be sensible in the short or medium term. Identifying their synergies and designing suitable business models would require some more time during which they can focus on retail credit.

PSBs need to be especially cautious in this regard. As consolidation is going on among the PSBs, the latest being the consolidation among 10 PSBs with a view to retain the large 4 PSBs alone (viz. PNB, CB, UBI and IB), the only feasible strategy that can 'keep them moving' in the short and medium terms is that of focusing on retail credit with due respect to ICT integration and constant product innovations. Focusing on large corporate or industrial advances or on project financing by these PSBs which are already heavily burdened with the issues of bad-debts (NPAs) and falling profitability and productivity will not at all be sensible in the short or medium term. Identifying their synergies and designing suitable business models would require some more time during which they can focus on retail credit.

Use of advanced ICT platforms that can support competitive tools like data mining and knowledge discovery is very desirable for any progressive bank for its survival and growth. Such platforms enable high level of customer engagement and facilitate targeting different customer segments with tailor-made products. Modern payment technologies like RFID (Radio Frequency Identification) need to be adopted to remain competitive in the market. ICT investments, further, should focus on improving responsiveness, resiliency and enterprise-wide collaboration. Strategic tie-ups and resource sharing among the banks can bring in enhanced efficiency in the use of technology. This is especially relevant for the PSBs which are undergoing consolidation. Among the various digital channels of service delivery by the banks in India, mobile banking deserves special attention as the use of the same is fast picking up, particularly in the rural areas of India.

Customer centricity has a vital role to play in banking industry in the future. Sustainable business models that ensure continued customer loyalty or long term relationships have to be followed consistently by all banks, including 'traditional' banks like PSBs and OPBs. Owing to their 'high-tech' nature, NPBs and FBs are far ahead of PSBs in ICT adoption. So, in view of the growing competition in banking industry adoption high-end technological platforms becomes an imperative for the PSBs for their survival and growth.

Huge investments in ATMs are not advisable for banks as the growth rate in the use of ATMs is gradually on the decline. Similar is the case of physical branches in which case also a consolidation would be more desirable. Because of the fast advances in ICT and also the discerning nature of modern customers, innovation of all types on an ongoing basis is a vital for retaining and attracting the customers. So, every product needs to be designed meticulously based on a clear understanding of the customer's quality value proposition. Banks need to focus on specialized customer segments, as a 'one-size-fits-all' policy no longer appeals the modern customers. To identify the target customer segments banks have to adopt scientific market research studies and use advanced ICT tools like data mining.

ISSN 2394 - 7780

Given the discerning nature of modern customers, provision of more high technology (Hi-Tech) products and delivery channels is an imperative for survival and growth of any bank, rather than a choice. The growing trend in computer literacy and the ever-growing affinity to modern products among the younger generation make the above strategy more meaningful. Also, it is essential to effectively defend the threat by specialized (niche) players, including the Fin-Techs which are growing fast.

With growing adoption of ICT-based applications, there are mounting trend in scams, information/cyber security issues, data leakages, frauds etc. So, setting up robust systems for risk management relating to information/cyber security should be a top priority for all banks.

From the part of the Government, it is advisable if it encourages a dynamic secondary market for housing finance, like, residential mortgage backed securitization (RMBS) is yet to emerge in India. The Government has to facilitate a vibrant RMBS market in India so that it acts as a new source of finance for the housing sector, particularly for the HFCs which are grappling with liquidity problems. Equally important is the need to promote the real estate investment trusts (REITs) in India. This in turn would promote the commercial real estate directly; and residential real estate too, but indirectly. Conscious efforts for encouraging the market innovations like RMBS and REITs are required in India for housing development. Special focus on residential REITs (those focusing on residential buildings) is an urgent need.

Given the growing disposable income and hence purchasing power of the rural population in India and after all the constantly growing rural tele-density, it is advisable to have a special focus on rural customers. Hence, rural banking should become a business strategy rather than a regulatory compulsion. As noted earlier, channels like mobile banking is quite effective in rural areas also as is evidenced by its constantly growing penetration.

Whatever is the level of ICT adoption, any banking service needs to have a human touch in order to be holistic and comprehensive. This 'human factor' in banking services must ensure adequate customer touch points for all products by way of meticulous planning.

All the above strategies have direct impact on the technological platform of the respective banks. A few other relevant strategies that can ensure superior performance of banks include, inter alia, enhanced transparency and strict corporate governance, enlarged accountability, adoption of international standards in accounting and reporting etc. More flexibility in human resource management (HRM) policies is required, especially for the PSBs and OPBs. This enables low cost and more flexible labour options (like, off-shoring). Besides, provisions to attract and retain the talent are required, which in turn may need more functional autonomy for the banks.

Concluding Remarks

In spite of issues like growing NPAs, need for recapitalization etc., particularly for the PSBs in India, it may be noted that still Indian banking system is adequately stable, resilient and reasonably equipped to comply with global regulatory norms. When NBFCs (including HFCs) are grappling with problems of liquidity, asset-liability mismatch, falling profitability and so on, banks in India are still healthier and more stable. However, banks in India have to play a greater role in the current situation of the country that is characterized by economic slowdown. Almost every sector in Indian economy is facing a slump, and the growingly worsening case of NBFCs (including HFCs) is no exception here. Notwithstanding the fast growth of digital transactions in India, regarding ICT adoption by banks in India, there appears to be good scope for improvement, particularly in respect of PSBs – still the backbone of the Indian banking system, in spite of their losing prominence. In fact, ICT upgradation and consolidation in banking industry are mutually reinforcing in nature and results in significant cost savings for the respective banks, which are mostly the PSBs. Need for restructuring the banks by adopting stronger customer orientation with robust technological platform assumes vital significance today. The recent governmental policies are all in the right direction. Focus on retail credit products like housing finance ensures better credit off-take during this slowdown phase and will also enable gradual recovery of the whole national economy because of the vast linkage effects. ICT adoption makes the whole process as above more cost-effective, transparent and customer-friendly.

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PROMOTION OF RETAIL BANKING WITH A FOCUS ON HOUSING FINANCE: AN IMPERATIVE FOR BANKS IN INDIA AND ALSO THE WHOLE ECONOMY

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Abstract
As Indian economy is passing through an economic downturn, there is a vital need for suitable anti-cyclical economic policies which are capable of kick-starting this recession-hit economy. Coupled with the above need, India is committed to attain the national goal of 'Affordable Housing for All by 2022'. In the above context, construction of houses and other residential buildings needs to be promoted which in turn underlines the relevance for promoting housing finance. Housing finance denotes one of the most important segments of retail credit. Given the economic slowdown in general and crisis in banking sector in particular, this paper studies the need for aggressive promotion of retail banking in India, particularly housing finance, for the faster growth of the Indian economy; primarily because of the vast linkages of housing industry with nearly 269 other industries, and also its high employment potential. The paper offers strategies in the above direction.

Keywords: Retail Credit, Housing finance, Risk diversification, Linkages, Employment, ICT.

1. Introduction

It is well recognized in the literature that housing and residential real estate sector has huge potential for economic development of any nation, apart from the social development role of this vital sector of an economy. This is particularly true in respect of developing nations like India. In the present context when Indian economy is passing through an economic slowdown which is characterized by crisis in the banking sector as well, need for promotion of housing development becomes more meaningful. Coupled with the above logic, the fact that India is already committed to the national goal of '*Affordable Housing for All by 2022*' makes the strategy for promotion of housing finance more meaningful in the Indian context. The case of promotion of retail banking products with a focus of housing finance as strategy for revival of India's banking sector which is under crisis now, and also kick-starting Indian economy which is passing through a slump, needs to be considered in the above backdrop.

2. Objectives of the Study

(i) To make an overall study of the present status of Indian economy as it passes through an economic slowdown, the status of its banking sector and also the housing situation;

(ii) To study the relevance of promotion of retail banking products by banks in India with a focus on housing finance, for the sustained growth of the national economy; and

(iii) To suggest strategies for the sustained growth of retail banking portfolio of banks, particularly housing finance, and hence sustained growth of the national economy.

3. Relevance and Significance of the Study

First, the vast forward and backward linkages of housing and residential real estate industry with 269 other industries enable it to promote faster and balanced economic development of a nation. This is especially relevant for developing nations like India where the housing shortage is severe. Housing and real estate industry has the potential to kick-start a recession hit economy too, because of the above linkage effects. Second, from a social perspective, housing is a primary requisite of human life and hence an essential ingredient in any welfare state. With the initiation of the economic reforms in India in the early 1990s, the housing sector has been getting more attention and conducive environment for its growth, notwithstanding the fact that successive Governments used to accord high priority to housing even before the reforms era, especially since the early 1970s. Third, in the ongoing regime 'Affordable Housing for All by 2022' is a national goal that India seeks to attain. Promotion of housing finance by commercial would benefit more people to have their own houses by availing financial assistance from banks. Thus, by promotion of housing finance banks seek to help the nation to attain its national goal. Fourth, the banking sector in India is facing a crisis, the first and foremost being the problem of NPAs. Housing finance being a relatively less risky loan, promotion of housing finance ensures higher credit off-take but at the same time lower NPAs/sticky loans. Fifth, retail credit products being relatively of lower amounts spread across very large number of customers across wide geographical areas, there is the benefit of risk diversification too. Sixth, housing construction sector is labour-intensive and hence has vast

ISSN 2394 - 7780

employment potential. In view of the foregoing analysis, considering the clear benefits of housing loans and the peculiar economic environment in India, it is relevant to study the relevance of promoting housing finance for the sustained growth of the nation.

4. Literature Review and Research Gap

Kiran Keswani (1997) [11] in his paper, 'The contribution of building centres to low-cost housing in India' in *Building Research & Information* has studied the reasons for the slow growth in low-cost housing projects in India. The author has suggested that the Government should assume the role of a facilitator rather than a provider. A three-pronged strategy has been suggested for promoting low cost housing viz. (i) examining critically the archaic laws on housing, (ii) disseminating information on technical aspects of house building, and (ii) training in updated technologies on low-cost housing. Peer Smets (1999) [30], in his paper 'Housing Finance Trapped in a Dilemma of Perceptions: Affordability Criteria for the Urban Poor in India Questioned' in *Housing Studies* has argued that a definitional issue associated with formal housing finance and 'eligibility' for the same in terms of 'affordability criteria in one go' has resulted in exclusion of the vast majority of the urban poor from availing finance from formal sources of finance. The author has advocated the need for 'incremental housing' and also the need to assess the 'affordability in a phased in manner' and 'not in one go'. Manoj P K (2003) [13] in his research paper, 'Retail Banking: Strategies for Success in the Emerging Scenario' in *IBA Bulletin* has suggested strategies for the sustained growth of the retail credit portfolio of banks, that mainly comprises of housing finance, as a safer way of increasing business and also kick-starting the then recession-hit industry of India. 'Linkages' – both forward and backward – of housing with large number of other industries, and the positive effect of such linkages for bringing about faster economic growth have been pointed out in the paper. Manoj P K (2004) [14] in his another research paper, 'Dynamics of Housing Finance in India' in *Bank Quest* has pointed out the growing appetite of commercial banks (CBs) towards housing credit, the falling share of housing finance companies (HFCs) in the market, and allied aspects. Some macro level strategies for the sustained and balanced growth of housing finance in India are suggested. The relevance of promoting secondary mortgage market (like, RMBS), alternative models like Housing Micro Finance (HMF) etc. has been noted. In a Working Paper 19 titled, *Housing Microfinance: Designing a Product for the Rural Poor*, released by Institute for Finance Management and Research (IFMR) (2007)[7], has noted the utmost importance of promoting Housing Micro Finance (HMF) – an alternative model for housing finance for the poor – for addressing India's chronic housing problem, which in turn is primarily that of the poor and marginalized in the country, like the LIG (Low Income Group) and EWS (Economically Weaker Sections). Only models like HMF could cater to such deprived sections that are not served by the formal sector agencies. So, models like HMF are required to solve India's 'real housing problem'. The report seeks to design the suitable HMF model for the Indian poor. Manoj P K (2008) [15] in his paper, 'Learning from Cross-country Experiences in Housing Finance: A Microfinance Approach' in *Journal of Global Economy* has suggested suitable macro level strategies for promotion of housing micro finance (HMF) in the Indian scenario by appropriately replicating the successful and time-tested models like HMF or other similar alternative housing finance models prevalent elsewhere in the world. A research paper on HMF by Manoj P K (2010) [21], "Prospects and Problems of Housing Microfinance in India: Evidence from "Bhavanashree" Project in Kerala State" in *European Journal of Economics, Finance and Administrative Sciences* has studied in detail the utmost importance of HMF for balanced and equitable housing development in India, and hence rapid economic development of the country. Strategies for promotion of HMF in India have been suggested, along with specific and category-wise strategies for the HMF based in Kerala and sponsored by the state government namely 'Bhavanashree'. Manoj P K (2010) [18] in his paper, 'Benchmarking Housing Finance Companies in India: Strategies for Enhanced Operational Efficiency and Competitiveness' in *European Journal of Economics, Finance and Administrative Sciences* has made a detailed analysis of the relative competitive position of the leading housing finance companies (HFCs) in India and has suggested strategies for the enhanced operational efficiency and competitiveness of HFCs.

The management consultancy organization, KPMG (2010) [11], in its Industry Report (Advisory), '*Affordable Housing – A key growth driver in the real estate sector?*' has sought to discuss the immense growth prospects of real estate players in the affordable housing market in India, given the huge demand and grossly under-penetrated market, very favourable Governmental policies etc. The demand and supply constraints, the relevance of PPP in the real estate sector etc. have also been dealt in detail. In a research paper by Manoj P K, (2010) [19] 'Determinants of Successful Financial Performance of Housing Finance Companies in India and Strategies for Competitiveness: a Multivariate Discriminant Analysis' in *Middle Eastern Finance and Economics*, has attempted to find the determinants of superior financial performance of HFCs. Using the tool Multivariate Discriminant Analysis (MDA), Discriminant Function having five distinct parameters (selected

ISSN 2394 - 7780

from the total 21 parameters used for MDA) which significantly influence the financial performance of HFCs has been derived. Yet another paper by Manoj P K (2010) [17], 'Financial Soundness Housing Finance Companies in India and Determinants of Profitability: A 'CAMEL' Approach along with ROE Decomposition Analysis' published in *International Journal of Business Policy & Economics* has employed the methodology of 'CAMEL' ranking along with ROE decomposition analysis to identify the determinants of profitability of HFCs. A research paper by Manoj P K (2011) [22], 'Determinants of Profitability of Housing Finance Companies in India and Strategies for Competitiveness: a Multiple Partial Correlation Approach' in International Journal of Business Intelligence and Management has suggested competitive strategies for various groups of HFCs with the help of the basic parameters that significantly influence the respective groups of HFCs.

A joint research paper by Hrushikesh Mallick & Mantu Kumar Mahalik (2015)[5] 'Factors determining regional housing prices: evidence from major cities in India', in *Journal of Property Research* has sought to identify the factors determining the housing prices with respect to 15 major cities in India using data relating to 16 Quarters (4 years, 2010 to 2013). It has been noted that fundamental factors are more significant than speculative factors. In a research paper by Manoj P K (2015) [25], "Socio-Economic Impact of Housing Microfinance: Findings of a Field-based Study in Kerala, India", published in *International Research Journal of Finance and Economics*, the reasons for the failure of 'Bhavanashree' – the HMF initiative of the Government of Kerala have been studied in detail. The author suggests strategies for effective implementation of HMF projects based on the "learning from the failure of 'Bhavanashree' project" in Kerala. The research report by the agency IFMR (2015) [8] entitled as *Affordable Housing Finance Sector: Overview* makes a detailed analysis of the need, relevance and significance of affordable housing in India in the context when the national goal of 'Affordable Housing for All by 2022' is implemented by the Government of India. The crucial role that HFCs have to play in this context is specially noted in the IFMR report. The fact that there is a gradual re-emergence of HFCs since 2013, thus overtaking the CBs in growth rate and significantly improving their market share has been specifically pointed out. In a paper by Manoj P. K. (2015) [23], "Deterrents to the Housing Microfinance: Evidence from a Study of the Bankers to 'Bhavanashree' in Kerala, India", in *International Research Journal of Finance and Economics*, the major problems associated by the bankers in financing 'Bhavanashree', the HMF initiative of the Government of Kerala, has been dealt in detail. Various issues like the unclear land tenure, fragile institutional framework of the HMF and its parent (mentor) 'Kudumbashree' etc. have been studied in detail. Suggestions have been made to the Government based on the findings of the study, for the purpose of enabling more meaningfully implement HMF initiatives in the future, 'Bhavanashree' initiative being more or less a failure. In a research article by Manoj P K (2015) [24], "Housing Microfinance: A Study on Quality, Cost and Default Rate with Respect to 'Bhavanashree' in Kerala", in *International Research Journal of Finance and Economics*, a detailed and critical study of the asset quality, administrative (transaction) costs, and default rates in respect of the HMF initiative of the Government of Kerala ie. 'Bhavanashree' has been made. Suggestions are made for more effective implementation of HMF projects by the Government. Another paper by Manoj P K (2016) [26], "Real Estate Investment Trusts (REITs) for Faster Housing Development in India: An Analysis in the Context of the New Regulatory Policies of SEBI" in *International Journal of Advance Research in Computer Science and Management Studies* has made an exploratory study of the utmost relevance of REITs in a developing country like India for promotion of its housing and real estate sector and hence the whole economy. BCG (2018) [2] in its report, *Digital Lending* has sought to highlight the immense opportunity for digital lending in India. According to BCG, it is a USD 1 Trillion opportunity over the next 5 years and the stakeholders can utilize the same. Industry research agency, India Brand Equity Foundation (IBEF) (2018) [6] in its report on Real Estate industry in India has pointed out the tremendous growth prospects of the real estate industry in India which is estimated to attain the size of USD 1 Trillion by 2030. Its estimated size as of 2019 is 3.7 Million Square feet and it is the fourth largest sector in terms of FDI flows. Rapid urbanization, growing affordability, and Governmental commitment to attain 'Affordable Housing for All' etc. brighten the prospects of India's real estate sector.

In view of the foregoing discussions, it is noted that though there are a number of studies on housing finance, studies on retail banking by banks with a focus on housing finance are scarce; an exception being the study by Manoj P. K. (2003) [13] 'Retail Banking: Strategies for Success in the Emerging Scenario' in *IBA Bulletin*. This study is by and large a re-look into the study of Manoj P. K. (2003) [13], after a long period of 15 years.

ISSN 2394 - 7780

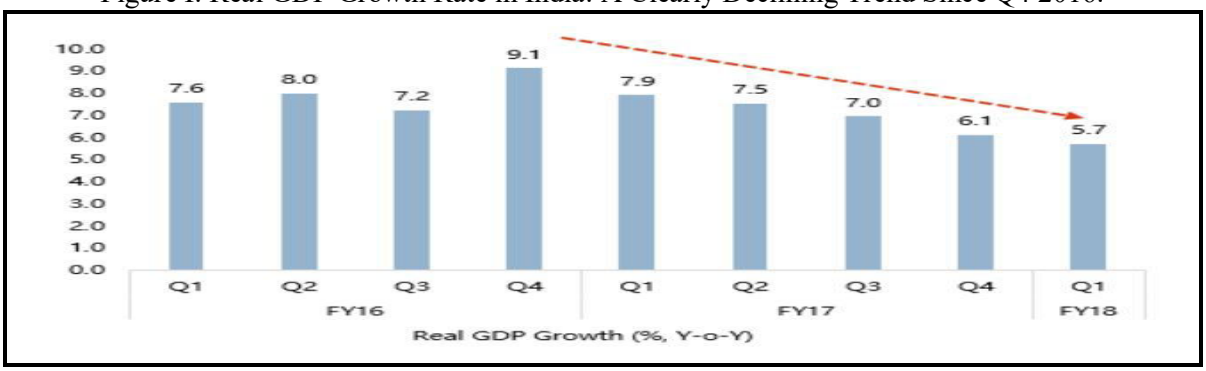
5. Methodology of the Study

The present study is descriptive-analytical as well as exploratory in nature. The study is descriptive to the extent that it describes the developments in the field of retail banking in India, with a focus on housing finance. The paper is analytical too as it seeks to analyze the need for focusing on retail banking, particularly housing finance segment within it, so as to tide over the present slump in the banking sector as well as the whole economy. The study is based primarily on secondary data from authentic sources like RBI, NHB, and CRISIL.

6. Current Status of Indian Economy, Housing Situation and Employment

There is a steadily falling trend in respect of GDP of India over the last few quarters and this is very prominent since the fourth quarter of 2016 (Q4, 2016) (Figure I) and this falling trend is likely to continue in FY 2019 also.

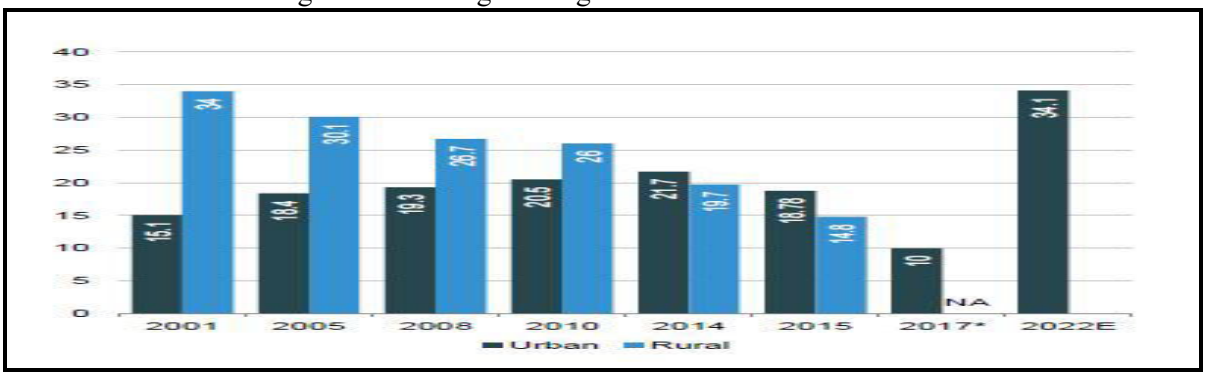
Figure I: Real GDP Growth Rate in India: A Clearly Declining Trend Since Q4 2016.



Source: CRISIL (Sept. 2018) [3]

Housing shortage is a reality in India even after 70 years of her independence. Though there is a gradually declining trend in housing shortage in rural India, it is still acute in urban areas of the nation and is showing a generally growing trend over the years. (Figure II).

Figure II: Housing Shortage in India – Rural and Urban.

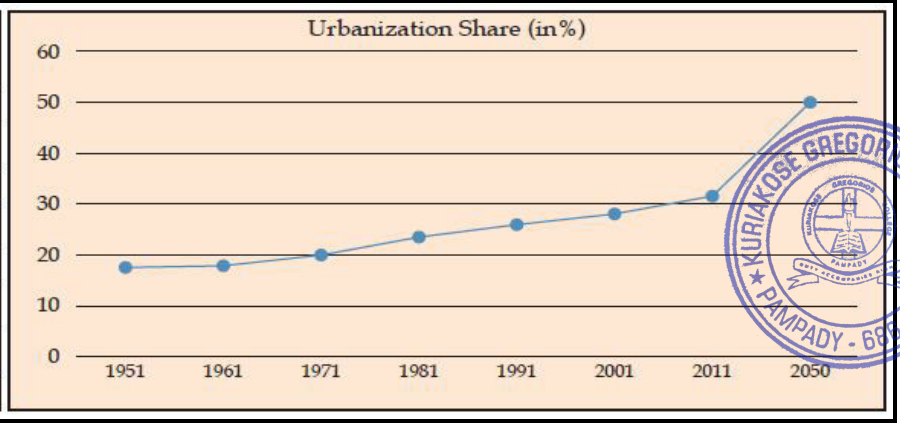


Source: IBEF (July 2018) [9]

Urban housing problem in India growing because of the growing urbanization in the country. (Figure III). The national goal of 'Affordable Housing for All by 2022' gives another dimension to the urgent need for solving the growing urban housing problem.

Figure III: Urbanization in India – Steadily Growing Trend.

Years	Urbanization Share in %
1951	17.29
1961	17.97
1971	19.91
1981	23.34
1991	25.71
2001	27.81
2011	31.16
2050	>50



Source: NHB (2018) [33]

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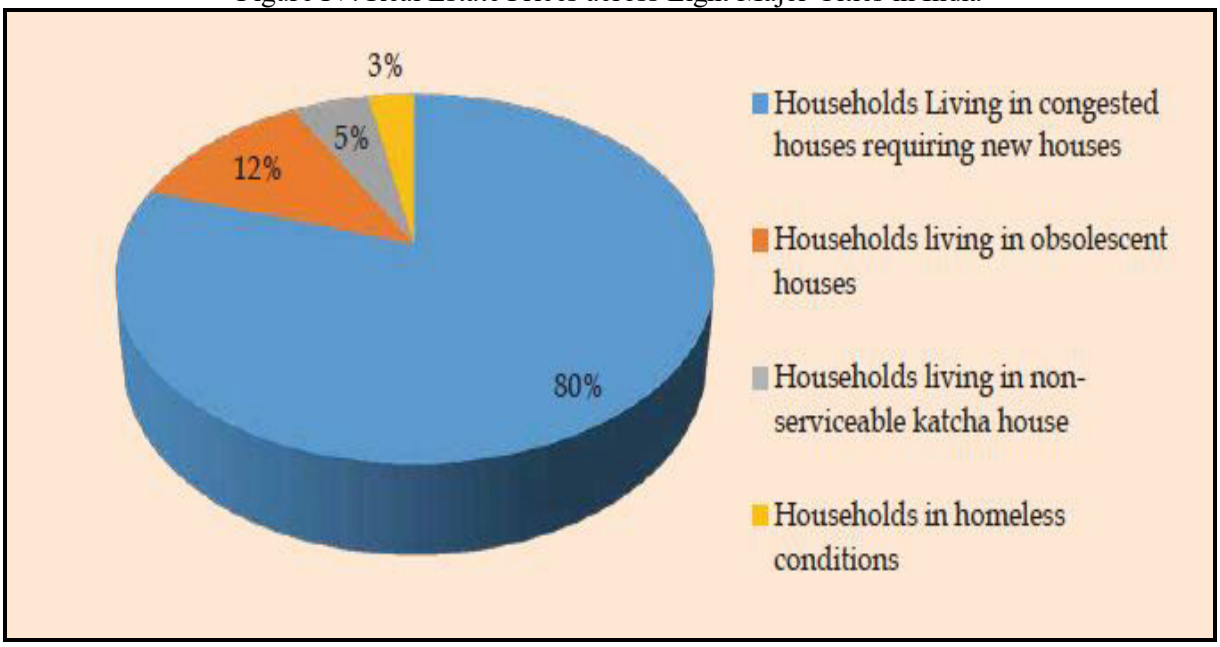
Regarding the nature of urban housing shortage in India, it is noted that vast majority of those who require houses in the urban areas (as high as 80 percent) are suffering from congestion and hence they need new houses. Another significant group of 12 percent of them are living in obsolescent houses. Of the rest 8 percent, 5 percent are living in non-serviceable katcha houses and the balance 3 percent are in home-less condition. The above situation relating to the urban housing condition in India points to the need for special attention to solving problems associated with housing congestion in urban areas. (Figure IV).

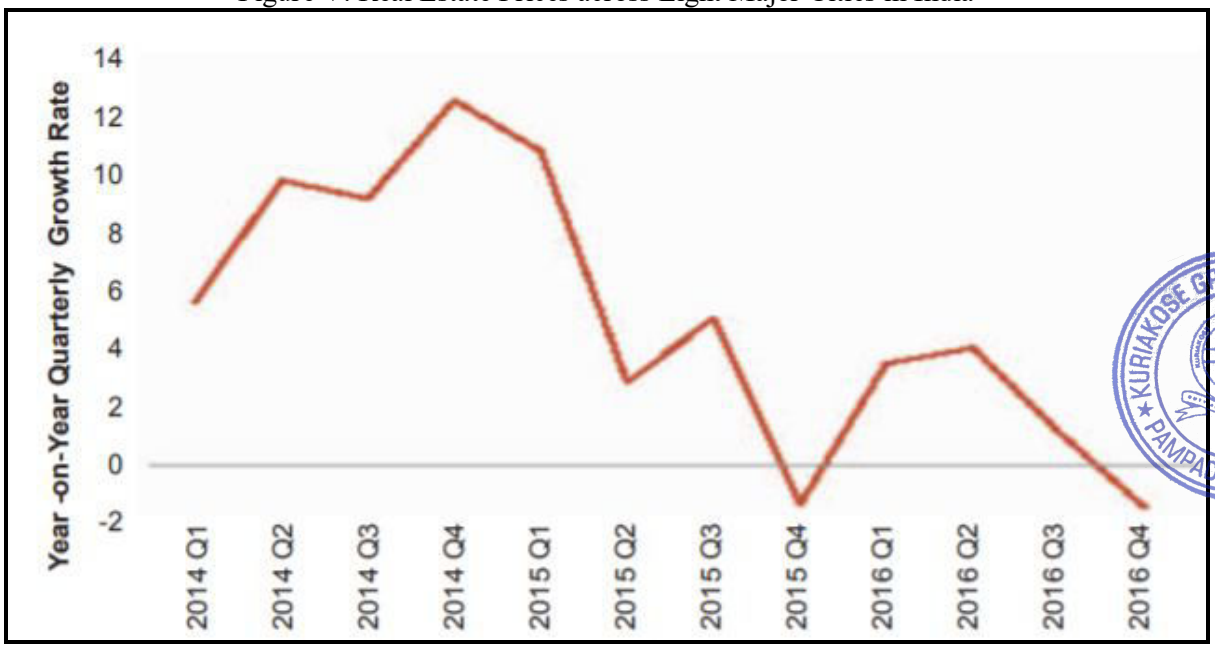
Figure IV: Real Estate Prices across Eight Major Cities in India



Source: NHB (2018) [33]

There is a constantly falling trend in the real estate prices across eight major cities in India (Figure V). This suggests that major cities in India have almost saturated as far as housing and residential real estate development is concerned.

Figure V: Real Estate Prices across Eight Major Cities in India



Source: *Knight Frank* and *Economic Survey 2016-17*; Adapted from, NHB (2017) [33]

In spite of the general slump in the housing development sector in India, it is noted that there is slight improvement in the growth rate of housing loan disbursements, this being primarily because of the growing demand in Tier II and Tier III cities. This suggests that now housing projects focus more on suburban sites (Tier II and III cities, instead of Tier I) as there is growing demand and relatively lower costs. (Figure VI).

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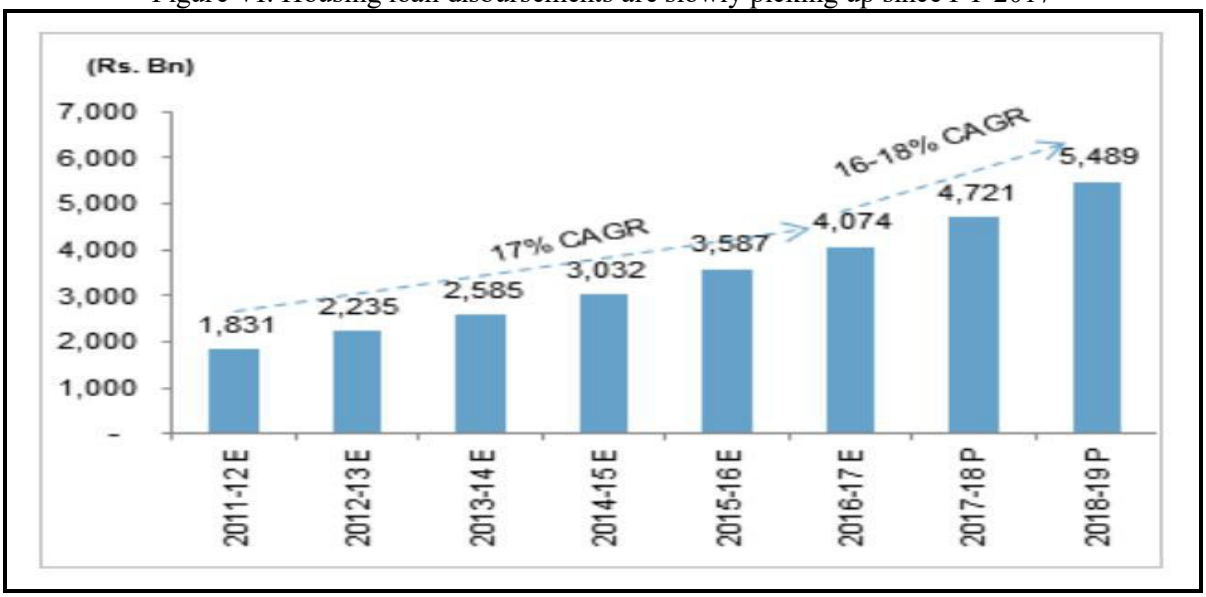
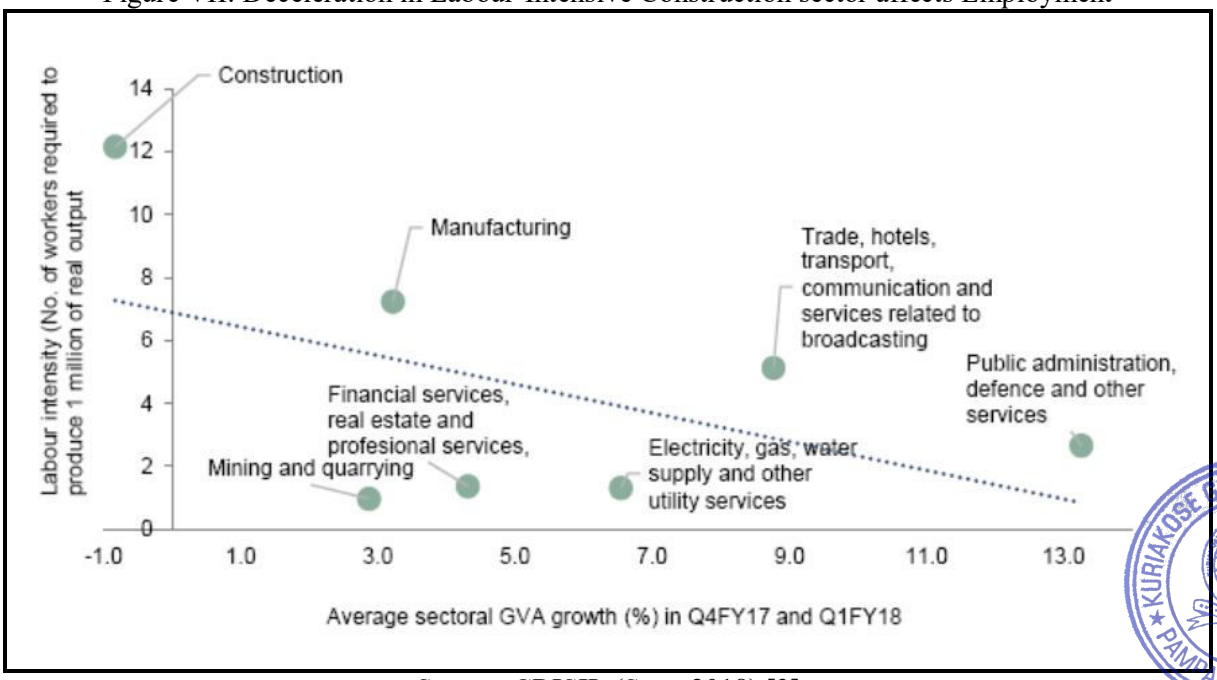
Figure VI: Housing loan disbursements are slowly picking up since FY 2017



Source: CRISIL (Sept. 2018) [4]

The general slump in the construction industry in India, which includes primarily the housing construction industry affects the employment creation in the country because construction is one of the most labour-intensive sectors and it requires as high as 12 workers to produce Rs. 1 million worth output. Deceleration in housing construction sector hence would adversely influence the employment generated in the country. Or, in other words, promotion of housing construction in India has a vital role (Figure VII).

Figure VII: Deceleration in Labour-Intensive Construction sector affects Employment



Source: CRISIL (Sept. 2018) [3]

7. Relevance of Promoting Retail Credit by Banks, particularly Housing Finance

The Mortgage to GDP ratio in India is still at a very low level of about 10 percent, though the same has been gradually growing over the years. The case of India in this regard is one of the lowest in the whole world. This fact points to the fact that there is enough scope for the housing and real estate sector in India to grow. In order to catch up with a nation like China also, India has to almost double its present mortgage to GDP ratio, as the current mortgage to GDP ratio in China is as high as 18 percent as against 10 percent in India. The national commitment towards attaining 'Affordable Housing for All by 2022' gives another impetus towards improving the very low mortgage to GDP ratio in India. In a period of economic slowdown as faced by India at present, banks and other players like NBFCs have the responsibility to focus on housing finance for their own growth as well as the wellbeing of the shelter-less masses and the national economic development. (Figure VIII).

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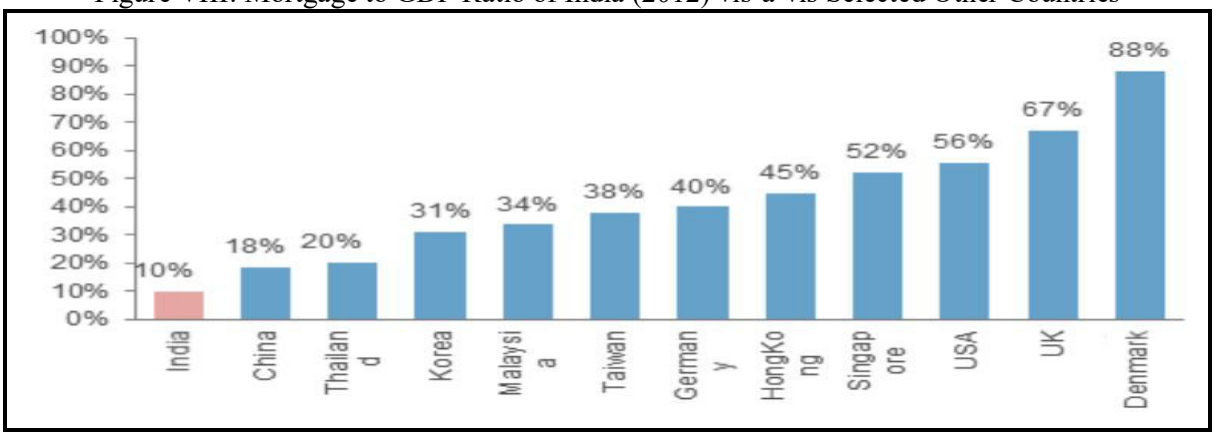
Figure VIII: Mortgage to GDP Ratio of India (2012) vis-a-vis Selected Other Countries

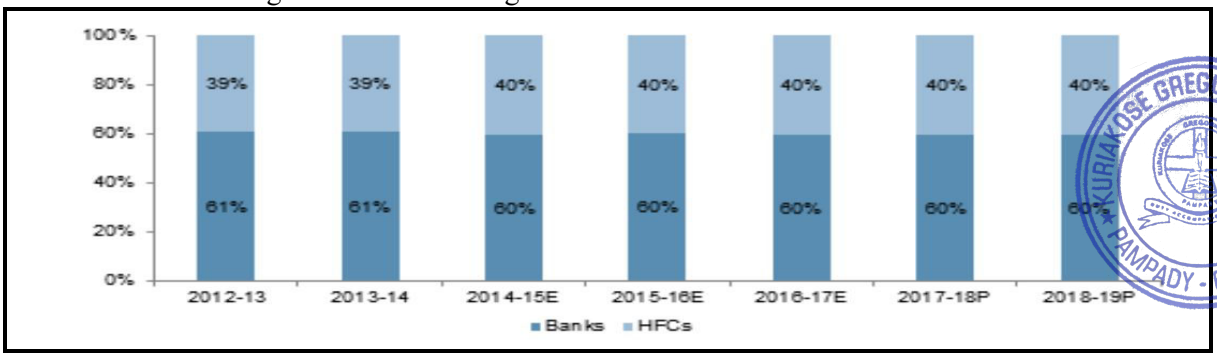


Source: CRISIL (Sept. 2018) [3]

Housing investments help not only the respective individuals directly but the socio-economic development of the whole nation as well. So, governmental policies on housing have vital impact on the national economic development besides the social and familial wellbeing of the citizens. Because of this fact housing is often called the growth engine for developing nations like India. Given the low mortgage to GDP ratio in India of about 10 percent which is one of the lowest in the whole world, there is enormous scope for the housing finance sector to grow in India. Retail credit, particularly housing loans portfolio within it, has got the capacity to generate more demand by way of creating multiplier effects because of its vast linkages with nearly other 300 allied industries. Besides a basic necessity of human life, housing is the most prominent activity under the construction sector which in turn accounts for over 50 percent of the developmental outlays of the government. A HUDCO-sponsored study to assess the impact of housing investments on employment and GDP has noted that housing sector ranks third among the major 14 sectors in India in terms of linkage effects with other sectors of Indian economy. It is reported that in respect of income multiplier housing sector ranks fourth and that it is ahead of other sectors like transport and agriculture. It is reported that unit rise in final expenditure on housing would create additional income of nearly 5 times. So, housing sector in India plays a major role by contributing to employment and income generation.

In India, the two major players in the housing finance market are Commercial Banks (CBs) and Housing Finance Companies (HFCs). The market share of HFCs in India is about 40 percent while that of banks (i.e. CBs) is about 60 percent. The chronic issues faced by Dewan Housing Finance Corporation (DFHL) – one of the prominent HFCs in India, and the mounting problems with Indiabulls Housing – another major HFC in India are just two examples to the multifarious issues that HFCs in India currently face. All the HFCs, both large sized as well as the mid-sized and small sized ones, face the problem of dwindling profitability because of growing cost of funding, deteriorating asset quality, lower growth rates and hence lower relative market share vis-à-vis the banks, and so on. The issues faced by HFCs, like growing borrowing costs, is more in respect of HFCs with ALM (Assets Liability Mismatch) issues and/or poor asset quality. Contrary to the case of HFCs, banks have better liquidity and hence can focus on lending more to retail credit, particularly housing finance. Moreover, in the present scenario of low credit off-take from the banking sector because of the looming economic slowdown, focus on retail credit makes better business sense. The relatively low repayment risks associated with retail credit products like housing finance makes the above strategy even more meaningful. The possibility of effective risk diversification is another advantage of focusing on retail credit. (Figure IX).

Figure IX: Diminishing market share of HFCs vis-à-vis Banks



Source: Adapted from CRISIL (2018) [3]

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The growth prospects of the sector, especially in the Tier 2 and Tier 3 cities are high. However, a sudden increase is not anticipated in the near future (CY-2019 or 2020). Rather, a stable trend or marginal increase alone is estimated. This is because the sentiments of the buyers are yet to become positive. Given the mounting problems faced by the NBFCs in general and HFCs in particular, the presence of Commercial Banks (CBs) in the housing finance arena is going to be higher, and so also their market share. So, the responsibility of CBs towards attaining the national goal of 'Affordable Housing for All by 2022' too has increased. As already noted, it is widely recognized that Indian economy is facing a marked slowdown today. The vast linkage effects of housing investments result in investments in allied sectors through multiplier effects. This would help revival of this economy from the present slump. The ability of this sector to generate employment is vitally significant here.

8. Strategies for Sustained Growth of Retail Credit, particularly Housing Finance

Given the national goal of 'Affordable Housing for All by 2022' in India, let us now try to design the medium term strategy for the banks that can take care of the above national goal and at the same time help tide over the present situation of economic slowdown. Irrespective of the fact that whether the economic slump is cyclical or structural in nature, investment in housing can act as a suitable remedial strategy. So, promotion of retail credit by banks, particularly housing credit is meaningful, especially when we consider the vast linkages of housing industry with not less than 269 other industries. Investment in housing can kick-start many a recession-hit sector in the economy and is a top employment generator also. Hence, the medium term banking strategy should be that of 'retail credit with housing finance thrust'.

Another vital need for the banking strategy is that of ICT integration. ICT ensures better competitiveness, significantly improve operational efficiency by reducing cost, and can enable better customer service also. Modern ICT-based tools like data mining can be of immense use because of their ability to generate relevant knowledge from large amounts of unorganized business data. Moreover, given the imminent invasion by the financial technologies (Fin-Tech) companies and also the ever growing expectations of today's discerning customers, banks have to constantly innovate their products and services, particularly in respect of the retail banking portfolio. Here, ICT acts as the means (enabler) and also the end. So, from the viewpoint of competition too ICT integration at all levels, especially in respect of retail credit, is an imperative for the survival and growth of the banks.

Public sector banks (PSBs) and Old Private sector Banks (OPBs) have to pay more attention to ICT adoption because they often lag behind the New generation Private sector Banks (NPBs) and Foreign Banks (FBs) in ICT adoption. This in turn enables them to catch up with NPBs and FBs in customer service and operational efficiency; especially in respect of retail credit wherein customer service and control of operating costs are vitally significant.

There is another reason for the PSBs to take special interest in retail credit. As consolidation process is going on among the PSBs, the only feasible strategy that can 'keep them moving' in the short and medium terms is that of focusing on retail credit with due respect to ICT integration and constant product innovations. Focusing on large corporate or industrial advances or on project financing by these PSBs which are already heavily burdened with the issues of bad-debts (NPAs) and falling profitability and productivity will not at all be sensible in the short or medium term. Identifying their synergies and designing suitable business models would require some more time during which they can focus on retail credit.

Use of advanced ICT platforms that can support competitive tools like data mining and knowledge discovery is very desirable for any progressive bank for its survival and growth. Such platforms enable high level of customer engagement and facilitate targeting different customer segments with tailor-made products. Modern payment technologies like RFID (Radio Frequency Identification) need to be adopted to remain competitive in the market. ICT investments, further, should focus on improving responsiveness, resiliency and enterprise-wide collaboration. Strategic tie-ups and resource sharing among the banks can bring in enhanced efficiency in the use of technology. This is especially relevant for the PSBs which are undergoing consolidation.

Customer centricity has a vital role to play in banking industry in the future. Sustainable business models that ensure continued customer loyalty or long term relationships have to be followed consistently by all banks, including 'traditional' banks like PSBs and OPBs. Owing to their 'high-tech' nature, NPBs and FBs are ahead in this regard.

Because of the fast advances in ICT and also the discerning nature of modern customers, innovation of all types on an ongoing basis is a vital for retaining and attracting the customers. So, each and every product needs to be designed meticulously based on a clear understanding of the customer's quality value proposition. Banks need

ISSN 2394 - 7780

to focus on specialized customer segments, as a 'one-size-fits-all' policy no longer appeals the customers of today's globalized markets. To identify the target customer segments banks have to adopt scientific market research studies and use advanced ICT tools like data mining.

Given the discerning nature of modern customers, provision of more high technology (Hi-Tech) products and delivery channels is an imperative for survival and growth of any bank, rather than a choice. The growing trend in computer literacy and the ever-growing affinity to modern products among the younger generation make the above strategy more meaningful. Also, it is essential to effectively defend the threat by specialized (niche) players, including the Fin-Techs which are growing fast.

With growing adoption of ICT-based applications, there are mounting trend in scams, information/cyber security issues, data leakages, frauds etc. So, setting up robust systems for risk management relating to information/cyber security should be a top priority for all banks.

From the part of the Government, it is advisable if it encourages a dynamic secondary market for housing finance, like, residential mortgage backed securitization (RMBS) is yet to emerge in India. The Government has to facilitate a vibrant RMBS market in India so that it acts as a new source of finance for the housing sector, particularly for the HFCs which are grappling with liquidity problems. Equally important is the need to promote the real estate investment trusts (REITs) in India. This in turn would promote the commercial real estate directly; and residential real estate too, but indirectly. Conscious efforts for encouraging the market innovations like RMBS and REITs are required in India for housing development. Special focus on residential REITs (those focusing on residential buildings) is an urgent need.

Whatever is the level of ICT adoption, any banking service needs to have a human touch in order to be holistic and comprehensive. This 'human factor' in banking services must ensure adequate customer touch points for all products by way of meticulous planning.

All the above strategies have direct impact on the technological platform of the respective banks. A few other relevant strategies that can ensure superior performance of banks include, inter alia, enhanced transparency and strict corporate governance, enlarged accountability, adoption of international standards in accounting and reporting etc. More flexibility in human resource management (HRM) policies is required, especially for the PSBs and OPBs. This enables low cost and more flexible labour options (like, off-shoring). Besides, provisions to attract and retain the talent are required, which in turn may need more functional autonomy for the banks.

Concluding Remarks

In spite of issues like growing NPAs, need for recapitalization etc., particularly for the PSBs in India, it may be noted that still Indian banking system is adequately stable, resilient and reasonably equipped to comply with global regulatory norms. When NBFCs (including HFCs) are grappling with problems of liquidity, asset-liability mismatch, falling profitability and so on, banks in India are still healthier and more stable. However, banks in India have to play a greater role in the current situation of the country that is characterized by economic slowdown. Almost every sector in Indian economy is facing a slump, and the growingly worsening case of NBFCs (including HFCs) is no exception here.

Notwithstanding the fast growth of digital transactions in India, regarding ICT adoption by banks in India, there appears to be good scope for improvement, particularly in respect of PSBs – still the backbone of the Indian banking system, in spite of their losing prominence. In fact, ICT upgradation and consolidation in banking industry are mutually reinforcing in nature and results in significant cost savings for the respective banks, which are mostly the PSBs. Need for restructuring the banks by adopting stronger customer orientation with robust technological platform assumes vital significance today. The recent governmental policies are all in the right direction. Focus on retail credit products like housing finance ensures better credit off-take during this slowdown phase and will also enable gradual recovery of the whole national economy because of the vast linkage effects. ICT adoption makes the whole process as above more cost-effective, transparent and customer-friendly.

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FACTORS AFFECTING THE WORK-LIFE BALANCE OFTHE EMPLOYEES OF PUBLIC AND PRIVATE SECTOR BANKS IN KERALA

Dr P N Harikumar*

Vipin K. Varughese**

Introduction

In the present work environment, work-life imbalance is the main topicof debate among the employees. In the present environment, filled with personal, official and social responsibilities, imbalance between these personal, official and social commitments has become an important issue. This imbalance has highly affected the employees in the banking sector. If a bank employee attempts to accomplish the demands in work-life, he/she will have to sacrifice his/her personal, family and social life to a great extent. Work is the crucial element in present day life. So an employee cannot reduce the work related activities for the sake of family life. Work-life imbalance influences the employee's family life. It affects the form of mental and physical stress. Such family-life problems generateproblems in official life. Work-life balance studies are one of the demanding areas in this century. Many research works are done on work-life imbalance in different industries. Many suchstudies have already been done in the banking industry. There is a lack of comparative studies in the area of public, old and new generation private sector banks.

At present, a reasonable number of bank employees, specifically officers, are facing work-life conflict in the form of mental and physical strain and are struggling to find useful time

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for their children and other family needs. Majority of the employees have to ignore the personal commitments towards family due to the heavy workload in Bank. They also neglect their commitments in social life. This work-life imbalance forces the employees and this results in low productivity, job burnout etc. This study tries to describe the factors affecting the work-life imbalance using collected data from selected 550 public and private sector bank employees in Kerala using questionnaire.

In this research paper, the demographic profile of the selected public and private sector bank employees in Kerala and the factors influencingtheir work-family-life imbalance is presented.

Objective

The main objective of the paper is to examine the factors affecting the Work-life imbalance of the employees of public and private sector banks in Kerala

Methodology

Primary data have been used for this study, which are collected from 550 selected employeeswith a well-designedquestionnaire, the employees were selected by applying Multi-stage random sampling method.

Tools

The collected data were analysed with appropriate statistical methods such as Friedman test and Multiple discriminant analysis.

Demographic Profile of Bank employees

The profile of sample explaining the occupational and personal features of bank employees is presented in the table given below.

Table 1: Occupational and personal profile of bank employees

	Categories	Frequency	Percent
Type of bank	Public Sector	300	54.5
	Old Private Sector	150	27.3
	New Private Sector	100	18.2
	Total	**550**	**100**
Name of the Bank	SBI	240	43.6
	Canara	60	10.9
	Federal	90	16.4
	South Indian	60	10.9
	ICICI	50	9.1
	HDFC	50	9.1
	Total	**550**	**100**
Designation	Senior Manager	120	21.8
	Junior Manager	195	35.5
	Clerk cum cashier	235	42.7
	Total	**550**	**100**
Experience	below 5 years	145	26.4
	5–10	174	31.6
	10–15	62	11.3
	15-20	38	6.9
	20 & above	131	23.8
	Total	**550**	**100**
Location	Urban	146	26.5
	Semi urban	366	66.6
	Rural	38	6.9
	Total	**550**	**100**
Distance between Residence to branch	below 10 km	250	45.5
	10-20	147	26.7
	20 & above	153	27.8
	Total	**550**	**100**
Number of hours worked per day	7 hrs	95	17.3
	7-9	240	43.6
	above 9	215	39.1
	Total	**550**	**100**
No. of transfers in service	Nil	54	9.8
	1-2	160	29.0
	3-5	200	36.4
	6-7	52	9.5
	above 7	84	15.3

	Total	550	100
Age	below 30	147	26.7
	30 – 40	198	36.0
	40 - 50	96	17.5
	50 & above	109	19.8
	Total	550	100.0
Gender	Male	327	59.5
	Female	223	40.5
	Total	550	100.0
Qualification	upto Degree	197	35.8
	PG	230	41.8
	Professional	123	22.4
	Total	550	100.0
Place of stay	Urban	128	23.2
	Semi Urban	332	60.4
	Rural	90	16.4
	Total	550	100.0
Type of family	Joint	183	33.3
	Nuclear	367	66.7
	Total	550	100.0
Marital status	Married	467	84.9
	Unmarried	83	15.1
	Total	550	100.0
Spouse employment	Yes	357	76.4
	No	110	23.6
	Total	467	100.0
Spouse employment type	Govt	112	31.4
	Bank	103	28.9
	Professional	21	5.9
	Private	101	28.2
	Abroad	20	5.6
	Total	357	100
Number of children	Nil	82	17.6
	1	153	32.8
	2	206	44.0
	More than 2	26	5.6
	Total	467	100.0
Number of dependents	Nil	158	28.7
	1	125	22.7
	2	121	22.0
	More than 2	146	26.6
	Total	550	100.0

Table 1 exhibits the profile of the sample respondents (employees) selected for the study. As per the table, while 54.5 per cent of the respondents belong to Public sector banks, 27.3 per cent belong to old private sector and the remaining 18.2 per cent belong to new generation private sector banks. Bank wise classification reveals that 43.6 per cent from SBI, 16.4 per cent from Federal bank, 10.9 per cent each from Canara bank and South Indian bank, 9.1 per cent each from ICICI and HDFC banks. Designation wise classification shows that 42.7 per cent are clerk cum cashier, 35.5 per cent are junior managers and 21.8 per cent are senior managers. Experience wise classification describes that 31.6 per cent of employees have 5-10 years of experience, 26.4 per cent have less than 5 years, 23.8 per cent have 20 and above years, 11.3 per cent have 10-15 years and 6.9 per cent having 15-20 years of experience in banking. It is observed that 66.6 per cent of employees working in semi urban branches, 26.5 per cent in Urban and 6.9 per cent in rural branches. Distance between residence to branch wise classification indicates that 45.5 per cent are staying within less than 10 KM distance, 27.8 per cent in 20 and above distance and 26.7 per cent in 10-20 km distance. Working hours wise classification reveals that 43.6 per cent are working 7-9 hours daily, 39.1 per cent working more than 9 hours and 17.3 per cent working 7 hours. Number of transfer wise classification shows that 36.4 per cent were transferred 3-5 times, 29 per cent transferred 1-2 times, 15.3 per cent transferred more than 7 times and 9.5 per cent transferred 6-7 times. 9.8 per cent not yet transferred. Age wise classification reveals that 36 per cent are in 30-40 age group. 26.7 per cent below 30, 19.8 per cent in 50 and above and 17.5 per cent in 40-50 age group. 59.5 per cent of sample employees are male and 40.5 per cent are female. Qualification-wise classification shows that 41.8 per cent are post-graduates, 35.8 per cent upto graduation and 22.4 per cent professionally qualified. 60.4 per cent of sample employees stay at semi urban area, 23.2 per cent in urban and 16.4 per cent in rural area. Type of family-wise classification describes that 66.7 per cent come from nuclear family and rest 33.3 per cent from joint family. 84.9 per cent are married and 15.1 per cent are unmarried. Spousesof 76.4 per cent of married employees are employed and 23.6 per cent are unemployed. Among employed spouses 31.4 per cent are in Government sector, 28.9 per cent in Banking sector, 28.2 per cent in private sector, 5.9 per cent are professionals and 5.6 per cent are abroad. 44 per cent of married employees have 2 children, 32.8 per cent have one child and 5.6 per cent have more than 2 children. 17.6 per cent have no child. Dependent wise classification

shows that 26.6 per cent have more than 2 dependents, 22.7 per cent have one dependent and 22.0 per cent have 2 dependents. 28.7 per cent have no dependents.

Dominant reasons for the discomfort in workplaces.

Out of the total 550 respondents 492 opined that they are facing discomfort in their workplace. Seven causes were identified, viz., heavy work load, overtime work, lack of support from superiors, lack of support from management, lack of support from colleagues, stress induced by customers, lack of job freedom. The mean rank computed from the rank preferences of selected employees are given below.

Table 2 Mean ranks for the causes of discomfort in workplace

	Mean Rank
Heavy work load	**1.95**
Overtime Work	**2.66**
Lack of support from superiors	4.88
Lack of support from management	4.91
Lack of support from colleagues	5.85
Stress induced by customers	3.61
Lack of job freedom	4.14

Table 3 Test Statistics[a] (Friedman Test)

N	492
Chi-Square	1181.466
df	6
Asymp. Sig.	.000

a. Friedman Test

As per Table 2; it is clear that Heavy workload has a mean rank of **1.95** which is the lowest mean rank in the matrix. As rank 1 should have the lowest mean, it may be observed that heavy

workload is the dominant factor which creates more discomfort among the bank employees in the workplace. Further the mean rank variation is tested by using Friedman test, and it was found that the value of the Friedman Chi-square is found significant at 5 per cent level. So it is clear that overtime work has a mean of **2.66** which is the second lowest rank in the matrix. Therefore it may be observed that overtime work is the second dominant factor which creates discomfort among the bank employees in the workplace.

Discriminant analysis between public sector and private sector banks

Discriminant analysis is the method used to find out the most critical factor which generates the maximum work-family-life imbalance to the public and private sector bank employees. The factors affecting the work-family-life imbalance are explained below.

1. Indifferent Customers' approach

Different types of customers visit the bank daily. Some of them react emotionally. Some of the branches have no token system in these branches some customers are reluctant to follow the queue system which creates problems. Some customers have lack of knowledge in filling the various forms. Use of mobile phones and asking doubts by the customers in the time transaction also makes problems. Improper arrangement of currencies affects the time management of the employees. Managing some of the premium customers is difficult.

2. More Number of customers

The number of customers visiting the branch every day is more than the manageable size. Some of the customers have more than one transaction like deposit, withdrawal, passbook entry, NEFT, draft etc. Transactions related to some consumers are time consuming. Bank management is not ready for a proportionate increase in staff.

3. Nature of the job

Some employees cannot control their emotions when customers become emotional. Work related complexities, large queue and targets create tension to some employees. Customers' noise leads to loss of concentration of some employees. Fear of committing mistakes in transactions and fake currencies also creates problems.

4. No Clarity in Job

Actual work is not according to the work schedule. There is lack of clarity in the procedures of work allotted. Duty allotted to others is shifted to the employees without consent. Suggestion of new ideas create work pressure.

5. No Control over the work

Employees cannot control the overcrowding of customers, work schedule and taking leave. It is difficult to take leave in emergencies due to heavy workload. Employees spend more hours to complete a target. Due to shortage of time and excess of work, sometimes the employee fail to complete the work perfectly. They have no control over the work time and lunch break. The employees have to work more time than they are expected to.

6. No Sharing of job

Employees are forced to do the job even when they are sick. Their work builds up when they or others take leave.

7. Lack of Team work

There is a lack of proper clarification mechanism. Management does not promote group work culture. There is also a lack of sufficient co-operation, team spirit and personal relation between employees.

8. No support from subordinates/colleagues

Some of the subordinates/colleagues are not cooperative, not ready to take additional responsibility and not ready to inculcate the changes in work. Some of the subordinates or colleagues approach in silly matters for clarification. Inefficiency of subordinates or colleagues also affect the work.

9. Negative Approach of top management

Employees have to face unwanted criticism and face criticism when they fail to achieve the target. They also face partiality from top management. Employees have no say if problems arise. There is a lack of appreciation even when targets are achieved. Top management is not empathetic towards employees. Sufficient staff is not provided for completing an assignment. Top management allot tasks in the area where employees have no control. They also allot tasks to employees without sufficient resources. Transfer and promotion norms are not applied always. Employees are not appreciated when the branch achieves good results.

10. **Indifferent attitude of Superiors**

Some superiors criticize the employees in front of subordinates or customers. Superiors do not allow the employees to take leave in emergency situations or leave the office early in emergency. Superiors unnecessarily interfere in the subordinates' work. Superiors do not understand the personal problems of subordinates. Inefficiency of superiors sometimes influences the work of employees.

11. Ineffective communication

Sometimes superiors are not ready to hear employee grievances and do not understand the work related problems. They are not ready to accept the explanation given by the employees.

12. Difficulty of Time Management

Work schedule is rigid. Employees work beyond working hours. They do not get enough time for lunch and primary needs. They cannot get sufficient time for self-development and can't avail the permitted leave.

13. Negative attitude of family

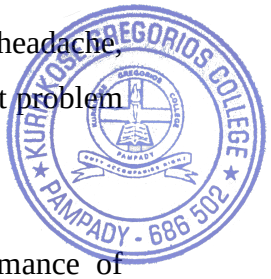
Family members' complain on employee's non availability during festivals and for pleasure trips. Children complain on non-supporting for their education. Spouse complaints on non-support in household activities. Parents blame employees for not giving sufficient care. Relatives' complain on non-availability in family get-togethers. Family members are not satisfied in the employee's support in their health related matters.

14. **Mental strain (stress)**

Some employees become mentally stressed when the counter is overcrowded. Some employees are tensed to handle money. Customer ire negatively affects the mental health of employees. Some employees are always depressed when the work is tedious.

15. Physical strain

The employees face the health problems like increase in blood pressure, persistent headache, regular backache, lack of sleep, increase in cholesterol levels, stomach upsets, eye sight problem and spondylosis.



16. Occupational stress

Employees have to perform multiple tasks and work more because of non-performance of another staff. There is mismatch between the authority and the work of the employees. Others interfere in the mode of work of the employees. Some employees feel the job is boring and

monotonous. Employees think that their salary is too low compared to the amount of work. They also feel that they are not getting opportunities to use their skill and expertise

The output of discriminant analysis for identifying the critical variable is presented in tables 4, 5 and 6.

Table 4 Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.865	54.439	16	.000

Table 5 Functions at Group Centroids

Public/ Private	Function
	1
Public	-.326
Private	.478

Unstandardized canonical discriminant functions evaluated at group means

Table 6 Standardized Canonical Discriminant Function Coefficients

	Function
	1
Indifferent Customers Approach	.270
More Number of Customers	-.209
Nature of The Job	.112
No Clarity in Job	.010
No Control over the Work	.218
No Sharing of Job	-.090
Lack of Team Work	**.579**
No Support from Subordinates/Colleagues	**.587**
Negative Approach of Top Management	**-1.259**
Indifferent Attitude of Superiors	.204

Ineffective Communication	.055
Difficulty of Time Management	-.272
Negative Attitude of Family	.196
Mental Strain (Stress)	-.075
Physical Strain	-.150
Occupational Stress	**-.489**

The factors affecting the work-life conflict among the employees of public and private sector banks is explained by applying multiple discriminant analysis. The statistic of discriminant analysis, the Wilks lambda characterized by the Chi-square is found significant (**Wilks' Lambda 0.865 with Chi-square 54.439, P < 0.05**). So the model is found valid for interpretation. The output also gives a centroid matrix, where negative co-efficient is belonging to public sector banks, while positive co-efficient is for private sector banks. From the standardized canonical discriminant function it may be seen that the highest negative co-efficient is **– 1.259**, the negative approach of top management and second highest negative co-efficient is **-0.489**, the occupational stress. But the highest positive co-efficient is **0.587** for no support from subordinates or colleagues and second highest positive co-efficient is **0.579**for lack of teamwork. Therefore, it can be concluded that in public sector banks, the negative approach of top management and the occupational stress and in private sector banks,lack of support from subordinates or colleagues and lack of teamwork are the critical factors andthese factors create more work-family-life imbalance among the employees in these two banking sectors.

Findings

1. More than half of the employees work in Public sector banks and more than 1/4th of the employees belong to old private sector banks. 2/5th of the employees belong to State Bank of India and 1/6th belong to Federal Bank. 2/5th of the employees are clerk cum cashiers and 1/3rd are junior managers. Around 1/3rd of the employees have experience of 5-10 years and 1/4th are new entrants. 2/3rd employees working in semi urban branches and 1/4th are in urban branches. Nearly half of the employees stayed within less than 10 KM distance. 2/5th of the employees working 7-9 hours and another 2/5th working over 9 hours. 1/3rd of employees transferred 3-5 times and nearly 3/10th transferred 1-2 times. More than 1/3rd of employees belongs to 30-40 age

group and 1/4th belongs to below 30 age group. Majority of the employees are male. 2/5th of employees are post-graduates and 1/5th are professionally qualified. More than half of the employees stay in semi-urban area. 2/3rd employees are from nuclear families. More than 4/5th of employees are married. 3/4th of spouse are employed. Nearly 1/3rd of spouse are employed in Government, bank and private sector each. 2/5th employees have 2 children and 1/3rd have one child. 1/4th of employees have 2 dependents and 1/4th of employees have no dependents.

2. Heavy workload has the lowest mean rank. Heavy workload is the most dominant factor which creates more discomfort among the bank employees in the workplace.So bank employees' main workplace problem is heavy workload.

3. Overtime work has the second lowest rank in the matrix. Overtime work is the second dominant factor which creates discomfort among the bank employees in the workplace. Besides heavy workload, bank employees face the problem overtime work.

4. Negative approach of top management and the occupational stress create more work-family life imbalance among the employees in public sector bank. The approach of the management towards employees is not employee-friendly and it negatively affects the work-life balance. Work related stress also affects the work-life balance of employees.

5. Lack of support from subordinates or colleagues and lack of teamwork create more work-family life imbalance among the employees in private sector banks. Employees work towards personal achievements and gains. But peer support and team work are not adequate enough.

Conclusion

In this research paper the work-life balance of public and private sector bank employees has been under study. Here, the main problems faced at the workplace by the employees of both public and private sector banks and the critical factors which create work-life imbalance among them are identified. There are various factors creating discomforts among the employees in both public and private sector banks. Among these problems heavy workload and overtime work are the most critical factors that create discomfort to the employees in the workplace. There are various

factors which create work-life imbalance among employees. Some factors affect the work-life imbalance of public sector employees and some others affect the private sector employees. Among these, the negative approach of top management and occupational stress are the factors critical to public sector bank employees and no support from subordinates or colleagues and lack of teamwork are critical to the private sector bank employees for their work-family life conflict.

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FOOD AND FEEDING HABIT OF HETEROPNEUSTES FOSSILIS (BLOCH) OF VELLAYANI LAKE, KERALA, INDIA

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Abstract
The stinging cat fish Heteropneustes fossilis,(Bloch) is an important fish occurs in freshwater bodies like pools, tanks, lakes, streams and rivers. The present investigation is on the food and feeding habits of the stinging cat fish Heteropneustes fossilis,(Bloch)of the Vellayani Lake (8"24'09" - 8"26'30" N; 76°59'08"-76°59'47" E), Thiruvananthapuram, Kerala. The study revealed that the fish is omnivorous; feeding predominantly on animals (49.13%) followed by plant components (32.71) and inorganic particles sand and mud (18.12%). The major preferred animal components were copepods (13.42%), cladocerans (10.49%), ostracods (8.65%), insects (6.81%), fishes (5.79%) and gastropods (4.01%). Plant components were represented by Oedogonium, Closterium, Cladophora, Ulothrix and diatoms. The young ones were more active feeders than the larger size groups. The consistent occurrence of sand and mud in the stomach throughout the study period indicates that the species is a bottom grazer as well. Variation in the diet according to the size of fish indicates small changes in the preference of food items in different size categories which may favour to avoid direct competition for food between the smaller and larger size groups.

Key Words: Heteropneustes Fossilis, Vellayani Lake, Feeding Intensity, Stomach Contents.

Introduction

The stinging cat fish Heteropneustes fossilis (Bloch) is an indigenous fish of South- East-Asia, occurs in freshwater bodies like pools, tanks, lakes, streams and rivers. It is an air-breathing fish containing pharyngeal lungs as accessory respiratory organs which enables it to tolerate low oxygenated and eutrophicated water bodies. The fish is not only recognized for its delicious taste and market value but is also highly esteemed from nutritional and medicinal properties of view (Chakraborty and Nur, 2012). It is considered as a valuable food fish species and recommended as diet for the sick and convalescents. Being a lean fish it is very suitable for people for whom animal fats are undesirable (Rahman et al., 1982; Khan et al., 2003). But in recent years, the fish has become gradually been endangered as the natural habitats and breeding grounds of this fish has been severely degraded due to over exploitation, ecological changes, reduction of water bodies, application of pesticides in rice cultivation, release of chemical effluents from industrial plants and hydrological changes due to construction of flood control infrastructure (Kohinoor et al., 2012).

Fishes consume different kinds of food and they differ greatly in the nature of food they consume. It is well known biological and ecological fact that food of an animal may be directly associated with its feeding habits and habitats. Knowledge on the food and feeding habits of fishes in an ecosystem will provide an insight in to the ecology and the life history of the fish. Knowledge on feeding intensity is essential to understand the interrelationship of the fish in the ecosystem and the effects of environmental changes on the feeding pattern of the fish. Vellayani Lake (8"24'09" - 8"26'30" N; 76°59'08"-76°59'47" E), the second largest freshwater lake in Kerala state, India, is located in the outskirts of Thiruvananthapuram, the capital city of Kerala.. It has a water spread area of 450 ha and is far rich in availability and abundance of the stinging Catfish Heteropneustes fossilis locally known as 'Kaari'. The present study aimed to investigate the food and feeding habits of Heteropneustes fossilis inhabiting the Vellayani Lake, Thiruvananthapuram, Kerala.

Materials and Methods

In the present study 128 numbers of live samples of Heteropneustes fossilis of various age groups were collected by cast net from different parts of the Vellayani Lake during the period December 2017 to May 2018. The total length and weight of Heteropneustes fossilis used in the present study varied from 18cm to 31.8 cm and 11.94 g to

216.41 g respectively. After measuring the total length and total weight, the fishes were dissected out and the stomachs were removed and preserved in 4% formaldehyde solution. Each stomach was emptied into petridish and examined under microscope. Both qualitative and quantitative analyses of diet were carried out. Attempts were made to identify the food items up to the possible taxonomic level depending on the state of digestion. The food contents were assigned semi digested matter status, when the process of digestion made identification impossible. To analyse the amount of each food item in the gut, the method of Platell and Potter (2001) was modified by evenly spreading the contents from each stomach in the counting cell chamber and examining under microscope. Analysis was done using frequency of occurrence and numerical methods as described by Hyslop (1980). In the frequency of occurrence method, the occurrence of each food item was expressed as the percentage of total number of stomachs examined. The number of each food item was expressed as the percentage of total number of food items found in the stomach of all fishes examined.

To assess changes in the diet with fish size, the fishes were categorized into 4 size groups, ranging from 15 – 20 cm, 20 – 25 cm, 25-30 cm and 30 – 35 cm.

Feeding intensity was determined based on the degree of distension of stomach and the amount of food contained in the stomach. The stomachs were classified as gorged, full, ¾ full, ½ full, ¼ full, trace and empty and the fishes were classified as actively fed(gorged, full, ¾ full), moderately fed (1/2 full) and poorly fed (¼ full, trace, empty). Monthly and length group based determination of feeding intensity was carried out.

Results and Discussion

Food habits and feeding ecology research is a fundamental tool to understand the role of fishes in aquatic ecosystems since they indicate relationships based on feeding resource. Knowledge on the food and feeding habits is also helpful for successful fish culture in extensive and intensive systems. Fig 1 shows the composition (mean) of the diet of Heteropneustes fossilis in the Vellayani Lake. The fish is omnivorous; feeding predominantly on animals (49.13%) followed by plant components (32.71) and the inorganic components sand and mud (18.12%). The major preferred animal components were copepods (13.42%), cladocerans (10.49%), ostracods (8.65%), insects (6.81%), fishes (5.79%) and gastropods (4.01%). Most of these items occurred throughout the samples. Plant components were represented by phytoplanktons such as Oedogonium, Closterium, Cladophora, Ulothrix and diatoms. Inorganic particles such as sand and mud and digested materials were present as a major food constituent throughout the samples. The high concentration of sand and mud (8.34-13.2%) in the diet of Heteropneustes fossilis in the present study is indicative of its bottom feeding habits. Sand particles play a significant role in the diet of fishes of fresh water systems (Bowen, 1981). The fish are able to digest plant material due to the breaking up of the plant cell by the grinding action of the sand grains (Blaber, 1976) and it has been suggested that the function of considerable fraction of inorganic particles in the stomach contents is to act as a grinding paste in the degradation of the plant cell walls in the stomach (Thomson, 1966).

Variation in the diet Heteropneustes fossilis of Vellayani Lake according to the size of fish indicates small changes in the preference of food items in different size categories which may favour to avoid direct competition for food between the different size categories of fishes. Percentage of various food items (Numerical % and Frequency of occurrence %) in various length groups of Heteropneustes fossilis in the Vellayani Lake is presented in Table I. The frequency of occurrence of plant components decreased from 100% in the smaller size category (15-20 cm) to 68.80% in the larger (30-35 cm) category. The percentage composition of food items found in the different size groups of Heteropneustes fossilis showed that the quantity of plant components (phytoplanktons) decreased from 44.29% (15-20cm) to 20.50% (30-35cm) and the various animal components (%) increased from 44.62 (15-20cm) to 60.56% in 30-35 cm (Fig.2). Feeding on certain food item at different intensities may be an adaptation to minimize the intra specific competition for food (Wijeyaratnae and Costa, 1990; Blay, 1995).The smallest length class selectively feed on insects, copepods and cladocerans among the animal components of the habitat while with the increase in size diverse animal components entered as their diet. It was also noticed that with an increase in size

there was a rise in the occurrence of sand and mud particles in the stomach which is indicative of the increased bottom feeding habit of the fish with the increase in size and age.

Monthly variations in the abundance of food items may be a reflection of the availability of the food in the environment. Monthly numerical percentage (N %) and frequency of occurrence (F %) of various food items of Heteropneustes fossilis in the Vellayani Lake is shown in Table II. During the post monsoon months (December and January) phytoplankton dominated the food items while zooplanktons and other animal components such as copepods, cladocerans, insects and its larvae, gastropods, ostracods and fish remains formed the major components during the premonsoon (February –May) months. Numerical percentages of plant matter showed a gradual reduction from 40.20 during December to 20.32% during May. Most fish species are opportunistic feeders, feed on a wide spectrum of organisms, but switch mainly on food items abundant at space and time.

Feeding intensity of fish in relation to months and size of the fish was observed between the periods December 2017 to May 2018. Active feeding (gorged, full, ¾ full) was found in individuals from 30% (December) to 77.7 %(March).The empty stomachs were dominant during December (14.4%) followed by May (11.7%). Moderate feeding (1/2 full stomach) was observed during all the months and the percentages ranged between 20 (December) and 47.82 % (April). The highest percentage of poorly fed fishes was during December (50%). Fig.3 shows monthly variations in the feeding intensity of Heteropneustes fossilis in the Vellayani Lake.

The percentage of feeding intensity in relation to various length groups is presented in Fig.4. Observation on feeding intensity in relation to size of Heteropneustes fossilis clearly indicated that as the fish grows in size active feeding declined. Active feeding was maximum (48%) in fishes of size 15-20cm and the minimum in 30-35cm (32%). Poorly fed fishes were minimum (20%) in 15-20cm size group and maximum (30.6%) in 30-35cm. The percentages of empty stomachs increased from 0% (15-20cm) to 35.8 % (30-35cm). Narrow range of variation (32-39.6%) was found in moderate feeding intensity. Low feeding intensity in large sized fish maybe due to physiological stress associated with spawning (Sivareddy and Babu, 1989; Zacharia, 2003).

Among the food organisms of Heteropneustes fossilis in the Vellayani Lake, insect larvae and insects occurred in good numbers almost throughout the period of study. Insect larvae and pupae are mainly of chironomids. The large scale occurrence of chironomid larvae and other insects in the guts of Heteropneustes fossilis from Vellayani Lake is also indicative of the polluted nature of Lake water.

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Table 1 Percentage of Various Food Items (N % And F %) In Various Length Groups of Heteropneustes Fossilis In The Vellayani Lake

Food Components	Size category							
	15-20cm		20-25cm		25-30cm		30-35cm	
	N%	F%	N%	F%	N%	F%	N%	F%
Plant matter	44.29	100	38.8	100	27.88	73.53	20.25	68.80
Insects and its larvae	8.00	8.20	6.80	12.00	5.80	20.20	7.05	32.00
Copepods	17.80	34.40	6.95	25.50	13.23	40.00	16.18	36.50
Cladocerans	18.82	58.20	8.82	44.44	8.82	38.60	5.88	26.45
Ostracods	0.00	0.00	10.08	35.60	11.76	40.20	12.76	38.60
Gastropods	0.00	0.00	5.00	0.00	7.84	12.10	8.19	10.80
Fish and fish remains	0.00	0.00	5.88	14.50	6.79	13.40	10.50	20.20
Sand and mud	11.9	90.20	22.70	100	17.88	100	19.19	100

Table 2, Monthly numerical percentage (N %) and frequency of occurrence (F %) of various food items of Heteropneustes fossilis in the Vellayani Lake

Food Components	Months					
	December N% F%	January N% F%	February N% F%	March N% F%	April N% F%	May N% F%
Plant matter	40.20 100	35.18 100	28.90 100	23.12 100	22.35 100	20.32 100
Insects and its larvae	9.24 25.2	18.24 43.80	20.42 54.50	23.20 48.4	20.82 43.20	18.78 35.20
Copepods	13.52 68.0	16.42 62.30	18.50 70.20	15.16 54.40	12.14 48.16	12.36 44.50
Cladocerans	20.68 75.5	10.20 65.50	8.30 40.00	9.20 42.40	8.30 40.80	7.60 42.80
Ostracods	8.02 45.6	1.36 28.20	1.82 30.00	1.82 25.60	1.39 22.80	1.26 20.40
Gastropods	0.00 0.00	0.00 0.00	1.80 18.80	5.46 21.90	9.46 30.20	13.30 38.25
Fish and fish remains	0.00 0.00	8.42 30.66	9.56 40.40	10.24 38.42	12.78 40.42	13.18 54.20
Sand and mud	8.34 86.80	10.18 96.36	10.70 100	11.80 100	12.50 100	13.20 100

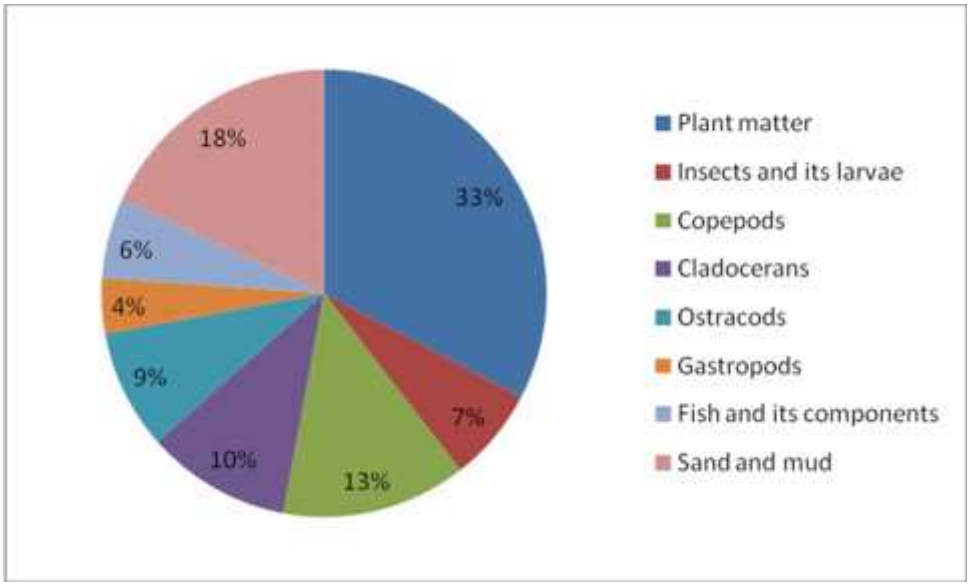

Fig 1 Composition (mean) of the diet of Heteropneustes fossilis in the Vellayani Lake

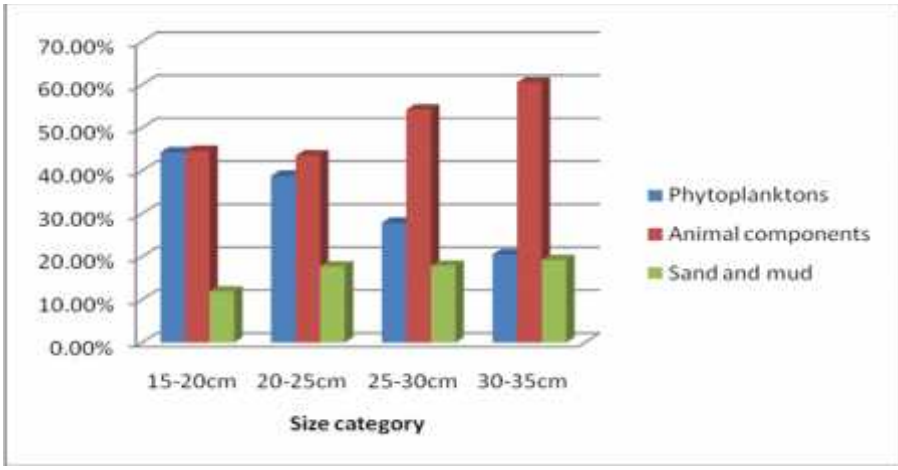

Fig 2 Size dependant variationsin the Composition (mean) of the diet of Heteropneustes fossilis in the Vellayani Lake

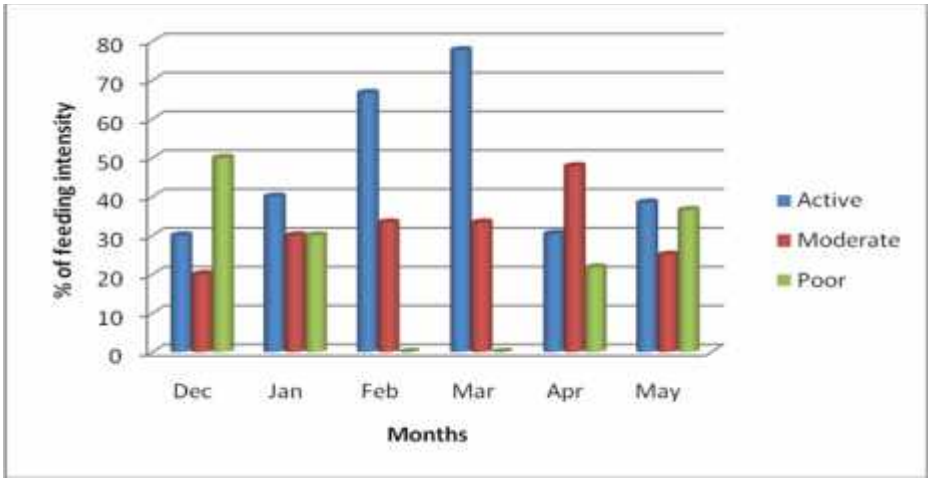

Fig.3 Monthly variations in the feeding intensity of Heteropneustes fossilis in the Vellayani Lake

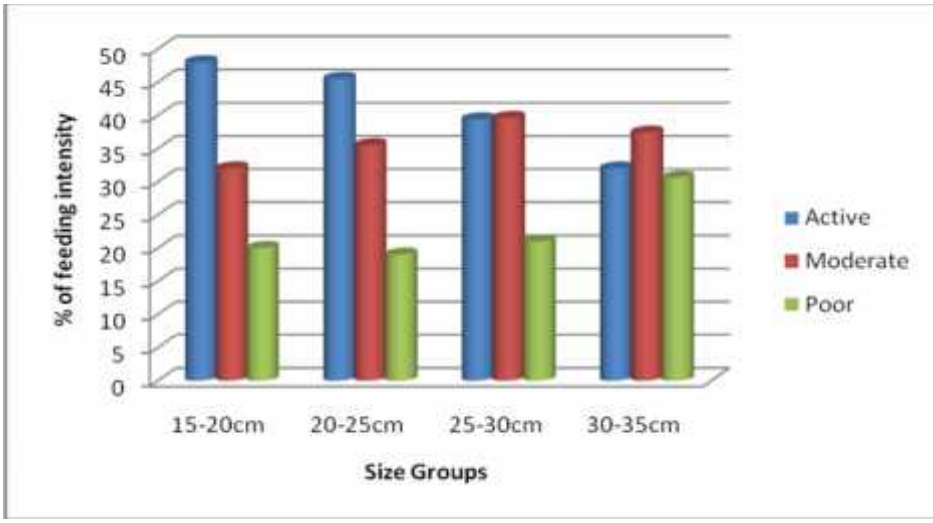

Fig.4 Size dependent variations in feeding intensity of Heteropneustes fossilis in the Vellayani Lake.

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Community Structure of Benthic Foraminifera in the Adimalathura Estuary, Southwest coast of India

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Original Article

Abstract

Foraminifera are successful inhabitants of every aquatic environment from deep oceans to brackish water lagoons, estuaries, and even rarely in freshwater habitats. Sediment samples collected from 3 stations in the Adimalathura Estuary (between latitudes 8^{0}0'-8^{0}24'N and longitudes 77^{0}01'–77^{0}03'E) exposed to pollution from domestic wastes and coconut husk retting were analysed for a period of one year on monthly basis to study the assemblages of foraminifera. The study has shown that *Elphidium advenumis* to be the most dominant and most widely distributed foraminifera species of the estuary. *Textularia agglutinans*, *Rotalia becarii* and *Elphidium crispum* are the other abundant species of the fauna. The fauna in general is dominated by the species of Nonionidae followed by Rotalidae. The Shannon-Wiener diversity index (H') annually ranged from 0 to 1.9225, the Margalef species richness index (d) from 0 to 1.1696, Pielou's equitability index (e) from 0 to 0.9543 and Simpson's index of dominance (C) from 0.1822 to 1. The index values in general were least during the southwest monsoon which coincided with a fall in the density of benthic foraminifera.

Keywords: *Benthic foraminifera, Species diversity, Estuary, Southwest coast of India*

Introduction

Benthic organisms are very sensitive to habitat disturbances, including organic enrichment of the sediment and contamination of the sediment by toxic substances. Any change in the estuarine environment leaves its print on the benthic community inhabiting the sediment biome. The vast majority of the coastal environments have been affected by the adverse effect of coastal contamination from land based sources. The discharge of excessive amount of human wastes to coastal area is one of the most wide spread pollution problems faced by the coastal zone. A fluctuation in organic input is considered to be one of the principal causes of faunal change in estuarine and near shore benthic environment.

Foraminifera are among the most abundant and scientifically important group of organisms. They are an important component of benthic communities in the open ocean, along the coast and in estuaries, where they form sometimes a dominant taxon, both in terms of abundance and species diversity. Their taxonomic diversity gives them the potential for diverse biological responses to various pollutants and to stay as index species for monitoring pollution from diverse sources. The application of benthic foraminifera has emerged

as an excellent environment monitoring tool for polluted aquatic ecosystems. Over the years, various characteristics of foraminifera have been applied for ecotoxicology and pollution monitoring. Rapid changes in abundance of foraminifera were considered as indicators of stressed environment by many researchers (Rao and Rao, 1976; Alve, 1995; Yanko *et al.*, 1999; Nigam, 2005). There are relatively few studies on benthic foraminifera of estuarine habitats.

An outstanding feature of the Kerala coast is the continuous chain of lagoons or estuaries lying along the coastal region and separated from the Arabian Sea by low belt of sand. These extensive estuarine water bodies are getting increasingly polluted as a result of persistent anthropogenic activities. Adimalathura Estuary is a small brackish water biotope between latitudes $8^0 0'$ -$8^0 24'$N and longitudes $77^0 01'$–$77^0 03'$E on the southern part of Kerala in Thiruvananthapuram district, on the southwest coast of India. This small brackish water biotope receive untreated domestic wastes from the thickly populated human settlement around and foul water from the near-by coconut husk retting grounds almost on a continuous basis. Some baseline data on water quality and benthic community is available from the Adimalathura Estuary (Anila Kumary *et al.*, 2007; Anila Kumary, 2014, 2016, 2017), whereas absolutely no information on the foraminiferal assemblages from this area is recorded. The present study was undertaken with the objectives to (1) prepare a check list of the benthic foraminifera species in the Adimalathura Estuary and (2) measure species diversity, richness, dominance and evenness using diversity indices.

Material and methods

Samples of sediment were collected using a hand operated steel corer (5.5 cm inner diameter and 25 cm long) at monthly intervals from three selected stations in the Adimalathura Estuary, station I located in the upper reaches, Station II in the middle reaches and Station III in the lower reaches, close to the bar mouth of the estuary(Fig.1). Totally 108 undisturbed core samples were collected manually and transferred to clean polythene bags and were preserved immediately in 10% neutralized formaldehyde solution. The isolation and extraction of benthic organisms were carried out by flotation decantation method (Holme and McIntyre, 1971). To identify the specimens, the samples fixed in neutralized formaldehyde solution were stained with Rose Bengal and the foraminifera specimens were sorted out. The specimens were identified under compound microscope (Olympus CX41 under higher magnification of 1000x) and classified following Loeblich and Tappan (1987). From the species composition at each station the descriptive measures of diversity indices were worked out following the expressions

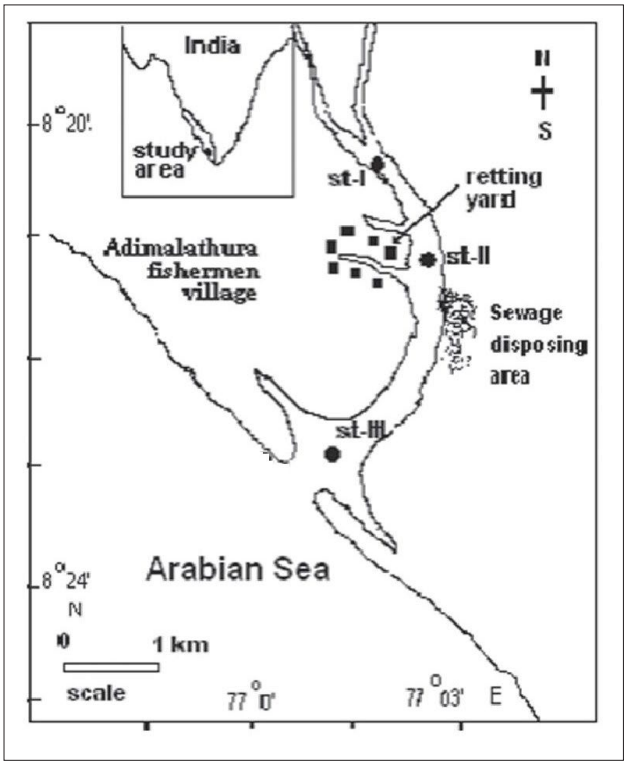

Fig. 1. Map showing the Adimalathura Estuary and location of stations

Index of species diversity (Shannon and Weaver, 1963) $H' = -\sum (ni/N) \log (ni/N)$

Index of Dominance (Simpson, 1949) $C = \sum (ni/N)^2$
Species richness index (Margalef, 1958) $d = S-1/ \log N$
Species evenness index (Pielou's, 1966) $e = H'/ \log s$
Where, ni = importance value of each species
N = total of importance values
S = number of species

Results and discussion

The study revealed the occurrence of 14 species of foraminifera belonging to 8 genera from the families Lituolidae, Textulariidae, Rotalidae, Nonionidae and Globigerinidae. The fauna in general was dominated by the species of Nonionidae followed by Rotalidae. Among these the foraminifera species widely distributed in the estuary are *Elphidium advenum* and *Textularia agglutinans*. This assemblage is characteristic of present-day intertidal and estuarine environment (Reddy and Reddy, 1982; Suresh Gandhi *et al.*, 2014). It was also observed that the foraminiferal species such as *Textularia cuneiformis, Nonion scaphum* and *Globigerina dubia* were very rare and low in abundance. Species such as *Textularia cuneiformis, Rotalia becarii*, *Nonion boueanum*, *Nonion scaphum*, *Globigerina dubia* and *Orbulina universa* were characteristic of the downstream station with high marine influence. Occurrence of foraminifera

species and their percentage contribution at the three stations of the estuary is given in Table 1.

Table I. Composition (% of species density) of foraminifera at the different stations of Adimalathura Estuary

Species	Station I	Station II	Station III
Ammobaculites taylorensis	0	6.2	0
Ammobaculites catenulatus	8.82	0.36	0
Textularia agglutinans	27.55	28.57	8.69
Textularia polustris	4.18	1.07	0.49
Textularia sagittula	0	1.58	0.68
Textularia cuneiformis	0	0	0.64
Ammonia becarii	1.21	1.17	0
Rotalia becarii	0	0	17.39
Elphidium advenum	59.43	54.16	60.62
Elphidium crispum	0	8.06	4.67
Nonion boueanum	0	0	4.16
Nonion scaphum	0	0	0.13
Globigerina dubia	0	0	0.78
Orbulina universa	0	0	1.91

The total density as well as diversity of foraminifera was generally low in the study area. The peak standing stock was 2422/ m^2 and there was considerable station to station variability in abundance and diversity. Foraminiferal density and species richness at the different stations are presented in Table 2. Upstream station was poorly populated while the downstream section of the estuary had a large population together with better species richness. The variation in total abundance of foraminifera in the Adimalathura Estuary is mainly due to the substrate as well as tidal current action. It was found that the bar mouth of the estuary is a zone of unstable substratum which uproots benthic foraminifera from the habitat. However, comparatively high density and diversity of foraminifera were recorded in the lower reaches of the estuary with sandy bottom. Further, low salinity due to freshwater influx may also have a control over the foraminiferal abundance in the estuary. Reduced number of species were noted in the upper fresh water zone and in the middle reaches of estuary.

Changes in the species composition in a community are capable of providing a more sensitive and clear measure of pollution disturbances. Some sensitive species decrease in relative importance, some tolerant species remain unaffected

Table 2. Density (mean) of total foraminifera (No/m^2) and the species richness (No. of species) at the different stations of Adimalathura estuary

Season	Station I		Station II		Station III	
	No/m^2	Number of species	No/m^2	Number of species	No/m^2	Number of species
Premonsoon	344	4	488	7	862	10
Monsoon	257	3	359	5	426	8
Postmonsoon	442	5	622	8	1422	10
Annual	348	5	490	8	904	11

and some which may benefit from the changed conditions increase (Warwick, 1988). Species diversity indices measure the way in which the individuals of an ecological community are distributed. Species diversity is at a minimum when all the individuals belong to the same species and maximum when the individuals belong to different species. The index of Shannon and Weaver (H') used to evaluate the diversity of foraminifera species in the Adimalathura Estuary varied from 0 (Station I) during June to 1.9225 (station III) during September. Monthly variations in the species diversity of benthic foraminifera at the three stations of the Adimalathura Estuary are presented in Fig. 2. All the three stations had maximum species diversity during the post monsoon season coinciding with higher density of total foraminifera. Foraminiferal zonatons are, in general, related to factors such as river runoff, currents, environmental stability and bio-geo chemical process (Denny and Sen Gupta, 1993; Elakkia and Manivannan, 2013).The monsoon period was generally characterised by poor density and low diversity. The shift in this community structure was probably caused by heavy rain and flood water discharge which might have flushed out the surface layers of sediment.

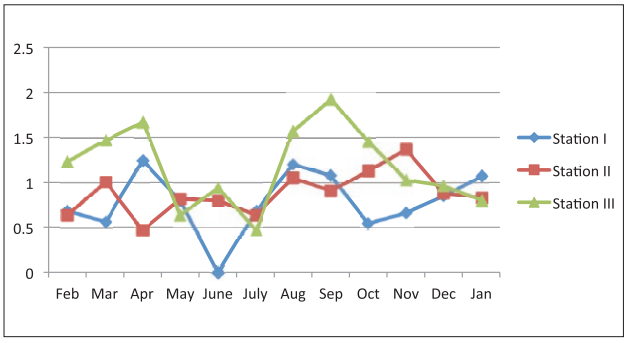

Fig.2 Monthly variations in species diversity index (H') of foraminifera

Species richness is the ratio between the total number of species and the total number of individuals and the index of species richness increase with the occurrence of several species. Higher values of species richness occur due to the occurrence of several species without allowing one or two species to dominate the community completely. Species richness in the estuary was maximum (1.1696) during September (Station III) along with the maximum value of H'. Lowest value of species richness (0) was during June at station I (Fig. 3).

A major component of community diversity is the evenness or equitability in the apportionment of the individuals among species. Species evenness describes how equally the various species are distributed in the community. High evenness index occurs when the large numbers of species

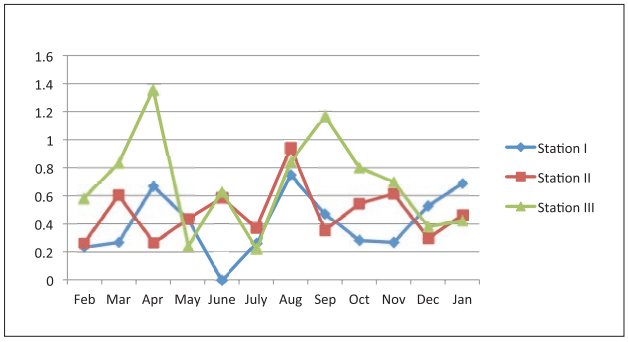

Fig.3 Monthly variations in species richness index of foraminifera

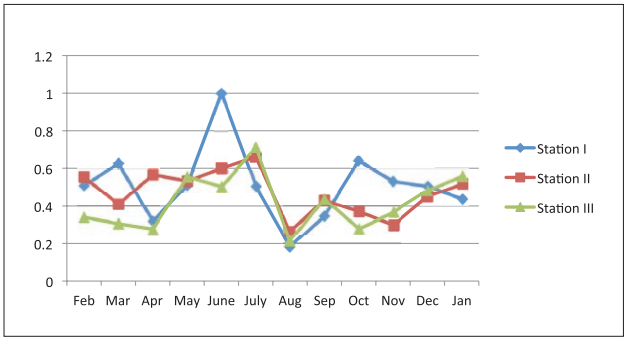

Fig.5 Monthly variations in species dominance index of foraminifera

in a community are virtually equal in abundance. The evenness of distribution among species may be the result of competition under optimum conditions (Patrick, 1971). Evenness index of foraminifera in the Adimalathura Estuary was least (0) during June at station I due to the complete dominance *Elphidium advenum* and the highest (0.9879) during September at station III (Fig. 4). The distribution of foraminiferal community was more even during the post monsoon season at all stations in the estuary.

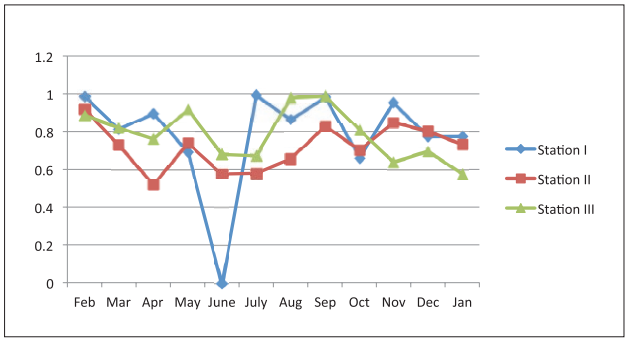

Fig.4 Monthly variations in species evenness index of foraminifera

Communities have species or species groups which largely control the energy flow and strongly affect the environment of all other species which are known as ecological dominants. The degree to which dominance is concentrated at one, several or many species can be expressed by the index of dominance (Simpson, 1949) which sums up the importance of each species in relation to the community as a whole. Dominance index is used to identify the main species in a community (Rosenberg, 1975). Among the different stations in the Adimalathura Estuary peak dominance index was during June (1.00) at station I with the complete dominance of *Elphidium advenum* and during July at stations II and III due to the clear dominance of *Elphidium advenum* over the other component species (Fig. 5).

Estuarine ecosystems are generally characterized by low species diversity because of various factors such as bathymetry, sediment texture, physicochemical characteristics of sediment as well as water and pollution (Pielou, 1975).The number of species present and the diversity indices were less at the upstream station with muddier deposits at the bottom whereas comparatively high density and diversity of foraminifera were recorded in the lower reaches of the estuary with sandy bottom. Foraminifera are very sensitive to any kind of pollution in the ambient environment. Anthropogenic stress may lead to alterations in the community structure of benthic foraminifera, which include changes in its density and diversity, high abundance of opportunistic species, barren areas, test deformations and the changes of test chemistry (Yanko *et al.*, 1988; Murray, 2006; Ferraro *et al.*, 2006; Nigam *et al.*, 2006). The impact of anthropogenic stress on benthic foraminifera community depends, however, on the type of stress, and its supply rate. The better dominance index prevailed at the intermediate station (Station II) could be attributed to the modification in the community structure consequent to changes in the organic load in to the estuary at the station.

Acknowledgements

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LENGTH-WEIGHT RELATIONSHIP AND CONDITION OF *HETEROPNEUSTES FOSSILIS* (BLOCH) OF VELLAYANI LAKE, KERALA, INDIA

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ABSTRACT
The present study relates the length-weight relationship and condition factor of *Heteropneustes fossilis* (Bloch) from Vellayani Lake, Thiruvananthpuram, Kerala. The study was carried out using fishes belonging to different size categories during December 2017 to May 2018. A total of 128 specimens of *Heteropneustes fossilis* were used for the analysis. The total length of the fishes analysed ranged from 18cm to 31.8 cm with a mean length of 25.27 cm and the total weight ranged from 11.94 g to 216.41 g with an average weight of 116.23 g. The length – weight relationship calculated for the total fishes was $W = 0.000070501\ L^{2.7414}$. The slope value was lower than the critical isometric value of 3 exhibiting negative allometric growth in larger length groups (25-35 cm) whereas 'b' exhibits positive allometric growth in smaller (15-25cm) forms. The condition factor of *Heteropneustes fossilis* observed ranges from 0.5078 to 1.0284 with a mean value of 0.8802. The negative allometric growth observed in the largest category may be due to lower feeding proficiencies or may be the result of loss of energy for breeding purpose.

KEYWORDS: Length-Weight relationship, condition factor, *Heteropneustes fossilis*, Vellayani Lake.

INTRODUCTION
The Indian stinging catfish, *Heteropneustes fossilis* (Bloch), belong to the fish family Heteropneustidae is found throughout south and Southeast Asian countries including.

Bangladesh, India, Laos, Myan-mar, Nepal, Pakistan, Sri Lanka and Thailand (Talwar and Jhingran, 1991). *H.fossilis* is considered as a significant fish commercially and aqua culturally in many Asian countries (Hossain *et al*., 2015). Due to the accessory respiratory structures it can survive even in oxygen depleted water. It is heavily fished for its energizing meat quality that includes taste, nutritional, and medicinal values. There are high amounts of protein, iron (226 mg/100g) and calcium in its muscles (Saha and Guha, 1939; Alok *et al*., 1993). Being a lean fish (fat content only 2.57 ± 0.24%), it is conducive to people on low-fat diets (Rahman *et al*., 1982).

Length- weight relationship is one of the most popular aspects which are being extensively studied in fishery biological investigations. It establishes the mathematical relationship between the two variables and helps in assessing growth, maturity, reproduction, general well being, and it enables conversion of one variable to another (Bagenal and Tesch, 1978; Pauly, 1983; 1993). The length-weight relationship can be extended for the estimation of fish condition assuming that a heavier fish of a given length is in a better condition (Le Cren, 1951). Variations in fish's condition factor primarily reflect its state of sexual maturity, degree of nourishment and the general well being of the individuals.

Inland fisheries have a great scope in Kerala, as the state is endowed with fresh water resources consisting of rivers, backwaters, estuaries, fresh water lakes, reservoirs, minor irrigation tanks and ponds. The inland fish production provides significant contribution to the animal protein supplies in rural areas of the state. Vellayani Lake, spread over 7.5 acres is one of the three rain-fed freshwater lakes in Kerala and is the largest fresh water lake in Thiruvananthapuram district, located 9 Kms from Thiruvananthpuram the capital city of Kerala. The lake water is extensively used for drinking and irrigational purposes in addition to the fish culture by the Fisheries Department, Government of Kerala.

Morphometric relationships of length and weight have been determined in several species of fresh water fishes. However, limited information is available on air breathing fish species. The Stinging Catfish *Heteropneustes fossilis* commonly known as 'Kaari' in Kerala is one of the major fish species in terms of abundance in the Vellayani Lake.

Therefore, the present study was undertaken to determine the length-weight relationship and condition factor of *Heteropneustes fossilis* inhabiting Vellayani Lake.

MATERIALS AND METHODS

In the present study 128 numbers of live samples of *Heteropneustes fossilis* of various age groups were collected from different parts of the Vellayani Lake during the period December 2017 to May 2018. The total length and standard length of the fishes were measured to the nearest mm and weight to the nearest 0.1 g. Length-weight (log-transformed) relationships were determined by linear regression analysis using the data analysis package in SPSS software (version-16). The mean, standard deviation and correlation coefficient of total length, standard length and body weight were also calculated. It was calculated for two length categories (15-25 cm and 25-35 cm) and for the total fishes collected.

The length-weight relationship was worked out as per cube law given by Le Cren (1951)

$W=aL^b$

Where, W = weight of fish (g), L = the observed total length (cm), 'a' is the rate of change of weight with length (regression intercept) and 'b'is the weight at unit length (regression slope).

The logarithmic transformation of the formula is

Log W = log a + b log L

When 'b' is equal to 3 isometric pattern of growth occurs, but when 'b' is not equal to 3, allometric pattern of growth occurs, which may be positive if >3 or negative if <3.Bailey's t- test (Snedecor and Cochran, 1967) was employed to determine if regression coefficients differed significantly from the isometric value of 3 following the formula,

t = b-3/Sb, where

b = regression coefficient of log transformed data and Sb= standard error of b

Condition factor (K), a measure of the well-being or plumpness of fish, was calculated following the equation proposed by Fulton (1904), assuming that the weight of a fish is proportional to the cube of length.

$K=100x\ (W/L^3)$

Where, W = body weight of the fish and L= total length of the fish

RESULTS AND DISCUSSION

The total length and weight of *Heteropneustes fossilis* used in the present study varied from 18cm to 31.8 cm and 11.94 g to 216.41 g respectively. Range and mean ± SD of total length, standard length and body weight for *Heteropneustes fossilis* are given in the Table-1.

Tables II and III represents the size related variations in the total length - weight relationship and standard length weight relationship of the fish. Regression equation revealed that the value of b for the total fishes collected (2.7414) is significantly different from 3 (t- test<0.05) indicating that length – weight relationship of the species depart significantly from isometry. The value of 'b' remains constant at '3'in an ideal fish (Allen, 1938), but under natural conditions the value of 'b' usually ranges between 2.5 and 4 (Hile, 1936; Martin, 1949). When b=3, the growth is isometric and the increase in weight is proportional to the cube of length. When the value of b varies from 3, weight increase is said to be allometric. In the present study 'b' varied between 2.414 and 3.209 in the various size categories. The slope value was lower than the critical isometric value of 3 in larger length groups whereas the 'b' value is higher than 3 in smaller sizes.

Any indication in biological events could be recorded by allometric law since 'a 'and 'b' of allometric formula might vary within a wide range for very similar data and very sensitive to even slight variations in various factors. Variations in the slope mostly reflect the change in the body form when the weight of the fish gets affected by environmental factors like temperature, food supply, spawning conditions and other factors like life stages, sex, fishing area, fishing time and sample size variations (Ricker,1973; Bagenal and Tesch,1978; Kleanthids *et al*., 1999). Allometric growth is negative (b < 3) if the fish gets relatively thinner as it grows larger, and positive (b > 3) if it gets plumber as it grows larger. The results of the present study is in conformity with the views of Le Cren (1951), Wootton (1992), Khan *et al*. (2011),Myla *et al*.(2012), Kuldeep Kumar *et al*. (2013) and Preetha G Nair *et al*.(2015) that the fish normally does not retain the same shape or body outline throughout their life span and specific gravity of tissues may not remain constant and the actual relationship may depart significantly from the cube law. Higher metabolic activity with spawning season lowers the 'b' value while less metabolic activities; accumulation of fat, weight of gonad etc. during the pre-spawning period increases the values (Weatherly and Gill, 1987). The negative allometric growth due to loss of energy in gonad development at breeding season was reported by Das *et al*. (1997). The closeness of 'b' values to 3 also suggests a healthy environment for the fishes with respect to feeding and growth. Figs. 1-6 illustrates the length-weight relationship in *Heteropneustes fossilis* of Vellayani lake. Standard length- weight relationship of the species in the lake was also allometric (b= 2.619 for total fishes) and the allometry was towards positive (b= 3.083) in the smallest size category (15-25 cm).The correlation coefficient 'r' in length- weight relationship of total fishes (r^2 = 0.9575) and that in the lowest size category (r^2 = 0.9515) were closest to 1.

The condition factor is used in fisheries science to compare the 'condition', 'fatness' or wellbeing of fish. It is based on the hypothesis that heavier fish of a particular length is in the better physiological condition than lower weight (Bagenal, 1978). Condition factor basically represents the quality of fish, which is actually the result of the interactions between biotic and abiotic factors and

their effect on the physiological condition of the fish. Condition factor is primarily used as an index for monitoring the state of sexual maturity and the feeding intensity of fish (Wootton, 1990; Williams, 2000). When condition factor value is higher it means that the fish has attained a better condition. The condition factor observed for *Heteropneustes fossilis* in the present study fluctuated from 0.5078 to 1.0284 and the values (mean) were comparatively higher in lower size category (Table IV). Fluctuations in condition factor were reported earlier in various species of fishes in relation to reproductive cycle, feeding rhythms, age, physiological state and physico-chemical factors of the environment (Kurup and Samuel, 1987; Kurup, 1990; Kalita and Jayabalan, 1997; Alex Nehemia *et a*l., 2012; Preetha G.Nair *et al*., 2015; Das *et al*., 2015; Anila Kumary and Smrithy raj, 2016; Anila Kumary and Pooja Moncy 2017; Anila Kumary and Karthika, 2017). The variations in condition factor in the size categories analyzed can be attributed to factors such as life stages, faster growth rate of young ones, differences in food reserves, food preferences and variations in the samples collected.

The present study has revealed that there is significant deviation in the slope value from the critical isometric value of 3 in *Heteropneustes fossilis* of Vellayani lake and shows low condition factor in the environment. . The lower size group shows insignificant positive allometric growth while the larger size groups exhibits significant negative allometric growth. The study suggests that effective management measures should be adopted for the conservation of the species in the study area.

Table 1: Range and mean ± SD of total length, standard length and body weight for *Heteropneustes fossilis.*

Morphometry	Minimum	Maximum	Mean ± SD
Total Length(cm)	18.00	31.80	25.27 ± 3.68
Standard Length(cm)	15.80	28.70	22.56 ± 3.43
Total weight(g)	11.94	216.41	116.23 ± 45.03

Table II: Size - related variations in total length - weight relationship of *Heteropneustes fossilis.*

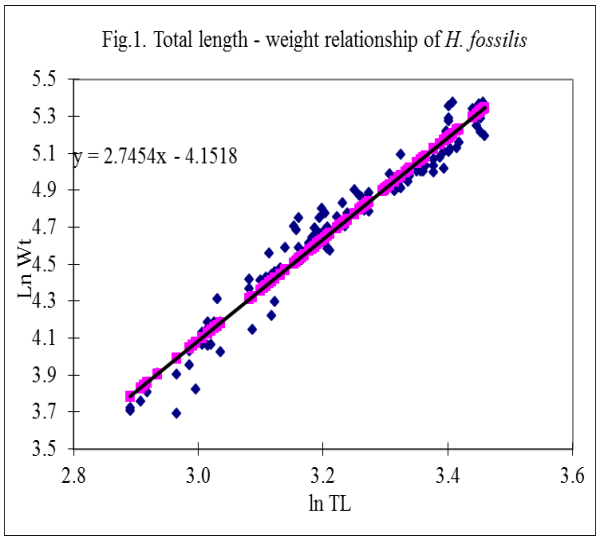
Category	No. of samples	Regression equation (log W= log a+ b log L)	Parabolic equation ($W= a L^b$)
15-25cm	62	-5754+3.2093 log L	$0.000002658\ L^{3.2093}$
25-35cm	66	-3.0568+2.414 log L	$0.0008774\ L^{2.414}$

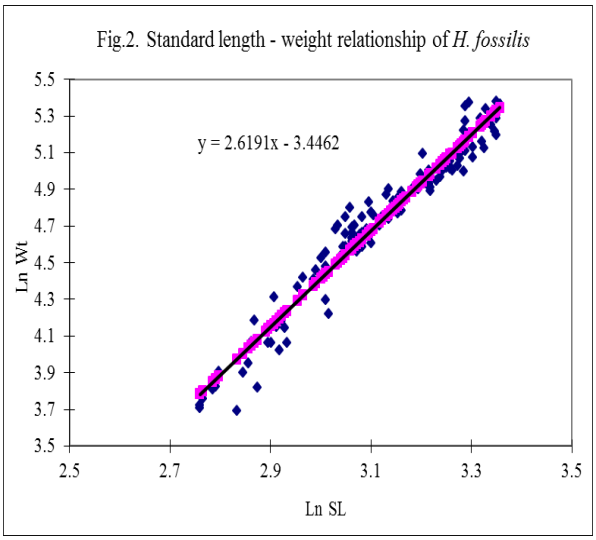
Table III- Size - related variations in standard length - weight relationship of *Heteropneustes fossilis*

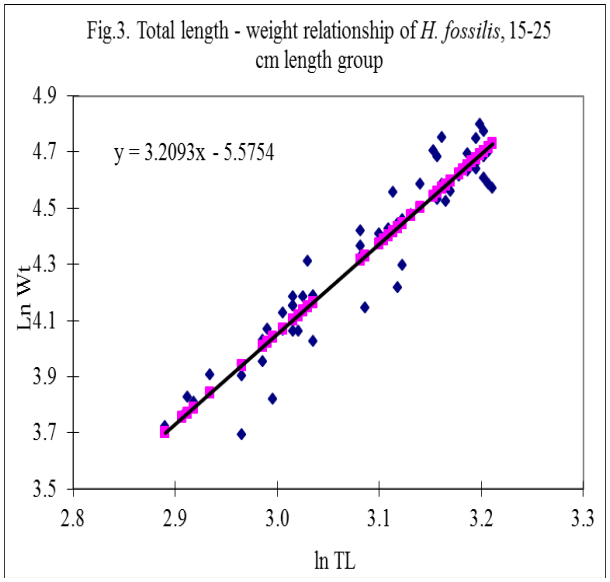
Category	No. of samples	Regression equation (log W= log a+ b log L)	Parabolic equation ($W= a L^b$)
Total	128	-3.4462+2.6191 logL	$0.0003579\ L^{2.6191}$
15-25cm	62	-4.8163+3.0837 logL	$0.00001562\ L^{3.0837}$
25-35cm	66	-2.3264+2.2696 logL	$0.004716\ L^{2.2696}$

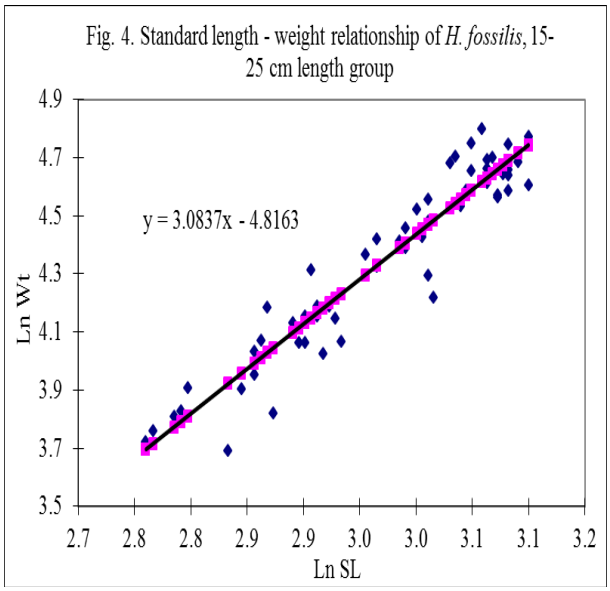
Table IV: Size dependent variations in condition factor of *Heteropneustes fossilis.*

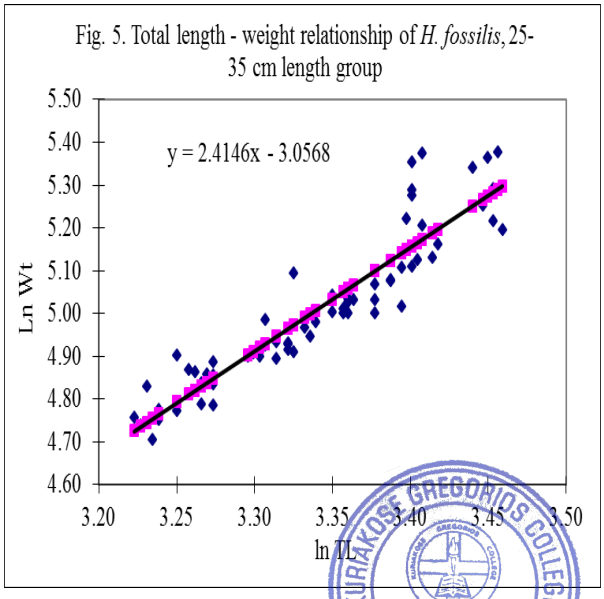
Category	No. of samples	Minimum	Maximum	Mean
Total	128	0.5078	1.0284	0.8802
15-25cm	62	0.5078	1.0284	0.9216
25-35cm	66	0.5612	0.9724	0.7591

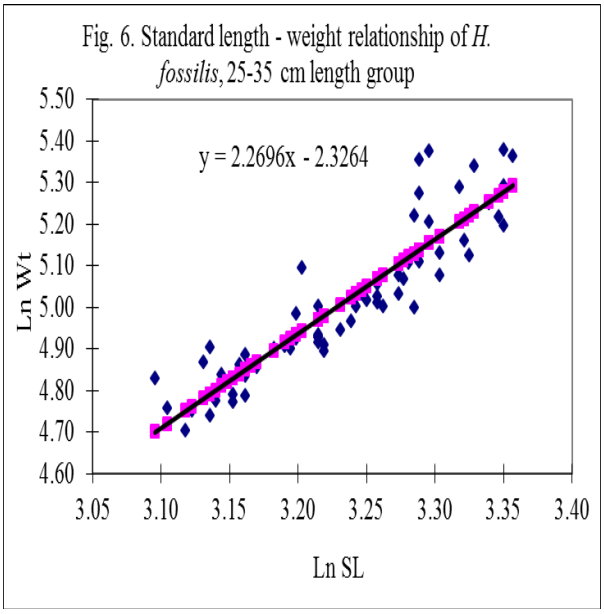












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COMMUNITY STRUCTURE OF BENTHIC FORAMINIFERA IN THE POONTHURA ESTUARY, THIRUVANANTHAPURAM, KERALA

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ABSTRACT
The present investigation reveals the spatio-temporal variations in the distribution, abundance and diversity of benthic foraminifera in the Poonthura estuary (latitude $8^0$25' - $8^0$30'N and longitude $76^0$55'- 77^0 00'E) on the southwest coast of India lying in the outskirts of Thiruvananthapuram, the capital city of Kerala. Sediment samples were collected from 3 stations in the Poonthura estuary and totally 108 core samples were collected in order to study the assemblages of foraminifera. Density of total foraminifera (No/m^2) in the estuary seasonally varied from 144 to 422. Upstream stations were poorly populated while middle and downstream stations have a large population. Foraminiferal species richness was very low, only 12 species were identified. Among the different foraminiferal species *Ammobaculites catenulatus*, *Textularia agglutinans*, *Textularia sagittula* and *Ammonia becarii* are found wide spread and abundant. Preferences for substrate type coupled organic enrichment and higher salinity conditions explain for the occurrence of benthic foraminifera in the Poonthura estuary.

KEYWORDS: Benthic foraminifera, Poonthura estuary, Species diversity.

INTRODUCTION
The occurrence and abundance of benthic species is determined by physical factors such as water depth, temperature, light availability, turbidity and turbulence of water as well as bottom sediment, chemical factors like salinity and biological factors such as food supply, presence of symbiotic organisms, parasites and predators (Murray, 1991; Jorissen, 1999; Elakkia and Manivannan, 2013). Foraminifera are unicellular microorganisms with the outer hard covering known as test which is generally either calcareous or agglutinated in nature. They are successful inhabitants of every aquatic environment from deep oceans to brackish water lagoons, estuaries, and even rarely in freshwater streams, lakes etc. Benthic foraminifera are extremely sensitive towards even subtle changes in environmental conditions and therefore, are considered to be the best proxies for understanding environmental disturbances. The application of benthic foraminifera has emerged as an excellent environmental monitoring tool for contaminated and polluted waters (Alve, 1995; Yanko *et al*., 1999; Jorissen, 1999; Scott *et al*., 2005).

Population growth and the resultant acceleration of domestic, industrial, agricultural and recreational activities are the major causes of anthropogenic pollution of the aquatic environment. Almost all estuarine environments traditionally serve as recipients for domestic and industrial effluents. Such pollution produces numerous obvious biological changes in community structure of biota inhabiting in such environment. Poonthura estuary on the southwest coast of India (latitude $8^0$25' - $8^0$30'N and longitude $76^0$55'-$77^0$00'E) is in the outskirts of Thiruvananthapuram, the capital city of Kerala. Downstream sections of Karamana River are designated as Poonthura estuary which is separated from the Arabian Sea by a sand bar at Poonthura. The estuary is freely connected with the Arabian Sea during monsoon season following heavy discharge of water from the Karamana River. The total length of the estuary is 4.35 km and encloses a small island called Edayar. Parvathy Puthanar canal, the most polluted canal of the city by the sewage spilled from the city sewage farm at Muttathara joins the estuary. Poonthua estuarine habitat also serves as coconut retting ground. Although some physico- chemical studies of water and baseline data on biota is available from the Poonthura estuary (Anila Kumary and Abdul Azis, 1992; Anila Kumary *et al*., 2001; Anila Kumary, 2008; 2016), absolutely no information on the foraminiferal assemblages of Poonthura estuary. The objective of the present study was to document the benthic foraminiferal abundance, distribution and diversity in the Poonthura estuary, Thiruvananthapuram on the southwest coast of India.

MATERIALS AND METHODS

Samples of sediment were collected using a hand operated steel corer (5.5 cm inner diameter and 25 cm long) from three selected stations in the Poonthura estuary, station I located in the upper reaches, Station II in the middle reaches and Station III in the lower reaches. Totally 108 undisturbed core samples were collected manually and transferred to clean polythene bags and were preserved immediately in 10% neutralized formaldehyde solution. The isolation and extraction of benthic organisms were carried out by flotation decantation method (Holme and McIntyre, 1971). To identify the specimens, the samples fixed in neutralized formaldehyde solution were stained with Rose Bengal and the foraminifera specimens were sorted out. The specimens were identified and classified following Loeblich and Tappan (1987). From the species composition at each station the descriptive measures of diversity indices were worked out following the expressions.

Shannon and Weaver (1963) index of species diversity
$H' = - \sum (ni/N) \log (ni/N)$
Simpson (1949) index of Dominance $C = \sum (ni/N)^2$
Margalef (1958) species richness index $d = S-1/ \log N$
Pielou's (1966) evenness index $e = H'/ \log s$

Where, ni = importance value of each species
N = total of importance values
S = number of species

Sediment samples were analyzed for grain size, redox potential and organic carbon percentage following standard procedures (Krumbein and Pettijohn, 1938; El Wakeel and Riley, 1956). Bottom water samples were analysed for salinity, Dissolved Oxygen and hydrogen sulphide (Strickland and Parsons, 1972).

RESULTS AND DISCUSSION

The study of foraminifera in the Poonthura estuary revealed a total number of 12 species belonging to 8 genera and 5 families. Among the total foraminifera, dominant families were Textulariidae, Rotalidae and Nonionidae. The most abundant genera were *Textularia*, *Ammonia*, *Elphidium* and *Nonion* and these were the common genera occur in many samples at the various stations of the Poonthura estuary. Density of total foraminifera (No/m^2) seasonally varied from 144 at station I to 422 at station III. Upstream station was poorly populated while the middle and downstream sections of the estuary have a large population together with better species richness. Density and species richness of foraminifera in the Poonthura estuary is presented in Table I.

Foraminiferal zonations are frequently shown to be related to natural water- mass boundaries (Denny and Sen Gupta, 1993), river runoff, seasonal changes, current and bio-geo chemical process (Elakkia and Manivannan, 2013). Some benthic foraminifer's species rapidly react with the input of organic matter from primary production exhibiting an increase in population size with organic enrichment (Murray, 1991). Several benthic foraminifera are known to exist in oxygen depleted environments (Murray, 1991; Fontanier *et al.*, 2002). The diversity of foraminifera depends largely on the ecological conditions at a site. The general trend in the distribution of foraminiferal assemblages of the Poonthura estuary is the increasing species diversity in line with increasing salinity gradients and environmental stability. Species richness was very low at the upstream station and maximum in the lower reaches of the estuary were the marine influence is maximum. Table II shows the composition (%) of foraminifera at the different stations of Poonthura estuary.

Almost all estuarine environments traditionally serve as recipients for domestic and industrial effluents. Their effects on the local fauna depends mainly on factors such as the nature and volume of the effluents, whether the effluents are discharged directly into the estuary from the point of sources or indirectly through the river system and on the hydrographical and geomorphplogical properties of the estuary. Among the different foraminiferal species *Ammobaculites catenulatus, Textularia agglutinans, Textularia sagittula, Ammonia becarii* and *Elphidium advenum* are found wide spread and abundant in the Poonthura estuary. These species have high tolerance for salinity variations and surviving successfully in estuarine environments and is comparable with species abundance in other estuaries with similar climatic condition (Reddy and Reddy, 1982; Narappa *et al*., 1982; Kameswara Rao and Balasubramanian, 1996; Jayaraju *et al*., 1998; Kameswara Rao *et al*, 2000, Naresh Kumar *et al*., 2012). In the upper reaches of the estuary only the arenaceous species were found while the area near the bar mouth was chiefly characterised by calcareous foraminifers. *Ammonia becarii* is reported to be highly tolerant to different ecosystems and widely considered as a cosmopolitan species (Suresh Gandhi *et al*., 2014, 2017). *Ammonia becarii* was the dominant species at the upper and middle reaches of the Poonthura estuary. This species was highly tolerant to the low dissolved oxygen and was resistant to the large amount of hydrogen sulphide and low Eh persistent at these stations. Negative effects of sewage effluents on benthic foraminiferal assemblages have been reported (Alve, 1995) in association with the presence of an abiotic zone or a zone of low oxygen and pH values. Reduced number of species has been noted in the upper and middle reaches of estuary which is the immediate vicinity of sewage out fall in to the estuary.

The character of substratum is an important factor in the distribution of foraminifera. A number of studies have revealed a close correlation between the nature of sediment, especially the texture of the sediment and the foraminiferal population (Reddy and Reddy, 1982; Setty and Nigam, 1982; Murray, 1991; Rao and Balasubramanian, 1996; Jannink *et al*., 1998; Fontanier *et al*., 2002; Suresh Gandhi *et al*., 2014). Silty and

muddy substrates are often rich in organic debris together with bacterial blooms. Such substrates are attractive to foraminifera species and usually support large populations. The abundance of foraminifera was associated with the sandy nature of the substratum with varying percentage of silt and clay in the present study. The relative abundance of sand, silt and clay in the sediments of Poonthura estuary indicates that most of the sediments are silty sand followed by sand while few are clayey sand. The accumulation of organic matter in the fine sediments favours the occurrence of stress- tolerant genera such as *Ammonia*, *Elphidium* etc. in the middle and lower regions of the estuary. Murray (1991) reported that *Ammonia* prefers muddy sand while *Nonion* prefers fine mud and silt. The variation in the abundance of total foraminifera as well as their species composition in the estuary is mainly due to substrate together with organic matter enrichment as well as tidal current action. Table III explains water quality and Sedimentological ranges preferred by Foraminifera species in the Poonthura estuary. Fresh water influx from the Karamana River and the low salinity control the foraminifer's abundance at the riverine station (Station I). Preferences for substrate type coupled organic enrichment and higher salinity conditions explain for the occurrence of benthic foraminifera in the estuary.

The variation in the total abundance of foraminifera in the Poonthura estuary is mainly due to substrate as well as tidal current action. Main ecological parameters which govern the distribution and abundance of foraminifera in the Poonthura estuary are organic matter content, salinity and the nature of the sediment.

Table I: Density of total foraminifera (No/m^2) and the species richness (No. of species) at the different stations of Poonthura estuary.

Season	Station I		Station II		Station III	
	No/m^2	No. of species	No/m^2	No. of species	No/m^2	No. of species
Premonsoon	144	5	188	7	362	10
Monsoon	157	4	259	5	226	9
Postmonsoon	242	5	342	9	422	11

Table II: Composition (% of species density) of foraminifera at the different stations of Poonthura estuary.

Species	Station I	Station II	Station III
Ammobaculites taylorensis	5.01	14.17	0
Ammobaculites catenulatus	1.22	9.11	3.15
Textularia agglutinans	41.76	15.99	6.01
Textularia polustris	0	7.07	0.88
Textularia sagittula	8.80	6.63	0.88
Ammonia becarii	43.21	30.17	14.57
Rotalia becarii	0	1.62	9.54
Elphidium advenum	0	0	50.07
Nonion boueanum	0	11.91	11.37
Nonion scaphum	0	0	0.59
Globigerina dubia	0	0	2.06
Orbulina universa	0	3.33	0.88

Table III: Water quality and Sedimentological ranges of Foraminifera species in the Poonthura estuary.

Species	Salinity BW (S.10^{-3})	DO BW (mg/l)	H_2S BW (mg/l)	Eh BS (mv)	OC BS (%)	Sand BS (%)	Silt BS (%)	Clay BS (%)
Ammobaculites taylorensis	0.66-25.76	0.0-6.06	0.0-4.56	-211-+101	0.84-8.43	22.30-52.25	39.28-65.46	1.18-10.82
Ammobaculites catenulatus	0.66-11.17	1.10-5.49	0.0-1.03	-199-+86	0.84-3.75	22.10-79.37	18.55-70.67	2.57-38.05
Textularia agglutinans	0.34-23.99	0.0-6.06	0.0-4.56	-211-+133	0.78-8.43	22.30-93.25	6.75-64.75	1.94-38.05
Textularia polustris	0.34-23.99	0.0-5.49	0.0-4.56	-211-+133	1.07-8.43	22.10-81.58	10.20-70.67	6.56-23.02
Textularia sagittula	0.34-23.99	1.93-5.23	0.0-1.03	-67-+108	0.84-3.75	26.38-77.17	17.45-58.75	0.0-35.01
Ammonia becarii	0.34-11.27	0.0-6.06	0.0-4.56	-211-+101	0.84-8.43	22.30-100	0.0-70.67	0.0-38.05
Rotalia	1.29-	2.21-	0.0-	-17-	0.24-	44.18-	0.0-	0.0-

becarii	26.27	5.51	0.23	+156	2.81	100	41.95	23.02
Elphidium advenum	0.34-26.27	1.65-6.33	0.0-0.99	-23-+156	0.24-3.32	59.90-100	0.0-40.10	0.0-17.20
Nonion boueanum	0.66-17.94	2.21-6.59	0.0-1.15	-133-+136	0.67-3.75	41.75-93.25	6.75-40.35	0.40-8.22
Nonion scaphum	2.90-26.27	3.77-6.33	0.0	+ 47-+156	0.24-268	74.75-81.58	5.0-30.63	2.40-5.99
Globigerina dubia	2.90-26.27	3.77-6.33	0.0	+ 47-+156	0.24-268	74.75-81.58	5.0-30.63	2.40-5.99
Orbulina universa	0.66-23.99	2.12-6.19	0.0	-32-+142	0.67-2.68	22.10-81.58	10.20-70.67	6.56-23.02

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Customer Experience of Internet and Mobile Banking Services of SBI

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ABSTRACT

Customer experience is generated from all interactions that occurs between customer and touch points. Internet and mobile banking is one of the banking touch points, which is growing at a rapid rate both in respect of volume and value of transactions. The present paper is an attempt to measure customer experience of internet and mobile banking services of SBI. Even though SBI offers various experiences to customers through internet and mobile banking services, the overall experience of internet and mobile banking customers is only at a medium level.

1. Introduction

Internet and mobile banking had witnessed tremendous growth in the recent past. Innovations and developments that took place in the information and communication technology is augmenting the pace of change in internet and mobile banking. Competition faced by banks from other institutions like small finance banks, payment banks etc., force banks to make their internet and mobile banking services more competitive and useful in order to give new and better experiences for their customers. Customer experience created through Internet and Mobile banking has now become very important as a result of rapid growth rate of internet and mobile banking. Banking is highly dependent on technology and entered into real competition with other banks and other companies external to banking industry. So Internet and mobile banking was identified by banks as the next battleground. Customer experience, which is the next competitive battle ground, should provide a source of sustainable differentiation and is a differentiator in today's highly commoditized economy. Product, price, people and technology are all so similar. The meaningful things that customers remember, over and above your product/ service is, such as the feel and perception of organisation and brand, are derived through the customer experience. So customer experience makes difference. Customer experience is generated from all interactions that occurs between customer and touch points. For banking companies there are six obvious touch points or contact points for various purposes and they are ATMs, branches, Internet, phone, mail or face-to-face representatives and the purposes are communicating, servicing, transacting or selling. Among the banking touch points internet and mobile banking shows average growth rate of above 300% every year. Internet and mobile banking now assumes utmost importance and this study is an attempt to measure customer experiences of internet and mobile banking services of SBI.

Customer Experience

Carbone and Haeckel described the customer experience as the aggregate and cumulative customer perception created during the process of learning about, acquiring, using, maintaining and sometimes disposing of a product or service.

According to C. Gentile, N Spiller, G. Noci ''The Customer Experience originates from a set of interactions between a customer and a product, a company, or part of its organization, which provoke a reaction. This experience is strictly personal and implies the customer's involvement at different levels (rational, emotional, sensorial physical and spiritual). Its evaluation depends on the comparison between a customer's expectations and the stimuli coming from the interaction with the company and its offering in correspondence of the different moments of contact or touch-points''

(Meyer & Schwagar, 2007)defined the customer experience as the customer's internal and subjective response to any direct and indirect contact with the company at multiple touchpoints.

2. Literature Review

(Garrett, 2006) in his article are of the view that marketing initiatives and strategies will not result in customer loyalty unless these initiatives and strategies result positive customer experiences. Experiences are personal, emotional, and ephemeral and positive customer experiences resulting out of customer interactions at touchpoints would create emotional bond with brand, leading to customer loyalty.

(Schmitt, 2003)is of the view that customer experience originates from all touch or contact points between customer and the company or the companies offer. Customer experiences are strictly personal and customer experience involves and engages a customers at different levels(rational, emotional, sensorial, physical, and spiritual).

(Schmitt, 1999)expressed the view that experiences are private events and occur in response to some stimulation. Experiences are usually not self-generated but induced. As such marketers should provide stimuli that result in customer

experience and stimuli should be experience providers. The SEMs have identified five types of experiences such as sensory experiences, affective experiences, creative cognitive experiences, physical experiences, and relational experience.

(Verhoef et al., 2009)developed a conceptual model showing the determinants of customer experience in retail environment from the point of view of providers. The determinants of customer experience includes elements on which the retailer or provider have control and do not have control. Customer experience includes customer's cognitive, affective, emotional, social and physical responses to the retailer

(Bejou & Palmer, 2017)in a conceptual paper tried to better understand customer experience and also to measure the relationship of customer experience with customer commitment. According to him customer experience have five elements namely, cognitive, emotional, social, physical and sensorial.

(Berry & Haeckel, 2002)explained the importance of customer experience in a competitive market. For managing customer experience efficiently companies have to gain a good understanding of the customer's journey, customer expectations and cues. Total customer experience is the end result of all cues offered by a company to its customers.

3. Statement of the Problem

Internet and mobile banking become quite common as a result of the rapid developments in information and communication technology including introduction of high speed telecommunication and mobile networks. Internet and mobile banking, which is one of the touch points of banks is gaining wider acceptance among the common people. Green banking initiatives, central government initiatives, growth in internet connections, smart phone revolution etc. reasons for the growth in internet and mobile banking. In order to sustain and grow in sector banks need to provide better experiences to the customers. In this context this study identifies the customer experiences of internet and mobile banking customers of State bank of India. The study gives answers to the questions like, whether customers are having experience during their interaction with internet and mobile banking. Which all experiences are offered by SBI to its internet and mobile banking customers? What is the level of various experiences felt by customers of SBI? Whether these experiences varies significantly based on other dependent factors?

4. Objectives of the study

- To identify experiences of internet and mobile banking customers of State bank of India
- To determine level of customer experiences of internet and mobile banking customers of State bank of India
- To determine whether the experience varies based on the demographic characteristics of customers

5. Hypothesis of the study

H_0: There is no significant difference incustomer experience among various age groups.
H_0: There is no significant difference in level of customer experience based on gender.
H_0: There is no significant difference in level of customer experience based on educational qualification.

6. Research Methodology

The study Customer Experience of internet and mobile banking customers of State bank of India is empirical in nature. The study is based on primary data collected from internet and mobile banking customers. Primary data was collected using well-structured questionnaire in Google form format sent to public at large through social media. Out of the 185 respondents took part in survey, reliable responses of 154 SBI customers are selected for further statistical analysis. Customer experience of customers are measured using 36 statements relating to five typesof customer experience on five point Likert's scale. Reliability of the instrument was tested and six statements were deleted to improve the alpha value. Cronbach's Alpha value for the instrument consisting of 30 statements is 0.896. (Schmitt, 1999)(Brakus, Schmitt, & Zarantonello, 2009)(Bejou & Palmer, 2017)(Mascarenhas, Kesavan, & Bernacchi, 2006) identified customer experience components as sensory experience, affective experience, cognitive experience, physical experience and relational experience. The constructs and number of items used for measuring each construct is shown in Table 1 below. Level of customer experience is determined using quartile values of mean experience score. For testing the hypothesis statistical test like independent sample t test and one way ANOVA was used.

Table -1

Sl. No.	Construct	No. of Items
1	Sensory Experience	6
2	Affective Experience	6
3	Cognitive Experience	5
4	Physical Experience	8
5	Relational Experience	5

7. Data Analysis and Interpretation

Table -2
Demographic details of Customers

Demographic details		Male	%	Female	%	Total	%
Age	Below 20	2	1.90	0	0.00	2	1.30
	21-40	78	73.60	42	87.50	120	77.90
	41-60	26	24.50	6	12.50	32	20.80
Total		**106**	**100.00**	**48**	**100.00**	**154**	**100.00**
Educational Qualification	+2/PDC	18	17.00	10	20.80	28	18.20
	Under Graduate	16	15.10	0	0.00	16	10.40

	Post Graduate	72	67.90	38	79.20	110	71.40
Total		**106**	**100.00**	**48**	**100.00**	**154**	**100.00**
Occupation	Student	10	9.43	4	8.33	14	9.09
	Self Employed	6	5.66	16	33.33	22	14.29
	Business	20	18.87	8	16.67	28	18.18
	Private Employee	64	60.38	14	29.17	78	50.65
	Others	6	5.66	6	12.50	12	7.79
Total		**106**	100.00	**48**	**100.00**	**154**	**100.00**

Source: Primary Data

As exhibited in table 1 above out of 154 respondents took part the survey 106 respondents are male and 48 are females, 77.9 % of respondents belong to age group of 21-40,73.6% &87.5 % males and females belong to 21-40 age group , 71.4 % of respondents have post graduate level educational qualification, 50.65 % of respondents are private employees and 60.38 % of male respondents and 29.17 % of female respondents are private employees.

Table -3
Level of Customer experience

Level	Frequency	Percentage
Low Customer experience	38	24.7
Medium Customer experience	78	50.6
High Customer experience	38	24.7
Total	**154**	**100.0**

Source: Primary Data

Table 3 shows that 50.6 % of online customers are only getting medium level customer experience, 24.7 % are experiencing high level of customer experience and 24.7 % are getting low level of customer experience.

Table -4
Levelsof customer experience types

Experience Types	High		Medium		Low		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Sensory Experience	42	27.20	66	42.90	46	29.90	154	100
Affective Experience	38	24.70	78	50.60	38	24.70	154	100
Cognitive Experience	54	35.00	50	32.50	50	32.50	154	100
Physical Experience	38	24.60	76	49.40	40	26.00	154	100
Relational Experience	40	26.00	26	16.90	88	57.10	154	100

Source: Primary Data

Table 4 displays that internet and mobile banking provided medium level sensory experience to 42.90 % of respondents, internet and mobile banking offered low level of sensory experience to 29.90 % of respondents and only 27.20 % of respondents get high level of sensory experience. Internet and mobile banking creates medium level affective experience to 50.60 % respondents, low and high level of affective experience was felt by 24.7 % of respondents each. Internet and mobile banking generated cognitive experience to 35% of respondents, 32.50 % each respondents got medium and high level of cognitive experience during their interaction in internet and mobile banking. 49.40 % of respondents received physical experience, 26 % experienced only low level physical experience, and 24.60 % experienced high level physical experience during internet and mobile banking. Internet and mobile banking provided only low level relational experience to 57.10 % of SBI customers, 26% of respondents are offered high level of relational experience and 16.90 % respondents experienced only medium level relational experience. Internet and mobile banking service of SBI offers high level cognitive experience only and provides medium level experience in respect of sensorial, affective and physical experiences.

Hypothesis Testing I

H_0: There is no significant difference in level of customer experience based on gender.

Table-5
Independent Sample t test

Gender	N	Mean	Std. Deviation	t value	Sig
Male	106	3.87	0.491	1.183	0.239
Female	48	3.77	0.347		

The t value of 1.183 is not statistically significant since the sig value .239 is more than .05.Therefore it is clear from table 5 that the difference between mean scores of males and females is not significant.

Hypothesis Testing II

H_0: There is no significant difference in customer experience among various age groups.

Table -6
Descriptives of Customer Experience Scores based on age group

Age Group	N	Mean	Std. Deviation
Below 20	2	3.84	0.00
21-40	120	3.85	0.46
41-60	32	3.77	0.44

Table -7
ANOVA

Customer Experience	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.170	2	.085	.413	.663
Within Groups	31.074	151	.206		
Total	31.243	153			

The F Value of 0.413 is not statistically significant since the sig value 0.663 is more than .05.

Therefore it is clear from table 6 that the difference between mean scores of different age groups are nominal and the hypothesis testing statistically establishes that,there is no significant difference in the customer experience among various age groups.

Hypothesis Testing III

H_0: There is no significant difference in level of customer experience based on educational qualification.

Table -8
Customer Experience based on educational qualification

Educational Qualification	N	Mean	Std. Deviation
+2/PDC	28	3.98	0.48
Under Graduate	16	4.03	0.42
Post Graduate	110	3.77	0.44

Table -10
ANOVA

Customer Experience	Sum of Squares	dof	Mean Square	F	Sig.
Between Groups	1.623	2	.812	4.138	.018
Within Groups	29.620	151	.196		
Total	31.243	153			

Since the Sig value 0 .018 is less than 0 .05, F value 4.138, is statistically significant and there is significant difference in customer experience based on educational qualification.

8. Findings

SBI offers all the five types of experiences to their customers through their contact point internet and mobile banking. Even though SBI offers all experiences overall customer experience reached only medium level customer experience from internet and mobile banking services, ie50.6% of customers receive only medium level customer experience. High level of cognitive experience was felt by 35 % of customers. Majority of respondents realised medium level sensory, affective and physical experiences.57.10 % of customers received only low level relational experience from internet and mobile banking service of SBI.

9. Conclusion

Customers always desire experiences in all their interaction with the banker. Since customer experience is the next battlefield for all entities irrespective of nature of business, bank should strive to offer superior customer experience in all interactions across touch points. To materialise full benefit of delivering such experiences banks must consciously design engaging experiences in products and services. So SBI need

to strive to improve the service quality and functional aspects of their internet and banking services to gain competitive edge and emotional bond.

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Nonlinear optical studies of calcium tartrate crystals

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Nonlinear optical studies of calcium tartrate crystals

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ABSTRACT

Calcium Tartrate crystals were synthesized using sol–gel technique. Linear optical studies of the crystals were carried out in the UV–Vis-NIR spectral range. Nonlinear optical open aperture z-scan studies were done using high sensitive z-scan experimental technique. Both saturable absorption and reverse saturable absorption behaviour were observed at different input fluences. Reverse saturable absorption characteristic of the crystals make them suitable for optical limiting applications. Our analysis revealed that the novel crystal has the optimum values for the optical limiting parameters which are required for a high-performance optical limiter.

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Highlights

- Open aperture z-scan and optical limiting of CaTT crystals are reporting for the first time.
- Crystals show both saturable and reverse saturable absorption.
- The optical limiting response of pure CaTT-crystals is better than CaTT-electric crystals.

1. Introduction

The widespread interest in nonlinear optical crystalline materials has been motivated by their potential use in the fabrication of all-optical photonic devices [1–6]. Transparent crystalline materials can exhibit different kinds of optical nonlinearities which are associated with nonlinear polarization. Recent years have witnessed an increased interest in research activities related to Calcium Tartrate (CaTT) crystals. CaTT single crystals have been found to have diverse applications in the field of optoelectronics on account of their ferroelectric and nonlinear optical characteristics [7–14]. Most often, research efforts have concentrated on synthesis and characterization of the CaTT crystals. Although there have been a large number of reports on various properties of these crystals, nonlinear optical properties of these crystals are rarely studied [15–23]. The CaTT crystal exhibits promising values of nonlinear optical parameters and hence it can be considered as a potential candidate for nonlinear optical applications [24,25].

In this context, linear optical studies, optical band gap determination, open aperture z-scan and optical limiting analysis of CaTT crystals is deserving of attention which to our knowledge have not been reported so far. Understanding the nonlinear optical properties of CaTT crystals is a pre-requisite for considering nonlinear optical applications. The purpose of the present study is to prepare CaTT crystals in different environments and to study their nonlinear optical properties such as open aperture z-scan and optical limiting. All derived or observed results are compared with similar systems found in the literature.

2. Experimental

CaTT crystals were prepared by sol–gel technique by employing a single diffusion method. Medium for crystal growth, hydro silica gel, was prepared from sodium meta silicate (SMS). The specific gravity of the gel and pH of the solution determine the quality of the prepared crystals. To the solution of SMS having specific gravity 1.05, 1 M tartaric acid is added. pH is adjusted to 4, 5, 6, 7 and 8. Solution was kept for 36 h to form a firm gel. 1 M calcium nitrate solution was supernated after the gel formation. Twenty days later, CaTT crystals were separated from the gel. The steps involved in the production of crystals are depicted in Figure 1. Small crystals were produced by nucleation at lower pH values. Crystals of increased dimensions were formed for pH 7 and 8.

To study the effect of electric field and magnetic field on the properties of CaTT crystals, two different types of CaTT crystals were synthesized by applying an electric potential 10 V perpendicular in the direction of diffusion (CaTT-electric) (Figure 2(b)) and by providing a magnetic field of 0.1 Tesla across the test tube (CaTT-Magnetic) (Figure 2(c)).

Structural studies of the synthesized crystals were done using X-ray diffraction (XRD) analysis (XPERT-PRO

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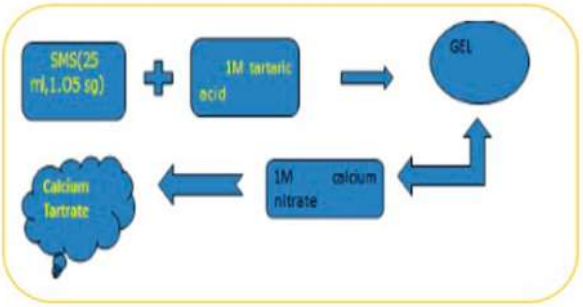

Figure 1. Schematic diagram of CaTT crystal preparation.

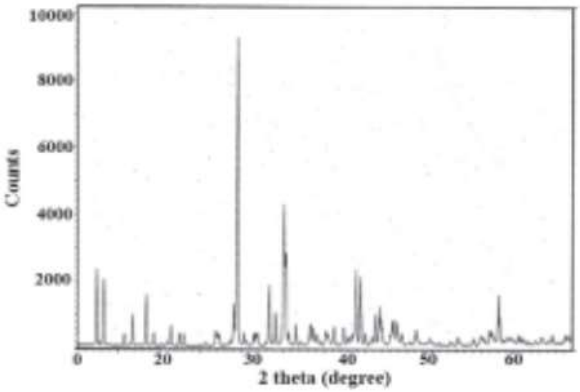

Figure 3. X-ray diffraction pattern of CaTT crystal.

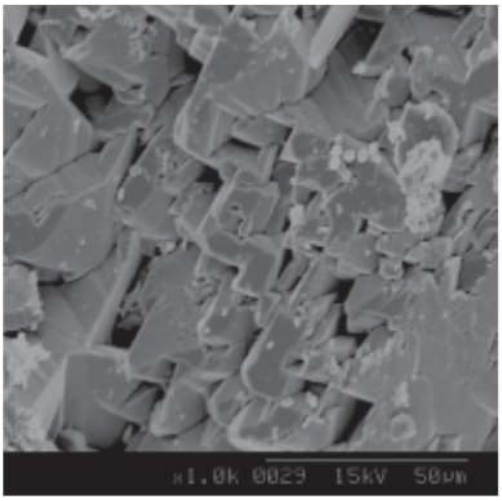

Figure 4. SEM image of pure CaT crystals.

using K-α 1.54060A0 (XRDML)). Linear absorption of the samples was recorded using Jasco V-570 UV/VIS/IR Spectrophotometer. A Q-switched Nd:YAG laser (Spectra physics Lab-1760, 532 nm, 7 ns, 10 Hz) was used as the source of excitation for open aperture z-scan studies. The CaTT crystals dispersed in water were taken in a 1 mm thick cell and moved along the z-axis through the focal point of a lens of focal length 20 cm [26,27]. Transmitted beam energy, reference beam energy and their ratios were simultaneously measured by using energy ratio metres Rjp 7620 (Laser Probe Corp) having two identical pyro electric detector heads (Rjp 735). CS_2 was used as the standard for the initial calibration of z-scan setup. All measurements were done at room temperature.

3. Results and discussions

The crystalline nature of the synthesized materials was confirmed by the powder XRD analysis (Figure 3). Sharp peaks in the pattern are due to large crystallite size, high relaxation time, high band gap and perfect crystalline property. A comparison with JCPDS values confirmed orthorhombic structure for the synthesized crystals (Figure 4).

A representative linear absorption spectrum of pure CaTT crystal dispersed in distilled water is shown in Figure 5. The absorption peak of pure CaTT crystal at the concentration of 0.02 gm/ml is located in the UV region with peak at 244 nm. The band gap of the material was estimated from the graph of $h\nu$ verses $(\alpha h\nu)^2$ (Figure 6).

Linear absorption coefficient α is related to the band gap E_g as $(\alpha h\nu)^2 = k\,(h\nu - E_g)$, where $h\nu$ is the incident light energy and k is a constant. An energy band gap of 5.48 eV for the present system points to its 83 nonlinear application potential.

Optical nonlinearity of the crystals was measured using open aperture z-scan technique by focusing the input beam on to the sample at 532 nm using a Q-switched Nd: YAG laser. For estimating the limits of saturable absorption (SA) and reverse saturable absorption (RSA) behaviour, z-scan curves were recorded at

(a) (b) (c)

Figure 2. Photographs of prepared CaTT crystals (a) pure CaTT (b) CaTT-electric (c) CaTT-magnetic.

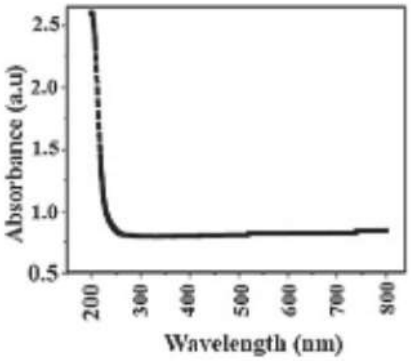

Figure 5. Linear absorption spectrum of CaTT crystal.

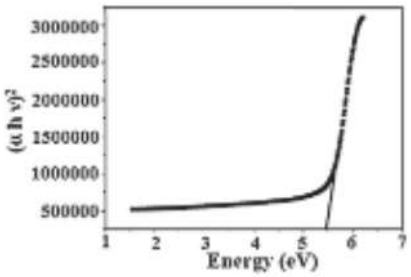

Figure 6. Optical band gap plot of CaTT crystal.

different fluences in the nanosecond regime using a Gaussian laser beam at three different input fluences (87, 125 and 251 MW/cm^2) (Figure 7).

The solid curves are theoretical fit to the open aperture z-scan experimental data. The nonlinear absorption coefficient β can be obtained from this open aperture z-scan data by fitting the normalized transmittance data to the open aperture formula given by [28]:

$$T(Z,S=1)=\sum_{m=0}^{\infty}\sum_{m=0}^{\infty}\frac{[-q_o(z)]^m}{[m+1]^{3/2}}|q_o(z)|<1,$$

where

$$q_0(z)=\frac{[I_0\beta L_{eff}]}{1+(Z^2/Z_0^2)},$$

where $Z_0 = kw_0{}^2/2$ is the diffraction length of the beam.

$k = 2\pi/\lambda$ is the wave vector, w_o = the beam waist radius at the focal point, $L_{\text{eff}} = (1 - \exp(-\alpha L))/\alpha$ is the effective thickness of the sample, I_0 is the laser intensity at the focal plane.

From Figure 7(a,b), it is clear that the nonlinear absorption coefficient β is negative due to the transmission maximum at the focal point. These figures show the SA behaviour of CaTT samples. As CaTT is a saturable absorber, it exhibits reduced absorption at high input intensities and shows a transmission peak. The z-scan data shows that the increase in the laser intensity induces bleaching in the ground state absorption, which results in a transmittance increase giving a SA process. Thus CaTT crystals at input powers 87 and 251 MW/cm^2 are well suited for passive Q-switching or mode locking of lasers. Figure 7(c) reveals RSA nature for CaTT-electric crystals. At a laser input power of 125 MW/cm^2, it acts as an RS absorber. At this particular input fluence value, a valley is obtained in the transmittance curve for pure CaTT and CaTT-electric. Since the wavelength used in the experiment is 532 nm, RSA corresponds to two-photon absorption (TPA) [29]. Values of nonlinear absorption coefficient β for three input fluence values are tabulated in Table 1. The saturation intensity I_s values for the saturable absorbed CaT samples are also given in the table. The CaTT-magnetic crystals exhibited only SA due to the depletion of ground state ions [30–32].

The RSA nature of CaTT makes it suitable for optical limiting applications. From the observed responses, it is clear CaTT is an effective optical limiter having low limiting threshold, large dynamic range and longer excited state life time to accumulate the population, high optical damage threshold, broadband response, fast response time and high linear transmittance. Figures 8 and 9 show the optical limiting response of CaTT and CaTT-electric crystals. The efficiency of an optical limiter is decided by its limiting threshold. It is obvious that lower the optical limiting threshold, better the optical limiting material. The optical limiting property occurs mainly due to absorptive nonlinearity which corresponds to the imaginary part of the third order susceptibility [33]. The optical limiting response of CaTT crystal at I_0 = 125 MW/cm^2 is 103 MW/cm^2 and that of

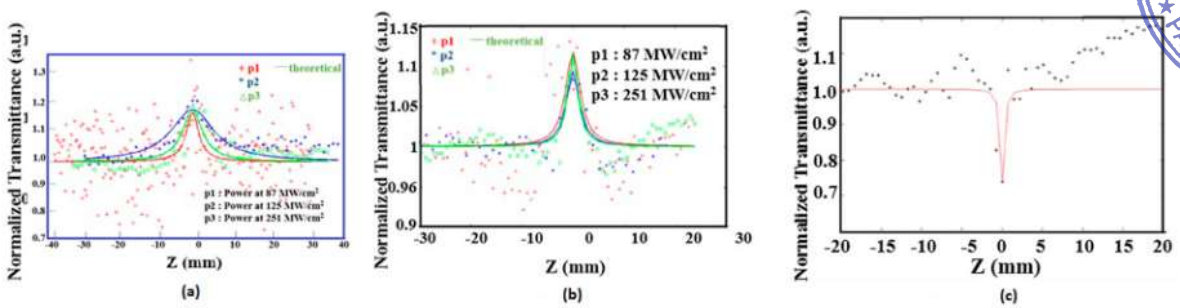

Figure 7. Open aperture z-scan plot of CaTT crystals (a) pure CaTT (b) CaTT-magnetic (c) CaTT-electric.

Table 1. Measured values of nonlinear absorption coefficient, saturation intensity and optical limiting threshold CaTT crystals.

	β (cm GW^{-1})			I_s (GW cm^{-2})			
Sample	I_0 (7 MW cm^{-2})	I_0 (125 MW cm^{-2})	I_0 (251 MW cm^{-2})	I_0 (87 MW cm^{-2})	I_0 (125 MW cm^{-2})	I_0 (251 MW cm^{-2})	Optical limiting threshold (MW cm^{-2})
CaTT pure	−42.9	57	−15	0.019	_	0.055	103
CaTT electric	−68	83	−14	0.014	_	0.069	116
CaTT magnetic	−33	−19	−11	0.016	0.028	0.049	_

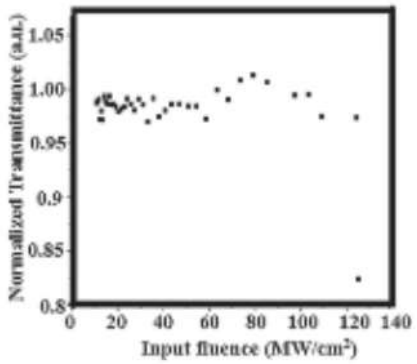

Figure 8. Optical limiting response of CaTT crystal.

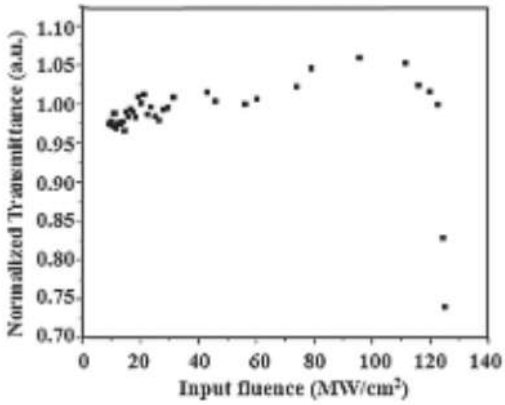

Figure 9. Optical limiting response of CaTT-electric crystals.

CaTT-electric is 116 MW/cm^2. From the data, it is clear that the pure CaTT crystal can be used as a better optical limiting material than CaTT-electric crystals.

4. Conclusion

The synthesis and linear optical and nonlinear optical characterization of Calcium tartrate crystals are reported. A detailed optical analysis of the crystal systems has been carried out using UV–visible and open aperture z-scan technique. Optical band gap, nonlinear absorption coefficient, saturation intensity and optical limiting threshold of the material have been evaluated. The investigation reveals that the CaTT crystal has the optimum values of the nonlinear absorption coefficient and optical limiting threshold required for an optical limiter.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Contents

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SBT – SBI MERGER AND ITS IMPACT ON THE BANKING INDUSTRY

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STATE BANK OF INDIA

The roots of the State Bank of India lay in the first decade of the 19th century when the Bank of Bengal was established on 2nd June 1806. The Bank of Bengal was one of three Presidency banks, the other two being the Bank of Bombay (incorporated on 15th April 1840) and the Bank of Madras (incorporated on 1st July 1843). The Presidency banks amalgamated on 27th January 1921, and the re-organized banking entity took as its name as 'Imperial Bank of India'. The Imperial Bank of India remained a joint stock company but without Government participation. SBI has acquired local banks in rescues. SBI took Bank of Bihar in 1969 with its 28 branches, National Bank of Lahore in 1970 with 24 offices and Krishnaram Baldeo Bank (Gwalior) in 1975. In 1955, the Imperial Bank of India was nationalized and was given the name **"State Bank of India"** to act as the principal agent of RBI and to handle banking transactions all over the country. Seven banks forming subsidiary of State Bank of India were nationalized in 1960.State Bank of India (SBI) is the government-owned corporation with its headquarters in Mumbai, Maharashtra. With the SBT-SBI merger, State Bank of India will enter the league of top 50 global banks with a balance sheet size of $37 trillion or over, 278,000 employees, $555 billion (50 crores) customers, more than 22,500 branches and 58,000 ATMs. SBI's market share will increase to 22 percent from 17 percent. It has 198 offices in 37 countries; 301 correspondents in 72 countries. The company is ranked 232nd on the Fortune Global 500 list of the world's biggest corporations as of 2016.

Saga of SBT

State Bank of Travancore

The SBT was the people's bank, and it was sown, watered and nourished by the rulers from time to time. It was the last major institution that the last ruling Maharaja of Travancore had founded. It might have been so distinct that His Highness Chithira Thirunal Balarama Varma had to kindle the light that should lead his bank to carry on the royal tradition of trust, devotion, and dedication to service for all time to come. State Bank of Travancore (SBT) was a major Indian bank headquartered in Thiruvananthapuram, Kerala, and was a principal associate of State Bank of India.

SBT was established in 1945 as the Travancore Bank Ltd. Although the Travancore government put up only 25% of the capital, the bank undertook government treasury work and foreign exchange business, apart from its general banking business. Its head office was at Thiruvananthapuram. In 1960, it became a subsidiary of State Bank of India under the SBI Subsidiary Banks Act, 1959, enacted by the Parliament of India., and thus achieved the name 'State Bank of Travancore.'

SBI: The International Scenario

As of 2014–15, the bank had 191 overseas offices spread over 36 countries having the most significant presence in foreign markets among

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Application of qualitative biospeckle methods for the identification of scar region in a green orange

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This study demonstrates the feasibility of a view-based method, the motion history image (MHI) to map biospeckle activity around the scar region in a green orange fruit. The comparison of MHI with the routine intensity-based methods validated the effectiveness of the proposed method. The results show that MHI can be implementated as an alternative online image processing tool in the biospeckle analysis.

Keywords: Biospeckle; view-based method; motion history image (MHI); green orange.

1. Introduction

Laser biospeckle technique has emerged as a significant optical tool to analyze the activity evolution of biological as well as non-biological processes. Due to its non-invasive and non-destructive nature, the technique has recently been widely applied especially in the areas of biology, medicine, agriculture, chemical and pharmaceutical industries.[1–4] The typical optical scheme required for biospeckle measurements is relatively simple and affordable.

The statistical description of biospeckle dynamics is implemented as a conceptual basis for the detection and visualization of biological or physiological activity. There are several statistical image processing methods available to extract meaningful information from the temporal sequence of biospeckle image frames. To extract quantitative information, the inertia moment (IM),[5] absolute value of difference (AVD)[6] and cross-correlation methods[7] are frequently used. The qualitative measurement methods often employ temporal difference (TD),[8] generalized differences

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(GD),[9] laser speckle contrast analysis (LASCA),[10] Fujii methods,[11] etc. The qualitative methods depict the spatial distribution of biospeckle activity in the form of a map which helps to identify distinct activity regions in the specimen.

As the origin of biological activity depends on several possible sources, activity maps may possibly depict some distinct characteristics depending on the suitability and effectiveness of the algorithms used. Among the numerical methods, IM is frequently used to extract information from the biological samples.[2,5,12] The IM is based on the generation of a specific matrix called the time history of speckle pattern (THSP) followed by an intermediary image, the co-occurrence matrix (COM).[2,5,12] Other methods such as the AVD give significant results when the sample contains low or medium frequency values.[6]

This work gives emphasis on several different qualitative methods of biospeckle data processing. The qualitative methods such the Fujii, TD, tLASCA and GD were used. The resultant activity maps generated using these qualitative intensity based methods were then finally compared with a view-based temporal template method, the motion history image (MHI). Unlike the intensity-based methods, the MHI generates a bidimensional activity map that detects if the speckle structure has changed over time.[13–15]

Fujii method is one of the algorithms utilized for the evaluation of biospeckle activity. This method generates an activity map by computing the sum of absolute differences between the intensities of consecutive image frames, weighted by their mean value in a single image frame.[11,16] However, the weighting process in Fujii algorithm introduces a nonlinear response that makes it more sensitive to regions of low activity where detector noise is amplified and could be interpreted as an activity signal.[12]

Temporal difference (TD) method, on the other hand, retains the temporal order of successive frames. TD is a simple and practical method that offers an easy interpretation of activity regions, with high sensitivity and relatively modest computational effort.[12]

LASCA has emerged as one of the fast and inexpensive online routines which records changes in the speckle contrast to map the biospeckle activity. The main limitation of LASCA is the reduced spatial resolution of the resulting activity map which depends on the size of the window used in its processing algorithm. In addition, LASCA operation demands imaging systems with specific technical properties such as the shutter access and control.[17]

GD is another offline algorithm which accumulates the differences between pixel values from non-consecutive frames to map the different time scales for low and high activity regions. This method does not preserve any information concerning the frequency of the biospeckle signal as its activity map sacrifices the temporal order.[12]

Due to the above-mentioned limitations of these intensity-based methods, one needs more efficient alternative methods. Recently, a vision-based temporal

template method, the MHI, has been adopted to assess the biospeckle activity in several biological media.[14,18]

We present experimental results to demonstrate the potential of the MHI method to identify the biological activity at peduncle insertion region in a fresh green orange by comparing it with some routine intensity-based biospeckle processing methods. Rabelo *et al.*[19] previously quantified the biospeckle activity of four different positions including the peduncle insertion region on an orange fruit surface using the IM and the statistical cummulant of the auto-correlation function of the THSP. In the present context, to discriminate the scar region of the fruit around the penduncle insertion point from that of the bulk, we adopted the MHI method. The results of MHI were further compared with the routine intensity-based methods such as Fujii, GD, TD and *t*LASCA.

2. Methods for Monitoring Biospeckle Activity

2.1. *Fujii method*

Fujii method has emerged as a feasible offline tool to map the spatial biospeckle activity.[20] The Fujii algorithm calculates the weighted sums of the absolute differences of gray-level intensity associated with each pixel of the time series of biospeckle patterns. The typical formula for the Fujii algorithm is described by

$$F(x,y) = \sum_{k=1}^{N} \left| \frac{I_k(x,y) - I_{k+1}(x,y)}{I_k(x,y) + I_{k+1}(x,y)} \right|, \tag{1}$$

where $F(x,y)$ represents the resulting Fujii image, k is the image index and I_k is the gray level intensity of a pixel at a location given by coordinates x and y.

In the final activity map presented by the Fujii method, high activity regions are marked with bright pixels, while dark pixels depict the regions of low activity. Here, the weighting term used in the denominator of Fujii's equation tends to cause a nonlinear response that emphasizes both the large as well as the small differences including the values from the limits of detector's dynamic range.

2.2. *Temporal difference (TD)*

TD has been used as another promising method to construct the biospeckle activity maps.[21] Fujii method suffers from the limitation that the resulting activity map only depicts the speckle activity as a whole during the observation interval, but lacks the evolution of the activity (temporal resolution). The prime advantage of the TD method is that it can yield results to register speckle activity in the temporal order. The algorithm to implement the TD method can be obtained by eliminating the denominator term from the original Fujii algorithm. Hence, TD algorithm calculates the sum of absolute differences of consecutive images separated by a time interval

yields the activity map as defined by Eq. (2)

$$.TD(x,y) = \sum_{k=1}^{N} |I_k(x,y) - I_{k+1}(x,y)|\,, \tag{2}$$

where $k = 1, \ldots, N$ represents index for the time series of images, and I_k denotes the intensity distribution in the kth frame given by coordinates x and y.

2.3. *Laser speckle contrast analysis (LASCA)*

LASCA has been established as one of the viable online visualization methods for biospeckle image processing.[22] This method is fundamentally based on the blurring caused by the speckles in the specimen image due to fast intensity changes during the integration time of the detector. The degree of blur in the image can be interpreted in terms of change in speckle contrast values deduced from the first-order statistics as expressed by Eq. (3).[12,23]

$$K = \frac{\sigma}{\langle I \rangle} = \frac{\sqrt{\langle I^2 \rangle - \langle I \rangle^2}}{\langle I \rangle}\,, \tag{3}$$

where σ defines the standard deviation of intensity, $\langle I \rangle$ and $\langle I \rangle^2$ correspond to the mean value of pixel intensities and the mean value of squared pixel intensities, respectively. In the case of relatively fast intensity variations, the finite integration time of the detector will cause a reduction in standard deviation of measured intensity variations and thereby decrease the contrast expressed by the equation.

The biospeckle evaluation based on LASCA commonly uses window sizes of 3×3, 5×5 and 7×7 pixels to generate the spatial statistics. It is observed that the lower number of pixels used for the computation of local contrast in the square window reduces the validity of statistics, whereas the higher numbers limit the effective spatial resolution of the resulting contrast image.[13] The window size is modified in proportion to the size of the speckles, so as to deliver the maximum possible statistical validity while retaining a reasonable spatial resolution. For the convenience of display and analysis, the resulting contrast image is often contrast stretched and transformed into a color-mapped image.

Dunn *et al.* introduced sLASCA for the spatially-derived contrast to enhance the contrast of basic LASCA by means of temporal frame averaging.[24] Unlike basic LASCA, this modified algorithm runs over a predetermined number of raw speckle images. Another improved version of basic LASCA called tLASCA, where "t" stands for temporally derived contrast, operates on the statistics along a series of n frames in the temporal dimension.[25] This implies that, for tLASCA, the mean speckle contrast solely depends on the number of frames. In tLASCA, the calculation of contrast is the same as that of standard LASCA, except that the standard deviation and mean intensity are calculated for each individual pixel from all collected frames. In this way, both the display and effective spatial resolutions of the original image can be retained.

$$K_{t\mathrm{LASCA}(i,j)} = \frac{1}{M \times M} \sum_{r=i-1}^{r=i+1} \sum_{c=j-1}^{c=j+1} \frac{\sigma_{i,j,t}}{\langle I_{i,j,t} \rangle}, \tag{4}$$

where $\sigma_{i,j,t}$ and $\langle I_{i,j,t} \rangle$ symbolize the standard deviation and mean intensity of all pixels at the location given by coordinates (i, j) in n frames along the temporal dimension, respectively. $K_{t\mathrm{LASCA}}$ is now calculated as an average over a spatial observation window of size $M \times M$. It can be noted that the number of pixels involved in an $M \times M$ pixel observation window using tLASCA algorithm is given by $(M)(M)(n/2)$, where n denotes the number of temporal frames.

2.4. *Generalized differences (GD)*

The GD algorithm computes the absolute sum of the differences between all possible pairs of biospeckle frames combination for each pixel intensity in the sequence. GD activity map is constructed from the biospeckle image sequence by using the expression[26]

$$\mathrm{GD}(i,j) = \sum_{f} \sum_{n} |I_f(i,j) - I_{f+n}(i,j)|, \tag{5}$$

where f and n represent the frame indices of image sequence and I_f is the pixel intensity at a point with coordinates (i, j) in the fth frame. This algorithm implies that the comparison between first image frame and successive image frames in the sequence is done throughout all available time scales and the averaged results are taken into account. Thus, GD eliminates the dependency on temporal order by including the differences between intensity values of pixel from non-consecutive frames.

2.5. *Motion history image (MHI)*

The MHI is a vision-based temporal template method that depicts the motion based on the time stamps of pixels from a set of static images corresponding to a motion sequence.[15] MHI incorporates both spatial location and temporal history of motion in a single frame and in this way it spans the time scale and direction of a motion sequence. The main advantage of MHI representation is that it permits the feasibility of implementing real-time monitoring. Over the years, MHI has been extensively employed for various research applications including action recognition, motion analysis, object tracking and so on.[27–29] The MHI method constructs the single final static image according to the specific algorithm that each individual pixel (x, y) in MHI labeled with the time stamp (in hour, minute, second, and millisecond) and will be dropped out if it does not change following a certain time lapse, known as the lifetime or duration of MHI. Here, pixels with higher intensity values appear as the most latest time stamps to indicate recent movements.

MHI algorithm maintains a cyclic buffer to hold timeline images. The size of the buffer controls the integration time of the final image which is usually a variable.

Once the buffer becomes full, the first image which exists longer over time will be cleared by shifting down the buffer and a new one will come to the last position and so on. As the next step, the silhouette images which depict the dominant motion information are generated by taking the differences between two consecutive images from the buffer of timeline images as defined by Eq. (6):

$$S_j = I_j - I_{j-1}\,, \tag{6}$$

where I_j and I_{j-1} represent gray scale images at the instants j and $j-1$. Each silhouette image is then binarized by applying a threshold function to remove most of the unwanted background noise. The threshold function can be expressed as

$$T_j(x,y) = \begin{cases} 1 & \text{if } S_j(x,y) > Z\,, \\ 0 & \text{if } S_j(x,y) \leq Z\,, \end{cases} \tag{7}$$

where Z and $T_j(x,y)$ represent threshold parameter and threshold image at each moment j. In the final step, the MHI algorithm uses a weighting constant to the binary silhouettes stored in the buffer of size n with respect to the lifetime of each image, as presented by Eq. (8)

$$\mathrm{MHI}(x,y) = \sum_{j=1}^{n} T_j k_j\,, \tag{8}$$

where k_j denotes the weighting constant and its value given by Eq. (9)

$$k_j = \begin{cases} 0 & \text{if imagelifetime} > \text{MHI } \textit{duration}, \\ \dfrac{\text{imagelifetime}.255}{k_n} & \text{otherwise.} \end{cases} \tag{9}$$

Here, the variable *imagelifetime* stands for the lifetime of the image in the moment j.

MHI method has recently been adopted to evaluate the activity in biological and non-biological objects.[12]

3. Experimental

The schematic representation of experimental arrangement for biospeckle image acquisition and storage is shown in Fig. 1(a). The whole experimental setup including test specimen was mounted on a vibration isolation table at room temperature. The test specimen was coherently illuminated using a 10 mw He-Ne laser source operating at 632.8 nm. A neutral density filter was introduced in the path of the laser to adjust the intensity of the beam while recording biospeckle images. The laser beam was then expanded using a spatial filter unit (20× microscope objective and 15 μm pinhole diameter) to uniformly illuminate the specimen surface. A CCD camera having 1.3 MP resolution and 3.75 μm × 3.75 μm pixel size was used to record subjective biospeckle images at 32 frames per second. The angle of illumination of the laser beam with the CCD camera was adjusted in order to obtain high-contrast images with minimal specular reflection of light.

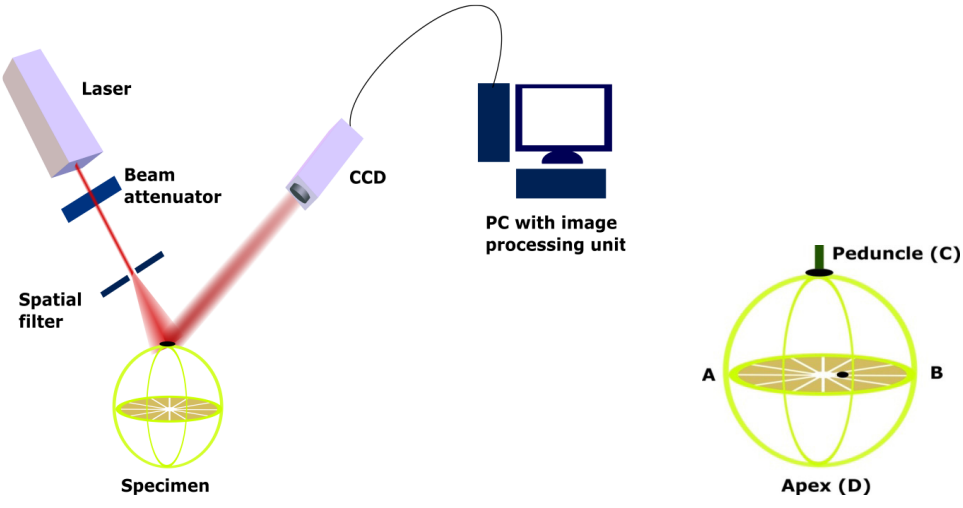

Fig. 1. (Color online) (a) Experimental configuration for biospeckle imaging and (b) points over the surface of orange.

For the experimental study, fresh green healthy orange fruits were sacrificed to biospeckle laser method. As shown in Fig. 1(b), points A and B denote diametrically opposite points located in the equatorial region while C and D denote peduncle insertion and apex region of the fruit, respectively.

The MHI and image intensity-based algorithms were implemented to process the biospeckle frames obtained from fresh green orange fruits. The MHI results were compared with the routine intensity-based methods.

4. Results and Discussion

This study aims to evaluate the biospeckle activity of the peduncle insertion region which displays low activity as it behaves as a scar where the peduncle is inserted.[19]

Figure 2 shows the gray level profile plot of the two regions of interests selected from the peduncle and the bulk regions of the orange. In the inset, we present a typical speckle pattern extracted from the biospeckle video sequence obtained from the orange surface. Two ROIs of size 10×10 pixels were selected and their respective profiles were plotted.

From Fig. 2, we can clearly see that the fluctuations in the intensity (or gray level) levels for the bulk region are higher in comparison to that for the peduncle region. This in turn reflects more biospeckle activity for the bulk region than that for the insertion part. This has been again confirmed with the obtained results presented in Fig. 3.

The MHI and image intensity-based algorithms were implemented to process the biospeckle frames obtained from fresh green orange fruits. The MHI results were then compared with the routine intensity-based methods.

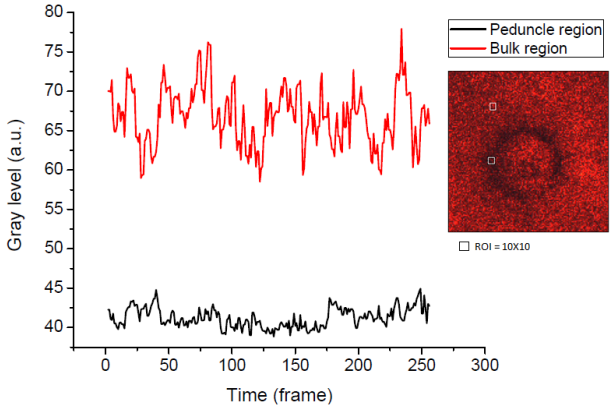

Fig. 2. (Color online) Gray level profile of the two ROIs selected from the peduncle and the bulk regions, respectively. An ROI of size 10×10 pixels were selected and their profiles plotted. Scale bar corresponds to 10 px = 2.64 mm.

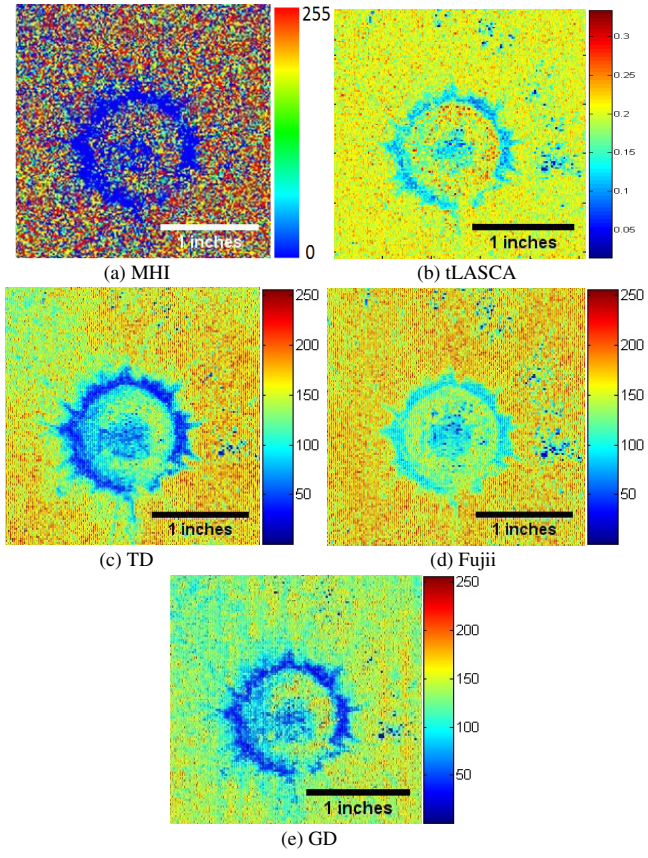

Fig. 3. (Color online) Activity maps generated using the methods of the MHI, the *t*LASCA, the TD, GD and the Fujii. Colorbar presents the activity levels where blue indicates low activity and red indicates high activity. Scale bar for all the images is equal to 1 inches and the scale is 96 pixels/inch.

The results related to the application of the MHI, TD, Fujii, *t*LASCA and GD in identifying the scar region (where peduncle is inserted) in a fresh green orange are presented in Fig. 3.

With the proper selection of the threshold level and buffer size, the MHI presented a characteristic behavior close to the Fujii, TD and GD maps. In the final MHI activity map, the scar region presents rather low activity compared to the surrounding regions. In the MHI map, high activity regions are characterized by higher density of dots while low activity area are characterized by the smaller density of dots. From Fig. 3, we observe that the MHI activity map clearly differentiates the scar region. The activity image generated by Fujii method shows its ability to emphasize low activity regions because of the weighting term in the processing algorithm. The Fujii map also produced more or less similar patterns of TD and GD but the activity regions are not so well differentiated. In contrast, the activity map generated by the alternate online method of *t*LASCA presented relatively poor activity differentiation compared to the TD, Fujii, GD and MHI methods. Thus by the comparative analysis of the MHI method with the intensity-based methods, it was possible to observe the feasibility of the MHI algorithm to describe the evolution of the biospeckle activity.

The quality of MHI results depends on the proper adjustments of its parameters, especially the buffer size and level of threshold. The selection of threshold level determines the capability of MHI to reinforce the separation of distinct regions of activity. The size of the buffer influences the information gathering capacity to identify the lower levels of activity. In the present study, the buffer size adopted was four positions, with an acquisition rate of 0.05 s, and a threshold value of 10, over collection of 100 speckle images.

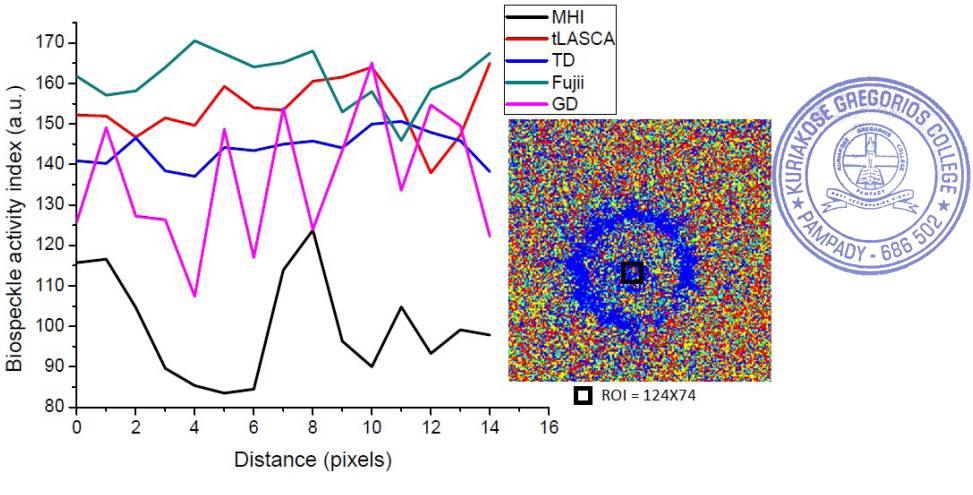

Fig. 4. (Color online) Biospeckle activity index, a comparison between MHI, *t*LASCA, TD, GD and Fujii index. The values show the activity index computed on the bulk region of the fruit. An ROI of 124 × 74 pixels was selected from the bulk regions and respective index values computed.

Figure 4 shows a comparison graph of biospeckle activity indices computed at the peduncle insertion region by using the MHI, *t*LASCA, TD, Fujii and GD methods.

It is evident from the graph that MHI presents rather low values of activity index in comparison to rest of the methods. Unlike other methods, the GD processing algorithm involves computation of difference between non-consecutive biospeckle frames which can be attributed to significant fluctuations in the biospeckle activity levels as indicated by the graph. Moreover, the methods such as *t*LASCA, TD, GD and Fujii follow almost a similar patterns of the biospeckle activity.

4.1. *Effect of threshold values on the MHI activity map*

Figure 5 shows the MHI images computed with different threshold values. The effect of thresholding can easily be assessed and one can observe that the adjustment of threshold value emphasizes the ability of the MHI to distinguish between distinct activity regions.

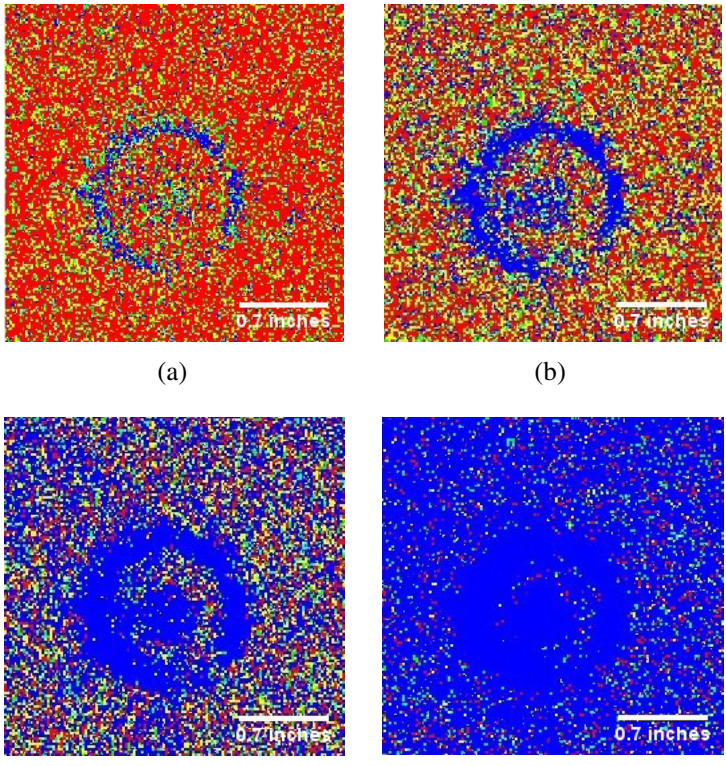

Fig. 5. (Color online) MHI images showing the effect of threshold values on the resulting activity maps of the scar region. The threshold value is equal to (a) 5, (b) 10, (c) 20 and (d) 30.

5. Conclusion

We demonstrated the feasibility of the MHI algorithm to map the biospeckle activity around the scar region in a fresh green orange fruit. The comparison of MHI with the image intensity-based routine offline methods such as TD, Fujii and GD as well as with the online method of *t*LASCA validated the effectiveness of the proposed method of MHI. The quality of MHI activity map obtained in this study ensures its implementation as an alternative online tool in the biospeckle analysis.

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Application of laser biospeckle technique for the analysis of artificially introduced local dynamics in apple fruit

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Abstract

Laser biospeckle technique has been extensively used as a significant characterization tool to analyze the complex inner dynamics involved in both biological and non-biological processes. The technique has been widely applied in the field of biology, medicine and agriculture as well as in the chemical and pharmaceutical industries. Among the challenges in biology or agriculture, one of the tasks is the assessment of the local dynamics of biological specimens. We report on an optical imaging technique, the laser biospeckle to assess the local dynamics introduced on selected biological specimens subjected to mechanical and thermal loads. This study also aimed to explore the technique in detecting the early stages of biological activities. An experimental configuration of the biospeckle laser imaging technique was used to assess the monitoring and prediction of the bruising on fruit surfaces within a specified time. The methods utilized to interpret the biospeckle data allowed pre-disposition detection of the formation of internal bruising in the early stages after the occurrence of a mechanical or thermal impact.

Keywords: laser biospeckle technique, fruit, non-destructive, local dynamics, time and frequency domain

(Some figures may appear in colour only in the online journal)

1. Introduction

Laser biospeckle is an optical imaging technique that has been extensively used as a significant characterization tool to analyze the complex inner dynamics involved in both biological and non-biological processes. Due to its non-invasive and non-destructive nature, it has been widely applied in the field of biology, medicine and agriculture [1].

The intensity fluctuations of the speckle pattern were reported as speckle boiling or speckle motion [2, 3]. Different methods have been established to characterize the behavior of such time-varying laser speckle patterns [4, 5]. The visual appearance of such dynamics or biospeckle patterns resembles a boiling liquid due to continuous change in their spatial structure with time. The methods that are currently used for biospeckle analysis are speckle contrast analysis, optical vortex metrology, laser speckle correlation analysis, etc [6–8].

There are several biological as well as non-biological processes that have been successfully assessed by using the laser biospeckle technique. Among the challenges in biology or agriculture, one of the tasks is the assessment of the local dynamics on biological specimens such as fruit subjected to some mechanical or thermal loads.

We therefore report on applications of the biospeckle technique to monitor the local dynamics on fruit surfaces subjected to mechanical and thermal treatment. The biospeckle data were further shown to be easily processed over time as well as frequency domain.

A multivariate statistical tool, principal component analysis (PCA) was used to monitor the progression of

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fast diminishing activity of a heat-inflicted apple surface and for the subsequent detailed visual perception of bruise scars left after the activity. The biospeckle activity on the apple surface was subjected to point pressure and subsequently assessed using frequency and temporal domain analysis. The temporal autocorrelation function and power spectral distribution (PSD) function were evaluated on the biospeckle data for analysis in the temporal and frequency domain. The biospeckle imaging technique has been shown to be successfully applied to evaluate the local dynamics introduced on the biological surface. The methods utilized to interpret the biospeckle data allowed detection of the formation of internal bruising in the early moments after the occurrence of a mechanical or thermal impact.

2. Theoretical background

2.1. PCA

PCA typically performs processing on data sets resulting from more than one variable; in biological or industrial processes such as corrosion, drying of paint and adhesive, etc. PCA operation accounts for the collective influence of more than one random variable by orthogonally transforming a set of observations of intercorrelated variables in an original data set into a new set of linearly uncorrelated variables known as principal components (PCs). The PCs provide a link to meaningful information and are relatively small in number compared to originally associated variables. From the viewpoint of statistical analysis, the information furnished by a specific PC is usually characterized by its variance. The larger the variance, the larger will be the information content it retains. Since the first few PCs having higher variance concentration retain most of the information, the trailing components can be eliminated with minimal loss. This reduces the dimensionality of the data processing and enables easy interpretation of the resultant data after inverse transformation [9].

The PCA processing on the temporal sequence of the biospeckle image enables the association of specific PCs to biological phenomena to mark the underlying dynamics of the specimen. During this processing, the temporal image sequence is rearranged in the form of a data matrix, where each image is considered as a discrete variable and each of its pixels as a separate observation. The data matrix thus generated is then transformed into a new coordinate system based on variance data where axes represent individual PCs. At this juncture, the relative contribution made by each component is studied and some irrelevant components may be eliminated. Finally, inverse PCA transform is performed with a small number of PCs and the reconstructed data are analyzed. The PCs having small variances usually contribute to noise in the data. Furthermore, the results obtained after PCA operation present significant enhancement in the visual quality of the activity images.

PCA algorithm involves several processing steps [10]. To perform PCA, let us consider an input data matrix A of dimension $M \times N$, where data is organized as

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1N} \\ a_{21} & a_{22} & \cdots & a_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ a_{M1} & a_{M2} & \cdots & a_{MN} \end{bmatrix}, \quad (1)$$

where the row index M is treated as the number of observations and the column index N as the number of variables.

The initial step in building the PCA algorithm is the centralization of data that can be achieved by the subtraction of the mean vector of A from every data vector in it.

$$y_i = a_i - \mu(a_i), \quad (2)$$

where y_i represents the centralized data vectors about the mean vector, a_i corresponds to the N sample vectors under investigation and $\mu(a_i)$ holds the mean of the sample vectors. The centralization step returns a new set of data vectors whose mean in all dimensions is zero. Thus, this step avoids the effect of points remote from the data center having a larger influence than nearby points.

The covariance matrix CO_Y is computed using the centralized data set as given by the expression

$$CO_Y = E\left(Y \cdot Y^T\right), \quad (3)$$

where Y and Y^T are the data matrix centered on the mean and its transpose, respectively.

The diagonal values of the covariance matrix specify the statistical variances of the data along the respective dimensions, while the off-diagonal values characterize the covariance between variables. Variance indicates the degree of deviation of a random variable from the mean, whereas covariance determines the similarity between two random variables by calculating the extent to which they vary.

Subsequently, the decomposition of the covariance matrix into a set of eigenvalues and eigenvectors using the equation are performed using the expression

$$CO_Y = V \cdot \Lambda V^T, \quad (4)$$

where $V = [\Phi_1\ \Phi_2 \cdots \Phi_m]$ is the symmetrical orthonormal matrix of eigenvectors $[\Phi_1\ \Phi_2 \cdots \Phi_m]$ that governs the directions and $\Lambda = \text{diag}\{\lambda_1 \lambda_2 \cdots \lambda_m\}$ denotes the diagonal matrix of eigenvalues $\lambda_1 \lambda_2, \cdots, \lambda_m$ which states how much variance there is in the data in a specific direction.

An uncorrelated data matrix, also called the principal component score matrix is formed by taking the product of the orthonormal eigenvector matrix V and centralized data matrix Y.

$$PC = V^T \cdot Y. \quad (5)$$

Inverse transformation is performed in the final step of the PCA algorithm for reconstructing the original data set by eliminating undesirable components using the equation

$$A = (V \cdot PC) + \mu(A). \quad (6)$$

2.2. Probability mass function (PMF)

The distribution of intensities of the speckles in a speckle intensity pattern could be conveniently represented using the probability distribution of the intensities. The specklegram

captured from the object sample results from interference of depolarized light, on account of multiple scattering. Typically, such a speckle pattern follows Rayleigh distribution [11].

For a discrete random intensity variable $X = \{x_i\}$, $i = 1,2,3,\ldots$, its probability distribution can be defined as a PMF [12], $f(x)$ that assigns probabilities to all the distinct values that X can take, so that

$$f(x) = \Pr(X = x) = \begin{cases} p_i & \text{if } x = x_i \\ 0 & \text{otherwise} \end{cases}. \quad (7)$$

When normalized, the probabilities sum to unity, as shown in equation (8):

$$\sum_{i=1}^{n} f(x_i) = 1. \quad (8)$$

The values x_i are intensity levels 0, 1, 2..., 255.

2.3. Measurement of temporal and frequency variations in specklegrams

The dynamic behavior of specklegrams can be studied by obtaining both the temporal as well as frequency variations in speckle intensities. The temporal variation can be computed using the temporal autocorrelation function r for the speckle intensity patterns with a time lag k, as defined by equation (9) [13]:

$$r_k = \frac{\sum_{i=1}^{N-k} (Y_i - \bar{Y})(Y_{i+k} - \bar{Y})}{\sum_{i=1}^{N} (Y_i - \bar{Y})^2}, \quad (9)$$

where Y_i are the measurement variables and N is the total measurement samples. Variations of the parameter r_k in time, elucidates the state of dynamism in the sample.

The frequency components can be obtained by computing the power PSD of the speckle patterns.

The PSD is the average of the Fourier transform magnitude squared, over a large time interval T, as defined by the following equation [14]:

$$S_x(f) = \lim_{T\to\infty} E\left\{ \frac{1}{2T} \left| \int_{-T}^{T} x(t)\, e^{-j2\pi ft} dt \right|^2 \right\} \quad (10)$$

where $x(t)$ is the biospeckle signal at time t and E signifies the expectation operator. Using this expression, several of the low-frequency components having higher relative power were identified.

3. Experimental

Figure 1 shows an experimental optical setup employed for performing biospeckle analysis. A He–Ne Laser of 632.8 nm and 18 mW was used to produce speckle images of the object samples. The mirrors 1 and 2 were used to direct the laser beam into a spatial filtering unit for further filtering and expansion. A spatial filter unit holding a 20× microscope objective and 15 μm pinhole diameter was used to obtain uniform

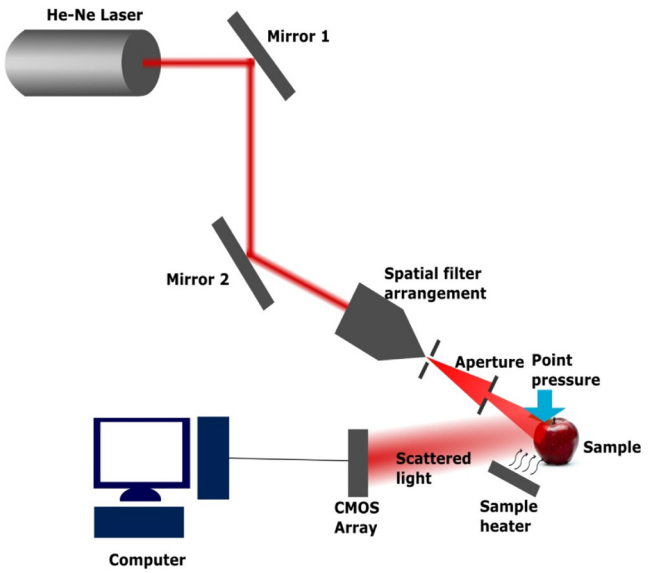

Figure 1. Experimental setup for biospeckle acquisition.

illumination over the region of interest (ROI) on the test surface by removing high-frequency spatial components in the laser beam. The illumination angle of the laser beam with a CMOS camera was adjusted to get high-contrast images with negligible specular reflections of light.

For the first application, a thermostat-enabled electronic sample heater was used to apply heat treatment to the apple surface previously marked with a square region. A sequence of biospeckle frames of the specimen, each with a resolution of 480 × 640 pixels was captured at a sampling rate of 20 samples s^{-1} for the duration of 1 min using a 2.2 μm pixel CMOS camera (DMM 42BUC03-ML).

The second study was to analyze the biospeckle dynamic response on the apple fruit surface subjected to point pressure. The biospeckle frames were successively recorded before and immediately after the application of point pressure. The speckle videos were then filtered using a Gaussian low-pass filter to remove high-frequency noise. The speckle images were converted to 8-bit gray scale images and transferred to a personal computer for further processing.

4. Results and analysis

4.1. Monitoring of biospeckle activity of a heat-inflicted apple using PCA

The PCA method was employed to monitor fast-decaying activity and its leftovers in the form of blemishes or bruises on an apple fruit surface modified by instant heat treatment. A MATLAB code for the PCA algorithm was developed and processed for a different number of PCs extracted from the original heat-treated grayscale image data set. It was found that data reconstructed using the first three PCs impart most of the information with significant improvement in signal-to-noise ratio. A sample movie sequence generated with the reconstructed PCA images corresponding to three PCs assisted in tracing the progression of fast-diminishing

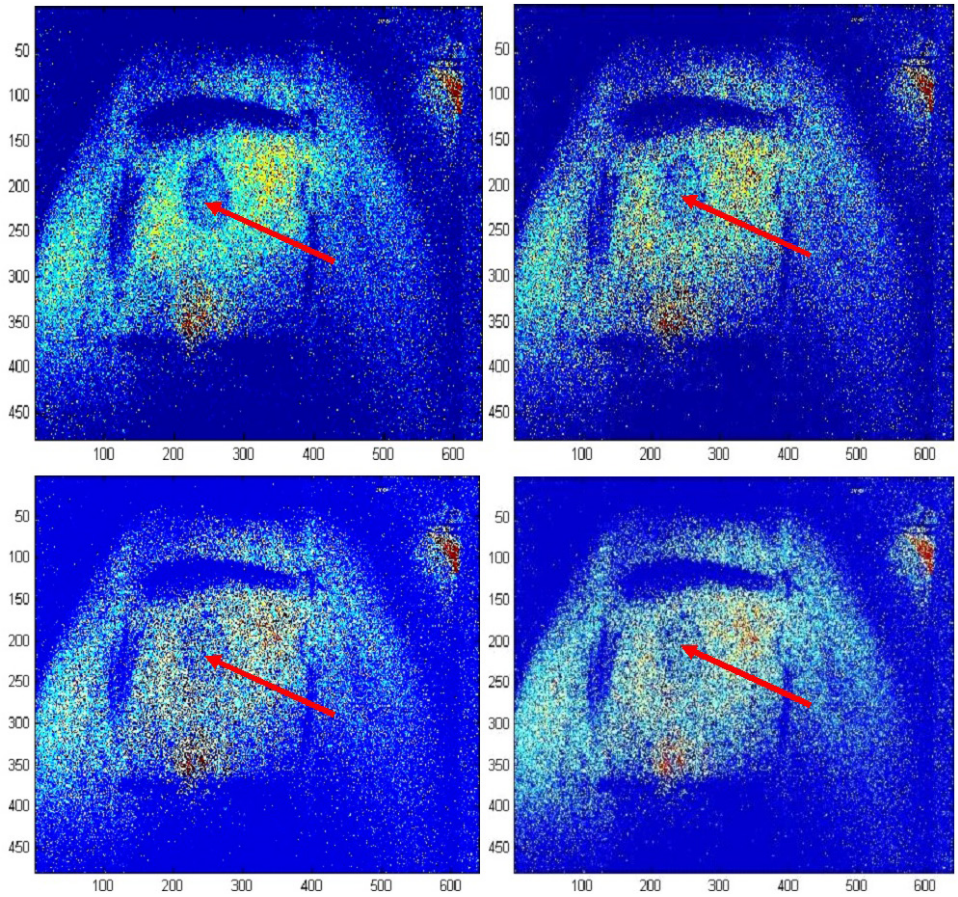

Figure 2. Sample frames of decaying activity reconstructed with three PCs.

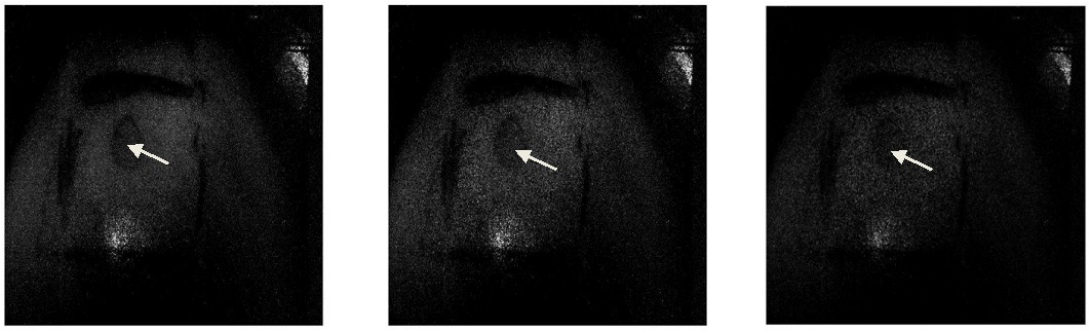

Figure 3. PCA images reconstructed with a different number of PCs.

activity around the heat-treated zone. Figure 2 displays the initial four sample frames of the PCA video sequence made with three PCs.

It was observed that the intensity of the bruise generated on the heat-inflicted zone kept on fading during the progression of decaying activity. The bruise scar left on the apple surface subject to heat treatment or mechanical impact is sometimes difficult to observe with the naked eye. PCA can be harnessed in such situations as a filter to improve the visual quality of the ROI in the images. Figure 3 presents the comparison of different sample frames reconstructed using PCA processing.

The blemish left after the low or zero activity caused by the instant heat treatment appeared as a dark region in the PCA images. Furthermore, it was evident that the PCA images reconstructed with a lower number of PCs were much finer in the ROI than the images reconstructed with a higher number of PCs.

4.2. Monitoring biospeckle activity on apple surface subjected to point pressure

4.2.1. PMF of speckle intensity. Speckle patterns with a resolution of 512 × 512 pixels were captured using a CMOS camera at 20 frames s^{-1}. This recording was obtained for 512 frames. The typical frame from this stack set had a PMF, as shown in figure 4(a). To reduce the processing time, the pixel size was reduced to 150 × 150 pixels for the 512 frames.

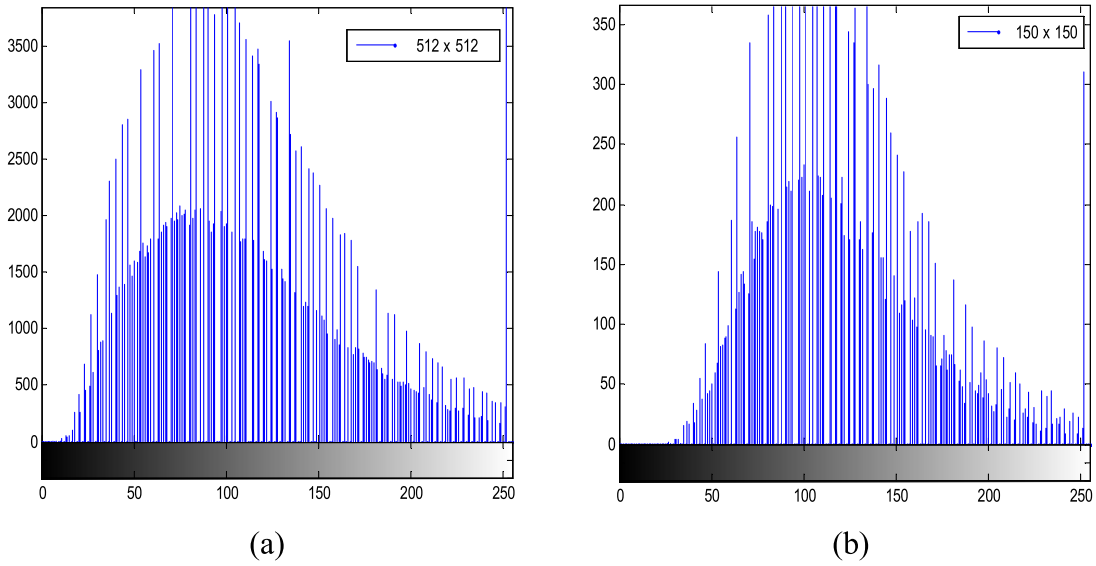

Figure 4. (a) PMF of a typical 512 × 512 pixel frame, (b) PMF of an extracted 150 × 150 pixel frame.

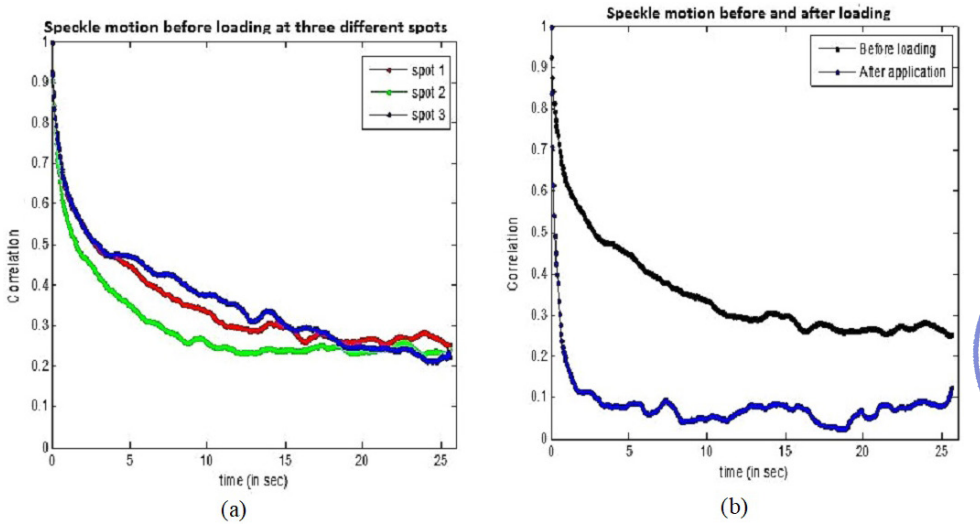

Figure 5. (a) Correlation of speckle pattern versus time for the sample object before loading, (b) comparison of correlation curves before and after loading.

This sub-stack was selected from the original stack of speckle frames without affecting the intensity distributions, for which the PMF was calculated and presented in figure 4(b). It was noted that the PMFs follow a Rayleigh distribution pattern for a dynamic speckle, as expected.

It was necessary to select such a speckle profile from the original image, so that the PMF of intensity statistics includes sufficient gray levels of intensity.

4.2.2. Temporal variations in specklegrams. Correlation matrices were obtained for the two speckle pattern videos of 512 frames of 150 × 150 pixels, one before and one immediately after the application of pressure. The correlation coefficients versus time for the videos were plotted. In order to obtain a smoother correlation curve, we used a moving average filter having a width of 20 points.

For the speckle data set taken, the variation of the correlation coefficient of individual frames in the set was obtained. A speckle video comprising 512 frames at 20 fps and of 25 s duration was recorded.

The results were obtained for the correlation coefficient versus time for the speckle video (figure 5(a)) at three different points on the object, before loading. The same procedure was repeated for before and after the application of point pressure. Figure 5(b) shows a plot of the correlation coefficient versus time before and after the application of point pressure.

For each specklegram video, the correlation coefficient was computed between the first and subsequent frames. For all three recorded specklegrams (from three different regions of the unloaded sample), we found that (figure 5(a)) the curves lie close to one another, indicating no significant difference in their dynamic behavior. Figure 5(b) shows the correlation curves before and after the loading. The settling value (decorrelated value after 10 s) of the correlation curve is higher for the unloaded sample. This is true because for the loaded sample there would be higher dissimilarity between the first frame

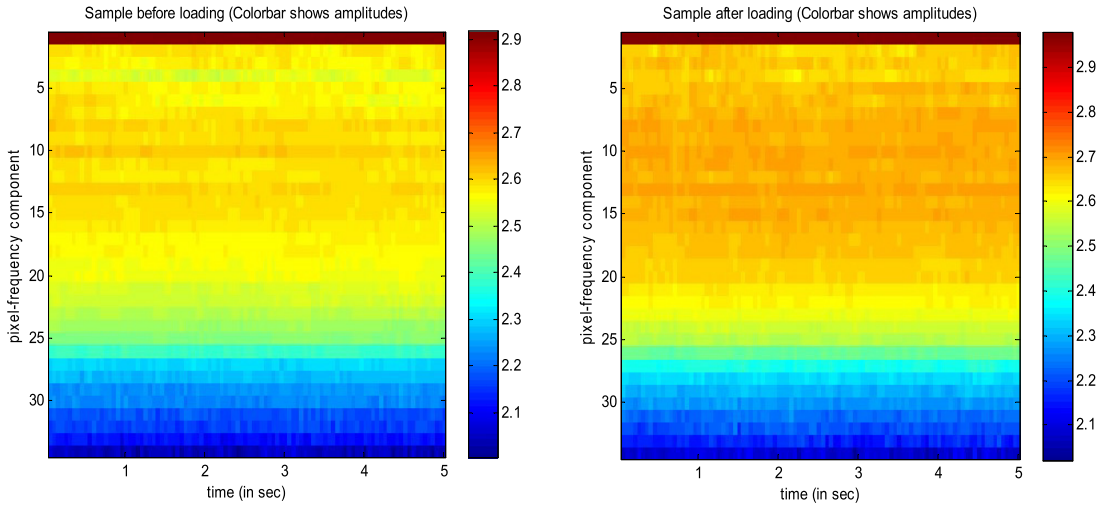

Figure 6. (a) Amplitude of pixel-frequency components versus time (before loading), (b) amplitude of pixel-frequency components versus time (after loading).

and the rest of the frames in the video sequence. The rate of decorrelation of speckle is higher for the loaded sample, as can be observed from figure 5(b).

4.2.3. PSD and frequency variations in specklegrams. We also obtained a profile to compare how the amplitudes of the frequency component behave with variations in the loading (pressure) on the object. For this purpose, the (PSD of the specklegram is obtained. From the PSD, we identified ROIs through several low-frequency components, where the power distribution concentration was high. The variation of the amplitudes of individual frequency components was studied. For this purpose, we obtained a profile showing the pixel-wise frequency component along the y-axis and successive frames in the speckle video cube along the x-axis. The analysis was restricted to the initial 5 s (100 frames) of the video pertaining to the duration of higher dynamic activity in the sample.

Figure 6 shows a plot obtained before, as well as after loading the sample. The amplitude of the individual pixel-frequency component versus time was studied. This plot helped in identifying frequencies that have higher amplitude variation vis-à-vis the unloaded sample. We can also observe that for all frequencies, the amplitude levels are higher for the loaded sample.

4.2.4. Comparison between specklegrams before and after loading. The specklegrams were analyzed for identifying a quantifiable change in the speckle pattern before and after loading. For this purpose, a particular frequency in the PSD was selected, and the variation of its amplitude with respect to time was studied. Four such cases are presented in figures 7(a)–(d), for pixel frequencies 5, 10, 20 and 30, respectively.

Furthermore, the typical variation in pixel-frequency amplitudes for each of the frequency components was analyzed and the cumulative sum of the amplitudes for each frequency over 100 frames was performed. Figure 8 shows the comparison of the cumulative sum of amplitudes with the pixel frequencies before and after load application.

From figure 8, it can be clearly observed that the difference in amplitudes before and after loading is significant. This difference is higher for the lower-frequency region. The difference in amplitudes reduces with the increase in frequency. For frequencies equal to and higher than 25, the difference is much less. This indicates that if we analyze the amplitudes of the lower-frequency components of the PSD of dynamic speckle, better differentiation of the sample in terms of its state of loading is possible.

4.2.5. Comparison between specklegrams at different intervals after loading. Specklegram videos were recorded immediately after loading, 10 s after loading and 20 s after loading. Correlation curves were plotted for these three cases, as before. Figure 9 shows the rate of decorrelation of the specklegrams at various times after loading. From figure 9, we find that the rate of decorrelation of the specklegrams is highest just after loading, and this rate reduces with time. After 5 s, the speckle becomes almost completely uncorrelated, as the activity on account of loading is high even after 20 s.

Figure 10 shows the comparison of the cumulative sum of amplitude and pixel frequency for the cases immediately after loading and 20 s after loading.

We noted that in the lower pixel-frequency region (till about pixel frequency 12), the summed-up amplitude is higher for the specklegram captured 20 s after loading. This shows that the low-frequency amplitude components are higher for specklegrams with a lower rate of decorrelation. This could be used as an identifier enabling us to distinguish objects having different rates of dynamic behavior.

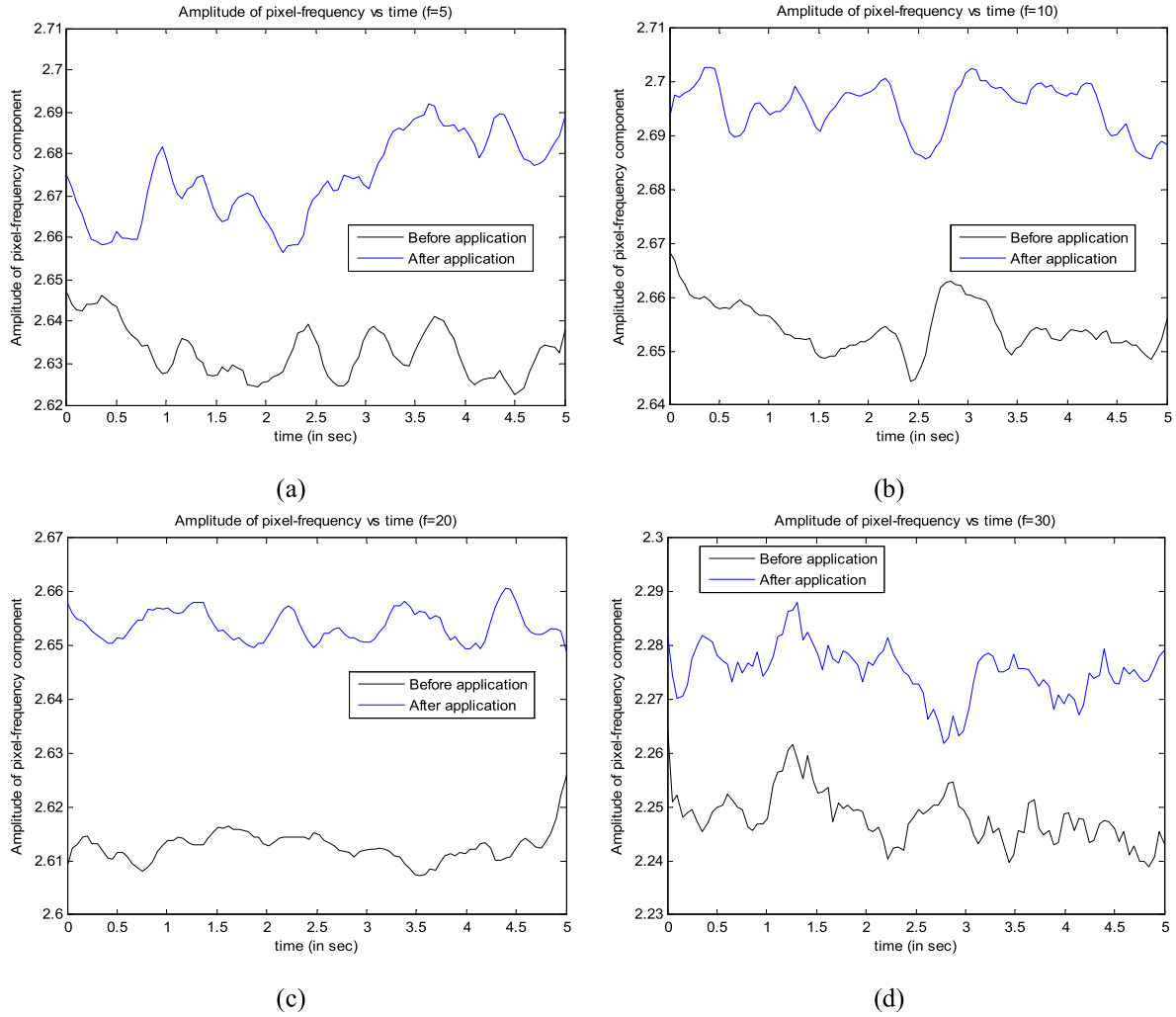

Figure 7. Amplitude variations in time for pixel frequencies (a) 5, (b) 10, (c) 20 and (d) 30.

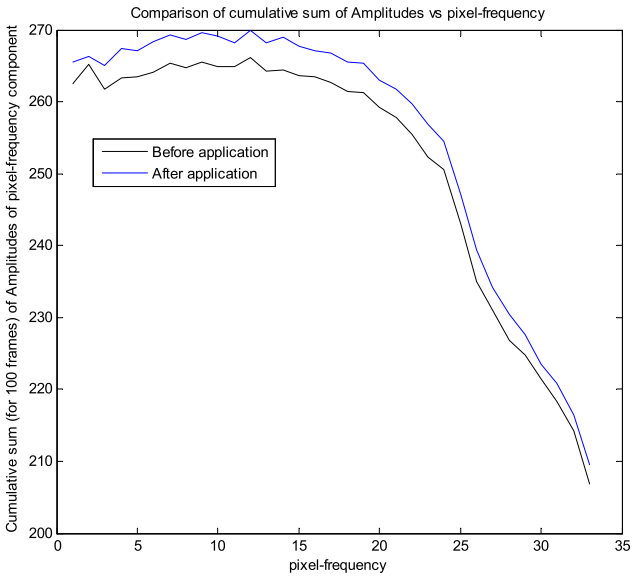

Figure 8. Cumulative amplitude variations for individual pixel-frequency components.

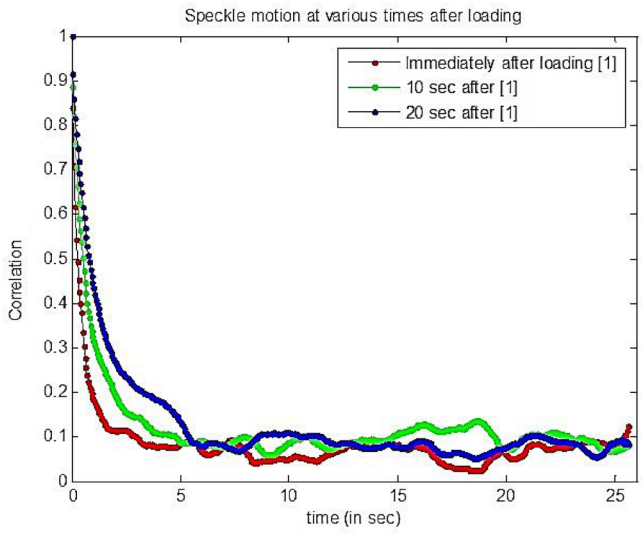

Figure 9. Rate of decorrelation of specklegrams at various times after loading.

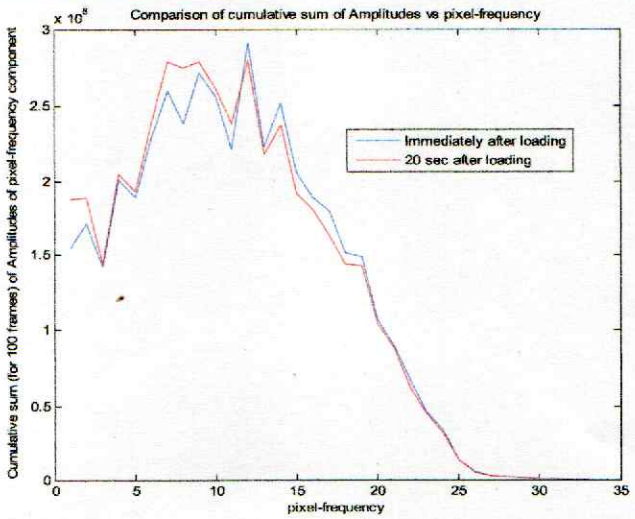

Figure 10. Comparison of pixel-frequency variations at different times after loading.

5. Conclusions

An experimental configuration of the biospeckle laser imaging technique was carried out to assess the monitoring and prediction of the bruising in fruit surfaces within a specified time. The methods utilized to interpret the biospeckle data allowed predisposition detection of the formation of internal bruising in the early moments after the occurrence of a mechanical or thermal impact. The local dynamics on the biological specimen subjected to mechanical or thermal loads using a biospeckle laser technique has been investigated. PCA has been shown to be a relevant statistical method for instantaneous monitoring of certain ROIs such as blemishes or bruises on fruit surfaces at some specific stages in an ongoing process such as heat treatment employed for insect disinfestation.

With analysis, the temporal and frequency variations of dynamic speckle fluctuations were established with the confirmation of Rayleigh distribution of the speckle pattern. Intensity profilometry of the specklegrams of the subject before and after the loading were compared.

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