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A QUARTERLY JOURNAL OF THE NATIONAL PRODUCTIVITY COUNCIL

PRODUCTIVITY published since Oct-Nov 1959 is the principal journal of National Productivity Council of India

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Contents

Industrial Clustering in India: Conceptual and Policy Concerns

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This paper examines conceptual issues in industrial clustering from a developing economy perspective and provides an alternative framework underscoring key characteristics of clusters and factors determining their dynamism. It analyzes 'policy' interventions in cluster development in India and points out several serious inadequacies those must be addressed. In the absence of a national cluster development policy and a limited and truncated understanding of dynamism of clusters dominated by informality, the paper engages with policy-responsive issues as developing a social statistics on clusters, recognizing myriad constraints facing rural craft-based clusters and networking for broad-basing market access by all clustered firms.

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1. Introduction

Throughout the history of industrialization in both developed and developing economies, micro, small and medium enterprises (MSMEs) have stayed on and contributed immensely to economic development in multiple ways by creating employment opportunities, raising local income and acting as disincentives to distress migration. The scalar upgradation of MSMEs—depending upon business prospects, firm maturity and resilient entrepreneurship traits—has not been a deterrent to the continued existence of and new entries into the domain of small-scale production. Further, MSMEs in a number of subsectors have performed the vital role of subcontractors to large firms either as original equipment manufacturers (OEMs) or job workers. Especially since the mid-1980s, as barriers to trade have gradually declined across several nations, small enterprises have emerged as a common content in trade negotiations. MSMEs, apart from producing thousands of distinct products using both modern and traditional technologies and skills, have the potential of paving ways for mutually beneficial exchange of ideas, support services, raw materials and skills that would create greater opportunities for jobs, income and trade. MSMEs have emerged as important export earners in several Asian countries since the late 1990s at least (Veeramani and Dhir, 2016).

While the relevance and significance of small enterprises in any industrial economy often have been acknowledged in policy circles during the recent decades, much attention has been drawn to the special form of industrial organization of small firms, known widely as industrial clustering. As detailed elsewhere (Das, 1995 and 2005), the re-emergence of enormous interest in industrial clustering could be traced to the publication of

The Second Industrial Divide: Possibilities for Prosperity three and a half decades ago (Piore and Sabel, 1984). Set in the backdrop of global recession following the oil crisis during the 1970s and beyond, this book explores (through detailed field investigations in select matured industrial economies) how certain small-sized enterprises performed remarkably well including in export markets during the crisis period while the Fordist-Taylorist large-vertically-integrated mass production enterprises floundered to keep business and also retain workers. The inherent rigidity or indivisibility of the organization of production of such large enterprises was identified as the drag, as "the thrust of competitiveness of firms was increasingly being shifted from a supply led volume and 'homogeneity' of production to a demand induced highly customized and differentiated production structure. The key to performance in a vacillating market remained the flexibility of firms on at least two counts— product/process innovativeness and custom responsiveness" (Das, 1996: 153–154). In order to nuance the flexibility, Piore and Sabel (1984: 17) articulated a unique concept 'flexible specialisation' which stood for the "strategy of permanent innovation: accommodation to ceaseless change, rather than an effort to control it. This strategy is based on flexible-multi-use-equipment; skilled workers; and the creation of, through policies, of an industrial community that restricts the forms of competition to those governing innovation". Labelled as *achieving* firms, these enterprises draw upon advantages of agglomeration economies of both scale and scope that clustering usually offers. Despite being small, typically, clustered firms derive their symbiotic strength through social embeddedness of business and healthy competition. The industry association, in most instances, plays a supportive role in acting as a conduit between the constituent firms and the state, and any external stakeholder engaging with the cluster.

2. Conceptualizing Industrial Clustering

Notwithstanding the revival of major interest in the phenomenon since around the mid-1980s, clustering of firms has been an old subject analyzed within the context of agglomeration and external economies, more than a century ago, by the famed neoclassical economist Alfred Marshall in his seminal volumes *Principles of Economics* (1890) and *Industry and Trade* (1919). He had pointed to the special gains small firms would enjoy in 'industrial districts' in terms of sharing common business infrastructure, trading and even a common pool of skilled labour. He observed that "so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air. Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed; if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material" (Marshall 1974: 225). The emphasis on the *spatial* dimension of clustering also related to the catalytic role played by localized demand for specialized products. The specialization efforts translate into upgrading product and process qualities in a collective manner. It was argued that clustering would lead to increasing returns to scale through knowledge or technology spill over, improved production and enhanced access to markets local and beyond.

References to industrial clusters, though quite commonplace in concerned policy and academic spheres, have not quite led to a comprehensive and copacetic definition of the phenomenon. A range of 'definitions' has been proffered by scholars though. For instance, Rosenfeld (1997: 10) holds that an industrial cluster is "a geographically bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialogue that share specialized infrastructure, labour markets and services, and that are faced with common opportunities and threats." Similar articulations are found in other attempts at defining clusters. As Cooke and Huggins (2003: 4) observe, "Clusters are geographically proximate firms in vertical and horizontal relationships, involving a localized enterprise support infrastructure with shared developmental vision for business growth, based on competition and cooperation in a specific market field". Or, the rather widely referred to definition comes from Porter (1998: 78) as "Clusters are geographic concentrations of interconnected companies and institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition. They include, for example, suppliers of specialized inputs such as components, machinery, and services, and providers of specialized infrastructure."

The various definitions of clusters notwithstanding, there have been intent critiques of theorizing the phenomenon. As, for instance, in a scathing rebuttal of Porter's *branding* and *marketing* of 'cluster theory', Martin and Sunley (2003: 5) hold that "the mere popularity of a construct is by no means a guarantee of its profundity. Seductive though the cluster concept is, there is much about it that is problematic, and the rush to employ 'cluster ideas' has run ahead of many fundamental conceptual, theoretical and empirical questions." Similarly, in a critical review of theories on clusters, it has been observed that "Most important, we found that the theory's descriptive and static nature necessitates a dynamic analysis. This requires analysis of not only how a successful cluster is organized today but also how it emerged, what kind of challenges it faced and resolved, and who played a major catalyst role…Although it was one of the core arguments, the cluster theory has been shown to be weak in explaining how to develop the interconnectedness or network aspect within a region. Whereas we have known that externalities and knowledge spill overs are critical for innovation and regional growth, we still know little about how exactly that happens" (Motoyama, 2008: 361).

The conceptualization of clusters, nevertheless, was most succinctly articulated by Marshall (1974) and Hotelling (1929) who based their central argument on the positive attributes of territoriality as derived by firms of a specific subsectoral activity co-located in space. The specialty of the production organization was stated to be the spirit of collectivity, no matter whether inter-firm competition or rivalry existed within the cluster. There has been the additional dimension, as expounded in Coase (1937), of reduced transaction costs in clusters due to the *sociality* of entrepreneurs. The eventual concentration of various business service providers, whether in transportation, communication, repair and spare parts, auxiliary services in design, painting, skill training, restaurants, rental accommodation for workers and so on, ultimately contribute to the reduction in various costs (search costs including), building a reputation for the cluster (that helps expand the market for its products) and, thereby, brings in advantages of both scale and scope economies (Chandler, 1990; and Alcorta, 2001).

In fact, through a prudent interpretation of the Marshallian idea, Becattini (1992: 38) brought in the social dimension to underscore the *non-economic* factors at work in a collectivity. He exposited cluster as "a socio-territorial entity which is characterized by the active presence of both a community of people and a population of firms in one naturally and historically bounded area. In the district, unlike in other environments, such as manufacturing towns, community and firms tend to merge". It is important to mention at this juncture that several of the subsequent policy attempts at cluster development in the global or domestic spheres have either failed to recognize or grossly neglected these foundations of cluster dynamism. The role of a range of *cluster stakeholders* both endogenous and exogenous to the space of production and business has been incorporated by taking recourse to important sociological constructs as social embeddedness, trust, mutuality and networking between these stakeholders. The economistic obsession with the growth and performance of clusters has yielded little useful insights into this form of industrial organization, especially when one focuses attention on developing economies.

3. Key Attributes of Clustering

Drawing upon the conceptual discourse in cluster literature, it is possible to identify the key attributes of an industrial cluster that could be represented diagrammatically. Envisaged over a decade now, the following discussion in this section is based upon Das (2008: 8–12). The three key characteristics of a typical cluster are represented through a simple diagram of a triangle showing the 3-S (i. Subsector/Sector; ii. Space; and iii. Support System) distinguishing a cluster (Figure 1). To elaborate further, a cluster is focused around a certain *subsector or sector* (manufacturing or services) and most related activities. In that sense, it differs from an industrial estate or an industrial area/zone/belt with multiple and diverse types of subsectors co-located. The *space* (not place, as often construed) refers to the fact that enterprises (and related activities) in a cluster are not merely 'co-located' but the business draws upon several spatial or regional endowments including infrastructure, entrepreneurship, community bond, local governance structure and nature of connectivity to the similar external resources. While any group of enterprises, irrespective of being part of a cluster, has to have a reference to a subsector and geography, what sets a cluster apart is its distinctive advantage of having one or more *support systems* which could either be formal or informal. This needs some elaboration. While, usually, a cluster level industry/trade association remains a classic instance of a formal (member-based) collectivity there have been several informal groupings or alliances based on caste, community or common social or

intellectual background. One could extend these relations to what is referred to as the Triple Helix approach wherein the stakeholders from enterprises, state and the academia or research community form a mutually beneficial coalition.
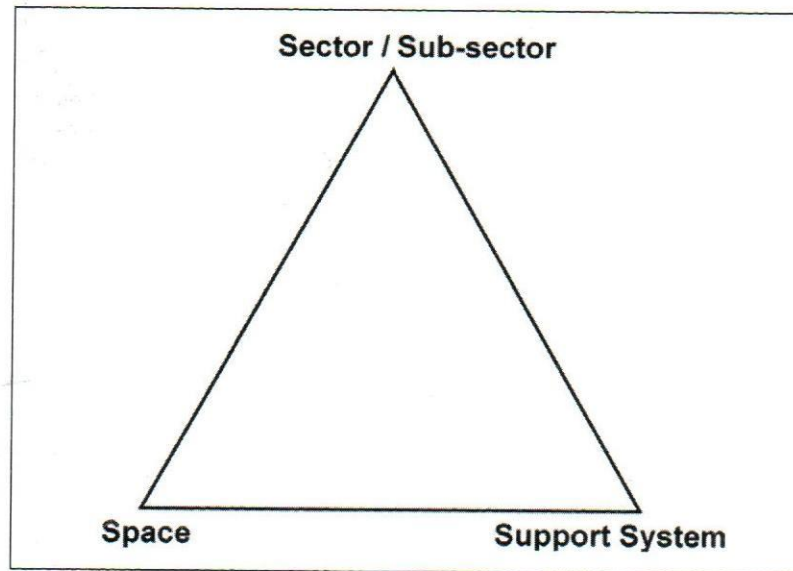
Source: Das (2008: 9)

Figure 1: Key characteristics of a cluster

A robust understanding about the dynamics of an industrial cluster must draw upon the endogenous and exogenous factors influencing the cluster's ability to achieve competitiveness of a higher order. Unlike matured industrial economies, clusters in developing economies often function within limiting macroeconomic policies in terms of accessing technology, reaching out to global markets and, importantly, networking with competent stakeholders outside the cluster. Similarly, the nature of informality in both the production and labour processes within clusters impinges upon the upgrading of social and economic standards that would have implications for accessing high value-adding markets within and outside the domestic sphere. An attempt has been made to represent these major factors through Figure 2 which relates the dynamism of a cluster to its target echelons
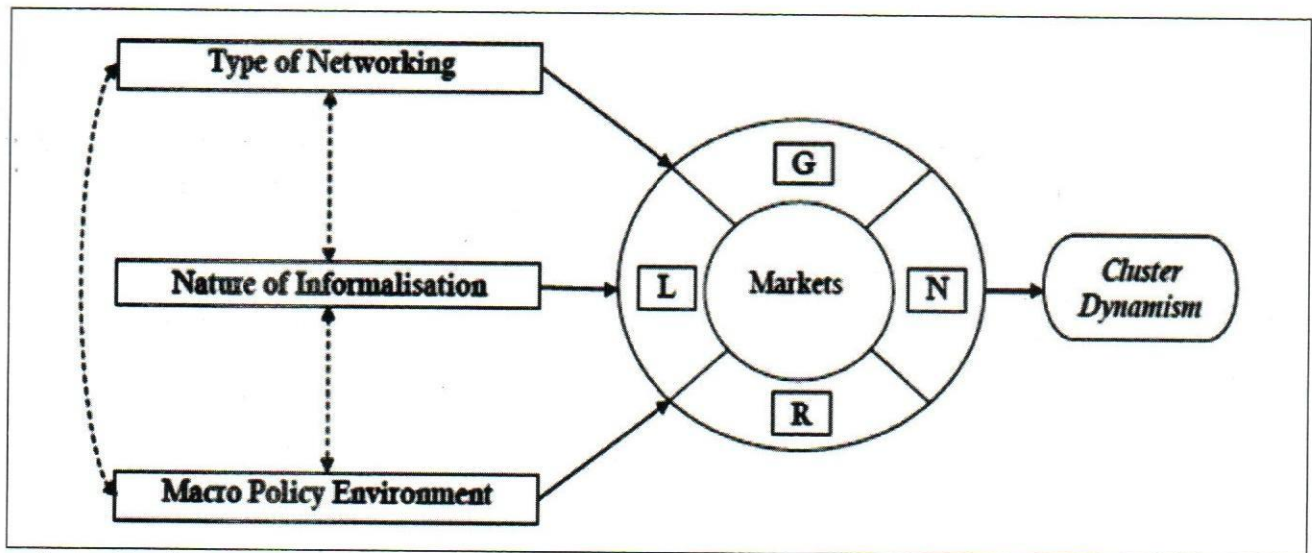
Source: Das (2008: 9)

Figure 2: Key determinants of cluster performance in developing economies

of market and interconnectedness between various stakeholders. It may be useful to point out that a closer understanding of layered markets catered to and/or available for enterprises in a cluster is an important dimension of conceptualizing a cluster's potential to compete and grow. For instance, in Ding (2007) one gets an idea about the dynamics of layers of markets *within* the domestic space in the Chinese context that calls for discrete policy interventions in cluster promotion. In the figure, at least four layers of markets—local, regional, national and global—have been indicated, although the possibilities would be more and varied. Eventually, market types would have implications for technological upgradation for concerned enterprises within a cluster.

The reference to networking would include a wide range of interactions of the cluster stakeholders with both formal and informal support systems, be those related to production, transport, training, sharing information on technology, financing, fiscal concessions, accessing generic infrastructure, or what Brusco (1992) described as 'real services', community-based groups or sectoral or trade associations. An important dimension of networking concerns forging subcontracting arrangements both within and outside the cluster including taking part in global production networks (GPNs). "Further, networks also imply inter-connections with input suppliers, business development service (BDS) providers, research and development (R&D) organizations, industry associations, trading agencies and the relevant government and inter-governmental bodies. Often, firms in a cluster, despite being based in a disadvantaged location and/or engaged in low-tech/traditional activities, have been able to supply to the global market through the sheer strength of networking with international promoters or traders" (Das, 2008: 10). There exists a strong possibility of these three key determinants affecting each other in facilitating or hindering business in a cluster.

An important hiatus in the conceptualization of industrial clusters in developing economies, going by the extensive literature available, relates to the near absence of detailed discussions on two issues: informality and labour (Das, 1999). This is despite early mentions of at least the latter issue could be found in both Schmitz (1990) and even Brusco (1982: 170-175); the latter discussed the poor working conditions of 'black' labour (casual, underpaid, discriminated and without social security) in the industrial clusters and artisanal enterprises of the dynamic Emilia-Romagna region of Italy. The *strategic*

silence on these two issues by the otherwise informed discourse engaging scholars from a multi-disciplinary perspective has been unhelpful both from theory-building and policy making. While the invisibility of work (and workers) in the informal sector covers up the precariousness and insecurity of casual workers in clusters, concerns also remain regarding the informality in the production process related issues such as "use of sub-standard inputs; unauthorized copying/using of brand names/trademarks; misguiding customers/dealers through exaggerated/false product information; unscrupulous business conduct and non-compliance to regulatory provisions, including avoiding taxes, ignoring environmental or safety norms" (Das, 2008: 11).

The macro policy environment deeply influences performance of clusters whether in terms of production, capacity expansion, modernization, exports and networking with external stakeholders for technology, training or finances. While fiscal and trade incentives facilitate sectoral growth and exploring external markets policies leading to major investments in building generic infrastructure in transportation, communications, power, banking or even technical education would have definite impact on cluster dynamism at the local level. Policies of local area development have been known to have positively influenced performance of industrial clusters (Das, 2008: 12).

The inadequacies in conceptualizing industrial clusters deter a sound understanding of their dynamics and, consequently, weaken policy thinking.

4. Policy Concerns in the Indian Context

It is an irony that a nation priding on MSMEs as the engine of growth and employment has such a poor database on the sector; the *latest* available census of MSMEs had collected data for 2006–07! Similarly, there is a serious dearth of reliable statistics on industrial clusters in India (this is not unique to India though). Estimates suggest about 6400 clusters are spread over the country of which about 94 per cent are in traditional or artisanal or craft activities dominated by handlooms (Das *et al.*, 2007: 12). It may be mentioned that the so-called cluster data provided in the last two MSME censuses (3rd census of small scale industries for 2001–02 and the 4th census of MSMEs for the period 2006–07) are highly problematic and, strictly speaking, incorrect. Cluster data cannot be bifurcated into 'registered' and 'unregistered' categories as any typical cluster would have a mix of the two types of enterprises

(belonging to the same sector or sub-sector, naturally). Again, the data are presented based on a perplexing norm of 'over 100 registered units' or 'over 500 unregistered units' making for a cluster in a given district. There are several other limitations of these data as well. A note on improving the database has been presented towards the last part of this article.

The official statistics on even the number of clusters remain both incomplete and incomprehensive. Tables 1 and 2 present such information on number of clusters across regions of the country as compiled about a decade and half ago. No updated data on the number and other relevant variables concerning clusters could be located on the official sites of the Ministry of MSMEs. There are also additional concerns about how clusters are defined, based on what benchmark. These limitations could derail any policy interventions planned.

Joining the bandwagon of UNIDO's cluster development programme (CDP)—an entrenched *sectoral* approach—across several developing economies of India,

Table 1: Distribution of Artisanal Clusters in India, by Region and Product Group

Product Group	Regions					
	North	South	East	West	Northeast	All-India
Wood Products	73 (23)	36 (25)	60 (15)	56 (22)	20 (10)	245 (95)
Metalware	27 (10)	27 (4)	81 (28)	32 (6)	5	169 (45)
Stoneware	8 (8)	10 (10)	12 (12)	14 (14)	-	44 (44)
Textile Products	153	67	94 (1)	102	40 (2)	456 (3)
Bamboo/Cane	25	28 (3)	65 (1)	44	43	205 (4)
Leather Products	17	2	6	24	2	51
Bone, Horn, Ivory	6 (2)	10 (3)	8 (4)	6 (1)	1	31 (10)
Clay/Pottery	37 (25)	14	65 (39)	35 (6)	10 (5)	161 (75)
Carpets	40	4	7	13	4	68
Jewellery/Fashion	37	23	36	42	9	146
Dolls and Toys	6 (6)	15 (15)	15 (15)	12 (12)	2 (2)	50 (50)
Glassware	5	1	-	-	-	6
Miscellaneous	7	4	8	2	3	18
Total	435 (74)	241 (60)	457 (115)	383 (61)	139 (19)	1656 (276)
% to Total	26	15	28	23	8	100

Source: Das (2005: 9)

Notes: Bracketed figures indicate number of artistic/decorative (as distinct from utility) products.

States by region are as follows:
North: Delhi, Himachal Pradesh, Haryana, Jammu and Kashmir, Punjab and Uttar Pradesh. South: Andhra Pradesh, Karnataka, Kerala and Tamil Nadu. East: Andaman and Nicobar Islands, Bihar, Orissa and West Bengal. West: Gujarat, Lakshadweep, Madhya Pradesh, Maharashtra and Rajasthan. North-east: Arunachal Pradesh, Assam, Manipur, Mizoram, Nagaland, Sikkim and Tripura.

'Miscellaneous' includes the following product groups (number of clusters): *Agarbathi* (10); *Bashetaries* (2); *Pactra* tribal jentiles (1); *Dhokra* (2); and Other Domestic (3)

Table 2: Non-Artisanal/Modern Clusters in India

Product Group	Regions				
	North	South	East	West	All India
Animal products, vegetables, horticulture, forest products, tobacco, pan masala and non-edible water/spirit and alcohol, chiefly used in industry	13	16	10	23	62
Ores, minerals, mineral fuels, lubricants, gas and electricity	4	5	0	10	19
Chemical and allied products	5	3	1	16	25
Rubber, plastic, leather and products	10	6	1	6	23
Wood, cork, thermocol, paper and articles	10	2	2	7	21·
Textile and textile articles	17	28	6	22	73
Base metals, products thereof and machinery equipment and parts thereof, excluding transport equipments	45	22	15	36	118
Railways, airways, ships, road surface transport and related equipment and parts	5	1	1	5	12
Other manufactured articles and services, not elsewhere classified	14	5	2	14	35
Total	123	88	38	139	388
% to Total	32	23	10	36	100

Source: Das (2005: 10).
Note: For the list of states by region, see Notes in Table 1

in 1997, formally launched its own CDP that followed the UNIDO approach (typically, involving and identifying a cluster, diagnostic study, devising cluster action plan, implementing of pilot/strategic projects, monitoring and evaluating and shifting over to a self-management phase, etc.). The idea was to promote clusters towards enhancing their competitiveness, helping them access external markets and facilitating their participation in the global value chains. That it would reduce poverty was also highlighted. The surge of various cluster schemes can be observed since 2000. The 'excitement' over the CDP was high, and while through a series of schemes and programmes quite some clusters were 'covered' the conceptual underpinnings of these initiatives remained emaciated as these failed to critically assess the relevance or otherwise of the UNIDO CDP approach. For one thing, complex but extremely important issues as working conditions, environmental degradation/pollution, preserving traditional knowledge and skills, building mutuality between unequal competitors, striving to promote an innovative ethos, etc. were hardly thought through as programme inputs.

In the absence of any comprehensive database on cluster intervention schemes and programmes in India, it is difficult to comment upon even if the state initiatives are effective or not compared to such efforts by non-state agencies including NGOs and private banks. However, in a compilation of state sponsored schemes and programmes concerning cluster development in India, Singh (2010: 9–18) suggests that there have been at least 24 such government initiatives. Moreover, the five important ones (Micro and Small Enterprises Cluster Development Scheme (MSE-CDP); Industrial Infrastructure Upgradation Scheme; Babasaheb Ambedkar Hastshilp Vikas Yojana (AHVY); Integrated Handlooms Development Scheme (IHDS); and Scheme of Fund for Regeneration of Traditional Industries (SFURTI)) had covered an estimated 1413 clusters across the country with an expenditure of about Rs. 1328 crore.

As a well-thought-out national policy on cluster development addressing multiple challenges facing various clusters does not exist, one can only identify issues through planning and implementation of discrete schemes and programmes by several agencies. What is disturbing is that there exists hardly any detailed evaluation of how these various interventions worked in cluster promotion. However, over a decade back, based on surveys of about nine clusters (of both modern and traditional subsectors) across the country and a close reading of various government schemes and programmes on cluster development, quite a few policy suggestions had been made (Das *et al.*, 2007). These relate to a range of issues depending on the status and potential of clusters. We discuss some of the important policy concerns including making a suggestion for an inclusive database framework for clusters.

i. As most clusters have a preponderance of small and micro enterprises and the collective action based on mutuality weakens or remains absent once the intervention agency—whether the so called cluster development agents (CDAs) or cluster development executives (CDEs) or the implementing non-government organisations (NGOs)—departs, the scene following the end of the period of intervention the problems of sourcing of inputs, sharing of large orders and *collective bargaining* for a remunerative price are hardly addressed. Instead, often a small set of entrepreneurs sharing certain commonalities—as those with a very high turnover or advanced technology or stronger networking abilities—come together and act as what we term as an "ace club" or "in exclusivity". This may defeat the very purpose of *social cohesion,* considered an important sub-system of clusters. As also observed in the context of Italian clusters, while a cluster draws its sustenance from the two sub-systems—a community of people and a population of firms—in pursuit of their private goals, some *leader* firms abandon the 'horizontal' relations in favour of more hierarchical ones. Such an approach may potentially undermine the cluster as a system of collective dynamism. From a policy perspective, this would warrant a "regulatory—as opposed to merely permissive—action to change the incentives that enhance short-sighted strategies." (Ramazzotti, 2010: 955). The very small or micro status of the enterprises often precludes their possibility to participate in appropriate value chains and benefit from market and networking advantages. Such non-participation would act as disincentives for these enterprises who fail to specialize or be innovative and get slotted into a low-level equilibrium. The schemes or programmes have little to address these constraints faced by cluster firms.

ii. Even as some of the schemes and programmes have infrastructure as a component, the relevance of such provisions to cluster-specific requirements has come under scrutiny. For instance, the training facility for making leather footwear of the Central Leather Research Institute at Athani in Belgaum district remains practically unused, as it is equipped with machines and other facilities to make boots whereas this is an old cluster known for Kolhapuri slippers. Contrarily, cluster programmes have provision for generic infrastructure whereas cluster-specific facilities are needed badly. Cluster specific infrastructure also includes economic and business development services as access to banking, quality testing laboratories, specific infrastructure as gas supply, common effluent treatment plants, formal provision to design and research centres or universities, trade facilitation services, cluster certification facilities, entrepreneurship training in financial management, and so on. The time-bound schemes and programmes are no substitute for a relevant and comprehensive policy for cluster development.

iii. The policy attention to rural artisan and craft-based clusters is particularly important as several of these are disadvantaged by several forms of exclusion in terms of locational attributes, declining demand for products, shortage of raw materials, inadequate infrastructure including transport and power, absence of institutional support mechanism whether for marketing, technology upgradation or acquiring new skills, seasonality of activities and non-existence of reliable official statistics. The existing schemes and programmes for rural clusters are nowhere near the innovative and highly supportive policy measures as designed by Asian countries such as Japan's 'One Village One Product' approach or Thailand's 'One Tambon One Product' strategy which represent a holistic policy framework to address discrete challenges facing rural clusters. Institutional constraints to innovation in rural clusters remain one

of least addressed of policy initiatives in India (Das, 2015). National level schemes on rural clusters, namely, SFURTI and AHVY, are virtually an extension of the existing small industry policy instruments and have hardly addressed the structural constraints facing the sector. It is often a mere target-reaching effort with very little follow-up mechanism set in place. In fact, there is hardly any effort to assess the nature of constraints beyond what the so-called 'diagnostic' study *per* se can indicate.

iv. As the very basis of policy lies in a comprehensive database on clusters, the absence of relevant information is a matter of concern. Keeping discrete intervention needs of clusters a priority, an attempt has been made to develop a database in a *social statistics* framework which would be both dynamic and accommodative of key characteristics of clusters (as distinct from MSMEs). The online portal based data framework is what we have named a Cluster Grid, originally conceptualized in Das (2008:

Table 3: Cluster Grid-I : (Identification)

Unique Identification Code													
Sector						Space					Support System		
Market	Informalisation			Macro Policy	Technology Level	Location	Regional Policy		Infrastructure		Own Groups	Other Clusters	Specialized Agencies
L/R/N /G	Lb	T	RC	L/N	H/Lw/NI	R/Tn/C	A	P	Transport	Power	List	List	List
Major Products:													
Source and Basis / Criteria for Defining the Cluster:													
Emergence / History:													
Turning Points:													

Source: Das (2008: 34).
Notes: L-Local, R-Regional, N-National, G-Global, Lb-Labour, T-Technology, RC-Regulatory Compliance, H-High, Lw-Low, NI-Nil, Ru-Rural, Tn-Town, C-City, A-Active, P-Passive

Table 4 : Cluster Grid-II: (Intervention/Initiatives)

Unique Identification Code										
Sector				Space				Support System		
Credit	Technology	Marketing	Trade./ IIPR	Infrastructure	Entrepreneur-	Regional Policy		Groups/ Associations	Related Clusters	Specialized Agencies
						A	P			
Existing Policies:										
Existing Database:										

Source: Das (2008: 34).
Notes: A-Active, P-Passive

32–34). Tables 3 and 4 are self-explanatory and can be easily accessed by specialized service providers, policy makers, entrepreneurs, researchers and other stakeholders including similar clusters elsewhere for any assessment or intervention purposes.

5. Concluding Observations

Intense interest in the potential of industrial clusters in contributing to local economic regeneration has been witnessed globally since the late 1980s. That clusters provide opportunities to enhance competitiveness of firms including micro and small enterprises has implied renewed policy emphasis in both developed and developing economies. In India, interest in promoting clusters has been effected through both state and para-state agencies in the form of cluster development programmes. However, several of these interventions have a truncated *sectoral* approach that undermines the very conceptual basis of clusters as an entity with three key elements as subsector/sector, space and support system. In the absence of a formal national policy on clusters, the myriad schemes and programmes by discrete agencies have not only been piecemeal and *ad hoc* in nature but has largely missed out on two requirements of cluster-specific real services and building a sustainable collective agency of cluster stakeholders. The rural clusters have been particularly disadvantaged as these face multiple challenges in terms of infrastructure (importantly, electricity and transportation) and shortage of raw material, typically, natural resources as forest produce, clay, metals, etc. Existing schemes hardly have addressed these challenges. One of the most neglected policy issues has been little or no efforts at infusing an inclusive innovative ethos in clusters that would enhance competitiveness of the clusters, rural or urban. As an immediate effective step towards cluster promotion in India, building up of a comprehensive database, in the lines of Cluster Grid as suggested here, would be a crucial policy intervention.

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> "Regional economic performance is strongly influenced by the traded clusters which appear to shape wages in local industries."
>
> — Michael Porter

Ecology & Economy Integrated Clustering Approaches for Sustainable Development in India

RAMACHANDRA T. V. AND SUBASH CHANDRAN M. D.

The concept of economic clustering and trade guilds in India has roots in pre-history. The cocoons and silk processing industry has traditionally existed in clusters, in places such as Banaras, Kancheepuram, Kashmir etc. Cluster-based economic development has become an increasingly popular topic for researchers and economic development professionals. The approach is considered an important aspect of a broader re-orientation of research and economic policy towards laying the foundations of a microeconomic approach for prosperity and growth. The past decades were under the spell of macroeconomics and the creation of market institutions in developing economies. While there is now a fairly broad consensus on the type of macroeconomic and legal conditions necessary to achieve economic progress, it is also becoming clearer that these conditions are not sufficient. As a new approach to help economies reap the full potential of an improved macroeconomic and legal context, cluster-based efforts have received a lot of attention. Clusters are groups of industries and institutions co-located in a specific geographic region (based on availability of natural resources) and linked by interdependencies in providing a related group of products and/or services. Because of the proximity among them—both in terms of geography and of activities—cluster constituents enjoy the economic benefits of several types of positive location-specific externalities.

This communication presents integrated clustering of villages for inclusive growth, promoting eco-friendly, local resources, local skill and manpower-based thematic developmental programmes through laying a stronger foundation for sustainable growth. Micro-finance and revival of village-centred enterprises and clustering of villages for thematic development programmes can greatly improve the financial and livelihood security of rural homes, and could provide the largest venues for women empowerment.

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1. Introduction

Cluster-based economic development approach aids in laying the foundations of a microeconomic approach for prosperity and growth at decentralized levels. Cluster-based efforts are emerging to help economies reap the full potential of an improved macroeconomic aspects (Ketels, 2003). Group of industries and institutions co-exist at a location based on the natural resources availability and enjoy the economic benefits of location-specific externalities.

The externalities include, for example, access to specialized human resources and suppliers, necessary knowledge base, a competitive atmosphere calling for higher performance, and learnings from the close interaction with specialized customers and suppliers (Ketels, 2003). Porter (2000) observed that in the age of globalization, economic geography involving clusters of entrepreneurs/ service providers would look paradoxical. Changes in technology and location have diminished many of the traditional roles of location. Yet, clusters or geographic concentrations of interconnected companies (in the author's focus) were considered a striking feature of virtually every national, regional, state and metropolitan economy, especially in more advanced nations. Porter's work caused a surge of interest in clusters as drivers of economic growth and hubs of innovation.

Cluster refers to the agglomeration of small and medium enterprises (in the Indian context) in producing same/similar products/services, or, engaged in the same line of manufacturing activities or services, located within an identifiable and, as far as practicable, contiguous area. The cluster concept gained prominence as an economic policy tool aimed to foster innovation and growth of a competitive private sector in developing countries (Ittyerah,

2009). Donors and development agencies have been paying attention to the potential of cluster initiatives to bring about pro-poor effects. Thriving clusters can generate employment, income and opportunities for the local community and become drivers of broad-based local economic development (UNIDO, 2010). In the last two decades, hundreds of cluster initiatives have been launched involving virtually all regions of the world, and their number is growing. Two-thirds of European Union countries have introduced the cluster approach in their innovation policy, while several European initiatives are based on the provision of incentives and funding to boost competitive territorial advantages (Oxford Research AS, 2008). Clusters are also a widespread phenomenon in developing economies and can display levels of dynamism and innovation similar to those in industrialized countries. The high-tech industry of Bangalore, India, the Chilean wine clusters and the Sialkot, Pakistan, surgical instruments cluster are few examples of many successful endeavours. These dynamic clusters have achieved high growth levels, gained a stable foothold in the international market and generated wealth and prosperity at the local level (UNIDO, 2010). Advantages of clustering are:

i. **Collective efficiency gains:** While the growth of individual small-scale firms is constrained by limited access to resources and inability to achieve scale and scope economies, firms within clusters benefit from collective efficiency gains, i.e. "the competitive advantage derived from local external economies and joint action" (Schmitz, H. 1997). External economies include the availability of a specialized labour force, machinery and input suppliers, the attraction of traders and buyers, as well as an industrial atmosphere where information and knowledge are easily shared. Therefore, cluster enterprises are able to achieve higher and sustained growth rates for synergies, and collaborative linkages allow them to pool resources and efforts for the achievement of shared economic goals. Collective efficiency gains can be further enhanced when the institutional and policy frameworks are responsive to the firms' needs and supportive of their efforts (Bellandi, M. 2002). Cluster-based developmental path will also prevent migration of rural youth, provide job opportunity while practicing agriculture, improvements in the infrastructure, etc.

ii. **Spatial proximity effects**: The achievement of collective efficiency gains is facilitated by spatial proximity such as among firms and local resources within clusters. Risk is decreased when firms know their partners and can easily gather information on their reliability. Firms have fewer incentives to engage in opportunistic behaviour since this will affect their future ability to acquire economic partners as well as attract social stigma. In general, proximity may facilitate the development of trust-based relations that lower transaction costs and support collaborative interactions (UNIDO, 2010).

iii. **Pro-poor growth and supports local people livelihood:** A cluster approach can be a valuable tool to tackle poverty and lay the ground for a process of broad-based growth. This is partly because clusters are also socio-economic systems where the population of firms overlaps with the community of people and their families, living and working in a delimited territory. Not only do entrepreneurs and workers share similar social, cultural and political backgrounds, but also norms of reciprocity and collective practices of self-help are common among employers and employees. Overall, this accounts for a distribution of the benefits of growth that is likely to be more inclusive than in other economic systems (UNIDO, 2010). However, still a considerable number of clusters in developing countries are lagging behind, trapped in a vicious circle of unrealistic competition. Although representing substantial pockets of entrepreneurial activities and providing a living to entrepreneurs and workers, when clusters are unable to shift from stagnation to growth, their potential to contribute to the development of local communities remains largely untapped (UNIDO, 2010).

2. Objectives

Objectives of the cluster-based local development approaches are: (i) consideration and scope for harvesting local skills (such as expertise in fishery, traditional handicrafts, wildlife trails and bird watching, etc.), (ii) upgrading skills to meet challenges (through greenskill development programmes, training programmes and awareness creation), (iii) identification of trainers and training institutes (to improve the skill base of clusters) and providing skills to match the needs of the cluster, (iv) generating economic opportunities for the poor: Promoting productive activities that facilitate fairer distribution of income than capital-intensive equipment; investing in

upgrading the skills and employability of marginalized segments such as women, migrants (Gowlis for eg.), forest tribes and castes, and encouraging the production of goods and services affordable by the poor. For the participation of the poor in the decision making, NGOs, village councils, women's federations and self-help groups will play key roles, (v) participatory approach: the adoption of a participatory approach, openly oriented at empowering the poor fringes of the society contributes to reducing their marginalization and encourages their active participation in the economic life of the cluster by improving their self-confidence and social status.

3. Economic Clustering in Ancient India

The concept of economic clustering and trade guilds in India has roots in pre-history. The cocoons and silk processing industry have traditionally existed in clusters, in places such as Banaras, Kancheepuram, Kashmir etc. In *Jataka*, Kasi was a principal centre of manufacturing cotton as well as silk in the 5th or 6th century B.C. Cotton clothes of Kasi were exquisitely woven, smooth, bleached completely white, and their fibres were fine and soft. Tradition says that when Buddha died, his remains purified with balm were wrapped with brand new cotton clothes of Kasi. Spinning and weaving of cotton was known to Harappans 5000 years ago. The Agarbatti industry had its traditional clustering in Mysore. Bidar became an important centre of alloy metal artworks, especially silver inlay on metals. Spice growing trade in general clustered along southwest India, particularly Calicut, Cochin, Nagarabastikeri, Banavasi etc. With the development of cities as industrial trade centres, various industries and enterprises clustered in the cities where different streets specialized in production or trading of different wares.

3.1 Collapse of agro-pastoral-cum-forestry clusters of central Western Ghats:

Pre-colonial land use system in central Western Ghats was characterized by shifting cultivation, secondary forests and savannah lands in hilly places, fairly large sized sacred groves (*kan* forests), and permanent cultivation in valleys. Whereas secondary forests were used for routine biomass needs, the sacred groves preserved climax forest biodiversity. There was regulated harvest of non-timber forest products (NTFPs) like pepper, cinnamon, Caryota (*Caryotaurens*) toddy, medicinal plants, edible fruits etc. from the *kan* forests. The *kan* forests were also the sources of perennial waters like streams, springs, ponds and lakes. These *kans* had prime role in recharging wells in the valley

downside. The landscape heterogeneity and the forests interspersed with grassy banks and savannahs favoured rich wildlife in the region. This traditional system of community-based landscape management suffered with the British claim over all forests including sacred groves and shifting of cultivation areas. The *kans* got merged with the rest of the reserved forests and lost their identity as sacred places. The locals were dependent on isolated *kans* in the middle of villages for firewood, leaf manure and other needs as they were not allowed access to such goods from timber-rich secondary forests. The Western Ghats Panel (2011) observed "serious deficit in environmental governance all over the Western Ghats tract" and urged that immediate steps be taken to address such issues. The Panel is impressed both by levels of environmental awareness and commitment of citizens towards the cause of the environment, and their helplessness in the face of their marginalization in the current system of governance.

3.2 Extraction pressures from forest-based industries

The 1940s witnessed escalating demands from forest-based industries such as plywood, matchwood, etc. on the forests of central Western Ghats. Dandeli Paper factory established in 1950s relied heavily on bamboo resources until almost near collapse of bamboo forests in Uttara Kannada. As choice timbers were being depleted in forests, even *kans* were not spared from industrial felling.

3.3 Community-based NTFP harvests replaced by contract system

The British, for the first time, started auctioning forest produce such as pepper, cinnamon, shikekai (soap nut powder), honey etc. to the contractors. The system of collection of NTFP by contractors was found to be very destructive to the forests, and the village communities were hard pressed for resources. In the recent decades, the move has been strengthening to give such NTFP collection rights to the Village Forest Councils (VFCs) and tribal co-operatives.

3.4 The hazards from monoculture plantations

Over-extraction of natural teak and the stoppage of shifting cultivation saw teak trees getting scarcer in Uttara Kannada. The British launched during the later parts of 19th century—systematic programmes to clear fell as much of natural forests—to raise teak plantations. The plantation activity became more vigorous after independence, and Eucalyptus and Australian Acacias were added to the

monocultures. Very often, these plantations were infested with weeds like Lantana and Eupatorium, suppressing the native vegetation. In the heavy rainfall areas especially, the replacement of natural forests with plantations, especially along hill slopes, caused severe soil erosion and drying up of perennial streams. Also, the reduction of diverse pollinators in the nearby localities has affected the crop productivities and hence the livelihood of people.

3.5 Impact of hydro-electric projects on ecology and livelihoods

Commissioning of the Linganamakki dam and Gersoppa dam for generation of hydro-electricity in Sharavathi River resulted in increased fresh water flow in the post-monsoon and summer months diluting the salinity in the estuary to nearly fresh water conditions (<0.5 ppt) most of the year. This caused serious collapse of the estuarine fisheries, both in diversity and quantity. Accordingly, fisheries-based livelihoods declined seriously in Sharavathi estuary and the bulk of estuarine anglers went elsewhere in search of jobs. The edible bivalve (clams and oysters) based fisheries also witnessed complete collapse. Mangroves are associated with very limited species that can survive in low brackish water conditions. Whereas the adjoining estuary of Aghanashini, which is not impacted by hydroelectric projects, has nearly 90 species of fishes, Sharavathi has hardly 50 per cent of this diversity. In the Kali estuary also, because of hydel projects upstream, fish diversity is much lower than in Aghanashini and edible bivalves shifted more towards the river mouth to a restricted zone.

3.6 The bane of estuarine shrimp aquaculture

Since early 1970s, intensive shrimp aquaculture started in Uttara Kannada estuaries with least regard for environmental norms. The traditional, salt-tolerant, Kaggarice-growing gazni fields were cut up and converted into shrimp ponds with almost irreversible consequences. The mangroves were totally cleared for creating many such farms. Monoculturing of shrimps with artificial feeds drastically cut down the sustainable production of a diverse variety of fishes from the gazni rice fields. Today, due to various reasons, aquaculture is on the decline but the estuarine ecology suffered seriously from this mega-venture. Moreover, with the contract system for fish catching from gaznis and shrimp aquaculture, the traditional estuarine fisher folks are restricted to the open parts of the estuary for fishing purposes bringing greater fishing pressure on the estuarine ecosystems.

4. Achieving sustainable development through cluster approaches

The original concept of sustainable development articulated in Our Common Future is of "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Some of the highlights of Principles of Ecologically Sustainable Development enunciated by Justice Brian Preston of Australia are: (http://www.lec.justice.nsw.gov.au/Documents/preston_principles%20of%20ecologically%20sustainable%20development.pdf):

- Effective integration of economic and environmental considerations in the decision-making process.

- Ecologically harmful cycle caused by economic development without regard to and at the cost of the environment could only be broken by integrating environmental concerns with economic goals. The Plan of Implementation of the World Summit on Sustainable Development held in Johannesburg, 2002, noted the need to "promote the integration of the three components of sustainable development—economic development, social development and environmental protection—as interdependent and mutually reinforcing pillars".

- The Precautionary Principle suggests that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

4.1 Application of sustainability principles for Uttara Kannada:

The ecological studies in Uttara Kannada during the course of last two and a half decades have created a sound database for the central Western Ghats-west coast region as a whole, enabling us to formulate an outline plan for decentralized, ecology-inclusive, low-risk sustainable development for bulk common good. The plan is in consonance with global trends in eco-friendly development for humid tropics. The highlights are stated below:

i. Protection of the pristine environment wherever possible, demarcating areas involving biodiversity rich centres associated with forests, hydrologically significant areas such as Myristica swamps and high endemism forests, sacred groves, highly productive estuaries etc.

ii. The development plans are inclusive, aimed at better livelihood opportunities for the locals, promote entrepreneurship at the grassroots involving even the most underdeveloped areas and marginalized people; at the same time, these plans are in spirit not to harm the fragile ecology of the district any further. Though there are no claims of zero ecological damage, simultaneous ecosystem enrichment is envisaged through apiculture, restoration of mangrove ecosystems, beach vegetation and bio-shielding, protection of Myristica swamps and relic climax forests, eco-friendly redesigning of village peripheral forests etc.

iii. In the field of agriculture, the thrust is on organic farming, in situ conservation of indigenous crop varieties, cultivation of medicinal plants and their primary processing, marketing of organic products, crop insurance against damages from wildlife, agro-processing, value addition, use of locally produced bio-pesticides and bio-fertilizers etc.

iv. A variety of low risk and low investment, and least polluting cottage and small-scale industries, mostly based on locally available or locally produced raw materials, and locally trained human-power are proposed. These are visualized taking into account global trends and sustainability. For instance, production of handmade goods or using low cost machinery and locally fostered human resources are going to reduce energy and transportation costs, and at the same time preventing mass migration of youth from impoverished villages into the cities, where burgeoning population and associated crises are turning out to be unsolvable for the Government. The fillip to growing of medicinal plants, apiculture, sericulture, preparation of vegetable dyes, scientifically prepared plant products like kokum (*Garciniaindica*) butter, coconut products, canned fruits, nutraceuticals, participatory ecotourism etc. are meant to capture the global market in the near future.

v. In the energy sector, having researched on the silent but serious repercussions within the ecosystems of hydro-electric projects, (Sharavathi and Kali estuaries—for instance), adoption of widespread harnessing of solar energy will lead to integrated eco-development, apart from biogas, energy efficient stoves, biofuel etc.

vi. The high importance given to fodder farms at panchayat levels is based on the finding of fodder scarcity and prohibitive price of other cattle feeds. The tendency of the people to do away with cattle is primarily because of increased expenses on maintaining them. The reduced availability of cattle manure will tell upon soil fertility and soil structure badly and undermine agricultural systems. Fodder farm is a simple low cost solution for livestock maintenance, achieving prosperity through dairying and for greater soil fertility and protection.

vii. Alternate sustainable use of crop residues for bioethanol, etc. would minimize the greenhouse gas hazards associated with the crop residue, and more importantly, gives an opportunity to the local youth to setup biofuel manufacturing units.

Clustering approaches for ecology-integrated sustainable development of Uttara Kannada has been suggested after due consultations with the stakeholders covering all sections of the society.

5. Ecology-integrated clustering for development of local bodies

The geographical clustering approach for integrated, ecologically-sound development seems to be the only solution for sustainability in rural India, a country which is still a fair mix of advanced state of biotechnology, IT industry and global leaders in textile production, iron and steel, and transportation co-existing with slash and burn cultivation in the North-East, handmade clothes, village blacksmiths, bullock carts and stone-age canoes. The integrated eco-cluster approach, recommended here for Uttara Kannada district, is meant to protect ecology, biodiversity, water resources, culture and traditions while paving way for locality-specific economic development, primarily aimed at elevating the levels of livelihood security. Such development is meant to counter the adverse impacts of globalization on environment and human life in this fragile, humid, tropical zone rich in biodiversity, both cultivated and wild, and to arrest the recent trends in mass migration of youth deserting their villages, seeking better livelihoods in big cities. The clustering of gram panchayats, including small towns, for carrying out a proposed set of economic activities per cluster, envisaged here, is the best alternative to mega-projects and macro-economic development for a fragile tropical zone, a part of the Western Ghats, one among 36 Global Biodiversity Hotspots (https://www.conservation.org/priorities/

biodiversity-hotspots). As cities like Bangalore are becoming unliveable due to unplanned urbanization (1028 per cent increase in paved surfaces with 88 per cent decline in vegetation cover and 79 per cent reduction in local water bodies, leading to severe scarcity of water and oxygen) with the burgeoning population and chaotic development, with water and power crisis looming large, rising pollution and scanty living spaces, the strains are felt in the Western Ghats for siphoning of water, producing hydro-power and even thermal and nuclear power, and extracting diverse kinds of natural raw materials, endangering ecology and impoverishing rural life, making the youth migrate in large numbers deserting their rural homes and leaving behind their traditional livelihoods.

6. Cluster development approach for Uttara Kannada

Sector-wise cluster development approach is inherent and is gaining importance in Karnataka. For instance, in the field of crop production, Bangalore urban and Rural, Kolar and Tumkur constitute a mango cluster targeting production of export-quality mangoes. Dakshina Kannada, Udupi, Uttara Kannada and Kolar make a cashew cluster. Most of the Malnadu districts of the state belong to a cocoa cluster and so on. An all sector-integrated, ecology-based cluster approach is lacking so far.

A taluk-wise clustering of Uttara Kannada has been proposed in Figure 1 for the ecology-integrated sustainable development. In each taluk, the taluk headquarter along with adjoining gram panchayats will constitute one cluster. The coastal gram panchayats are grouped into coastal clusters (Figure 2.1) in view of their proximity to sea, marine fishing as a form major livelihood, their threats from sea level rise and sea erosion in future, nearness or inclusion of estuaries and creeks—which themselves are highly productive ecosystems, low, hilly lateritic terrain, the possible compacted deposits of ancient Gondwana Land erosion, with specialized ecosystems and so on. The inner coastal panchayats bordering on Western Ghats are grouped into separate clusters. If major west-flowing rivers intervene in the landscape, the gram panchayats on either sides are grouped into separate clusters (Figure 2.2). In the Malnadu taluks, the eastern relatively drier gram panchayats and western ones along the crest of the Western Ghats—clad in mainly evergreen forests—make separate clusters. The Anshi-Dandeli Tiger Reserve—including Anshi National Park and Dandeli Wildlife Sanctuary—along with associated villages, constitute one cluster (Figure 2.2). In this cluster, developmental activities are primarily related to eco-tourism and the associated areas, considering the sensitivity of the conservation area. In Mundgod and Haliyal, the taluks merging with the Deccan zone (Figure 2.3), the GPs of relatively flatter eastern portions having numerous ponds and lakes are brought in clusters, separated from those bordering Malnadu forests. Development activities are proposed considering the terrain, landscape elements, ecology, farming systems, associated human life etc. The resulting clusters form self-reinforcing networks of local industries, research institutions, universities, financial bodies and public sector organizations characterized by a high level of competition and collaboration.

6.1 Cluster facilitators and need for institutional structure for implementation

Village panchayats form ideal units for implementation of cluster approach for integrated eco-friendly development. The success of cluster-based development programmes will depend on the active participation of facilitators. The various government departments, financial institutions and NGOs will have active roles to play in the success of the integrated cluster-based approach. In addition, there is also need for district- and taluk-level facilitator committees for scrutinzation of developmental plans and review of progress achieved. The role of some facilitators, for instance, is indicated below.

6.2 Forest and wildlife departments

As forests constitute a major asset of the district, the Forest department needs to be strengthened with more workforce. With regards to development of nurseries, local people need to be involved and are to be encouraged and guided to make nurseries of forest trees and medicinal plants (*Coscinium fenestratum, Nothapodytes nimmoniana, Asparagus racemosus, Emblica officinalis, Saraca indica, Terminalia bellirica, Adhatoda vasica, Rauwolfia serpentina, Tinospora cordifolia* etc). It is suggested to look into the feasibility of purchase of medicinal plants or their products by the Forest Department, or by the local VFCs, from the producers at fair prices and also the sale/supply of these goods to pharmaceutical companies are to be undertaken by the Forest Department itself. This recommendation is being made to stop rampant illegal collection and trade of medicinal plants from the wild. The local ayurvedic pharmaceuticals (within the district) and local people are to be engaged in the cultivation, and value addition to medicinal plants be supplied with medicinal plants/products on priority basis to enrich the local economy and employment potential.

6.3 NTFP collection, developing beekeeping involving forests and mangroves and value addition

Contract system for collection of NTFP from forests found to be highly detrimental to forests and biodiversity and economic well-being of local people be stopped forthwith and co-management system involving local people be adopted. Production of bamboo-based products by local craftsman and effective utilization of bamboo for local development is important. As beekeeping is recommended as an important activity for almost all clusters, roadsides, common lands, under-stocked or degraded forest patches around villages are to be planted with appropriate nectar plant species. Use of alternative energy sources replacing firewood. Development of bettas (minor forests) for tree farming, medicinal plants and fodder. Promoting backwater, mangrove, beach tourism, development of rural tourism and home stays in the vicinity of forests and wildlife areas. Regular conduct of training in bird watching, wildlife studies, trekking trails, hygiene and solid waste management involving VFCs, local youth in forest and wildlife related tourism areas be arranged with view of generating eco-friendly employment potential. Utilization of weeds and harvestable trees/tree parts, bamboos, canes etc., from plantations or other designated areas for vegetable dyes, medicines, weaving, furniture, handmade paper, sports goods production. Awareness creation and conservation of sacred groves, sacred *kans*, which are biodiversity-and hydrology-significant areas and still playing unique cultural roles in rural society. All hydrologically significant forest patches, as indicated, for instance, by high Western Ghats endemism among trees, be preserved both for the sake of perenniality (i.e. 12 months water availability) of water courses and for their biodiversity content. The Department to consider pooling back good part of income from VFC-managed areas into sustainable income generating activities in the cluster level.

6.4 District Industries Centre (DIC)

Main focus agency for promotion of small scale and cottage industries, which include easy registration of small scale and cottage industries, infrastructure assistance, investment subsidies, linking with the employment generation programmes, entrepreneurship development programmes, technical training, assisting in sale of products, buyer-seller meets and not allowing polluting (new red and orange category) industries in Malnadu and coastal taluks. Orange category may be considered under strict norms and social audit, away from biodiversity centres.

6.5 Tourism department

Integrated community-based eco-tourism development is being conceptualized to benefit some clusters of adjoining local self-government units as a strategy to address high incidence of poverty among the communities, while such areas are teeming with tourism potential. This includes developing integrated community-based eco-tourism, assistance in building aesthetic cottages/rooms as part of home stays of bonafide locals or local VFCs. Local grass root level tourism related enterprises to be preferred against construction and commercial lobby, developing tourism awareness in the appropriate panchayat clusters. Conducting programmes on safeguarding local cultures, performing arts and biodiversity. Providing necessary registration/licenses for village home stays (managed by individuals/VFCs/communities) and requires to publish details of homestays in the government portals. Training youth in tourism/home stay management and fostering tourism related entrepreneurship among the local people to increase self-employment opportunities in rural areas and small towns.

6.6 Horticulture department

The responsibilities include facilitate farming of desired crops only under insurance coverage, training women in preservation of fruits and vegetables, and promoting organic cultivation for exports and Indian markets.

6.7 Financial institutions

Government financing and micro-financing institutions to step in to promote cluster-level development programmes through local panchayats, VFCs, Biodiversity Management Committees (BMCs), NGOs, departments, societies etc. Financing from charitable and voluntary organizations, and NGOs and not-for-profit financiers to be considered and may be recommended by related departments. Crop insurance, preferably, in identified human-wildlife conflict zone is highly necessary for future of biodiversity conservation. Financial literacy is very critical for the envisaged participatory development programmes.

6.8 Mining and Geology

Mining in the ecologically fragile regions such as Western Ghats to be phased out. Mining for building stones/jelly be limited to meet local demands, and in any case, not to be transported out of the district. Sand mining in the rivers and estuaries is to be limited strictly for use within the district. Considering coastal laterite as Gondwana land soil/rock deposit, and its limited nature, its special

ecosystem value sustaining rare and unique biodiversity, laterite quarrying from coastal hills should be limited to meeting local demands. Laterite transport to outside the district is to be banned. Mining of stones/sand/shell etc. from VFC/BMC jurisdiction areas be limited to local use and, in any case, not to be transported outside local area/district as is deemed fit by the joint decision of VFC-BMC and Forest and Mining-Geology departments.

6.9 Education department (Primary and Secondary):

The environment education initiatives with high school students and teachers show they are effective in documenting many aspects of biodiversity and related knowledge existing at village level. Within a reasonable time, say one or two days spent on motivating and familiarizing them with the concepts of biodiversity documentation and data collection formats, they could contribute substantially towards building up a dynamic database at village-level that is ready for integration into the People's Biodiversity Registers (PBRs). They are more effective in meeting and interviewing organic farmers, in noting down details on traditional cultivars, collecting details on sacred groves, major wildlife related details etc.

6.10 District administration/Zilla panchayat:

Thin plastic carry bags production and sale to be banned, to promote locally-produced cloth and paper bags. Hoteliers and bulk purchasers of milk to purchase milk in larger containers, which the milk producers are to use mandatorily and need-based. Use of plastic disposable cups and plates to be banned to reduce environmental hazards and to provide market for locally produced biodegradable eco-friendly materials made up of say areca-spathe or washable utensils. Government institutions, offices, public sector undertakings, educational institutions, temples, hoteliers and roadside eateries, and bulk caterers have to comply with such norms. Imposition of fines/cleaning charges be levied on polluters at all levels. Toilet facilities, within the reach of every household, are to be provided. Villages where open defecation is preferred, Zilla panchayats should introduce eco-friendly community sanitation facilities.

7. Conclusion

Cluster-based development approaches are easily implementable at decentralized levels, which constitute a vital path for a broader re-orientation of research and economic policy towards laying the foundations of a microeconomic approach for prosperity and growth. A taluk-wise clustering of Uttara Kannada considering the taluk headquarter along with adjoining gram panchayats as one cluster. The study highlights that the coastal gram panchayats grouped into coastal clusters forms highly productive ecosystems, with the decentralized job opportunities in fisheries, fish products processing, etc. The inner coastal panchayats bordering on Western Ghats are grouped into separate clusters. The Malnadu taluks, clad in mainly evergreen forests, make separate clusters and provide opportunities for forest-based food-processing clusters. In Mundgod and Haliyal, the taluks merging with the Deccan zone, the GPs of relatively flatter eastern portions having numerous ponds and lakes are brought in clusters, separate from those bordering Malnadu forests. Development activities have been proposed for each cluster considering the terrain, landscape elements, ecology, farming systems, natural resources available, associated human life, etc. The resulting clusters form self-reinforcing networks of local industries, research institutions, universities, financial bodies and public sector organisations characterized by high level of competition and collaboration. Thus, cluster-based local development approaches help in harvesting local skills (such as expertise in fishery, traditional handicrafts,wildlife trails and bird watching, etc.), upgrading skills to meet challenges, identification of trainers and training institutes (to improve the skill base of clusters) and providing skills to match the needs of the cluster, while generating economic opportunities for the economically backward section of the society.

Acknowledgement

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"Economic clusters and conventions have become synergistic"
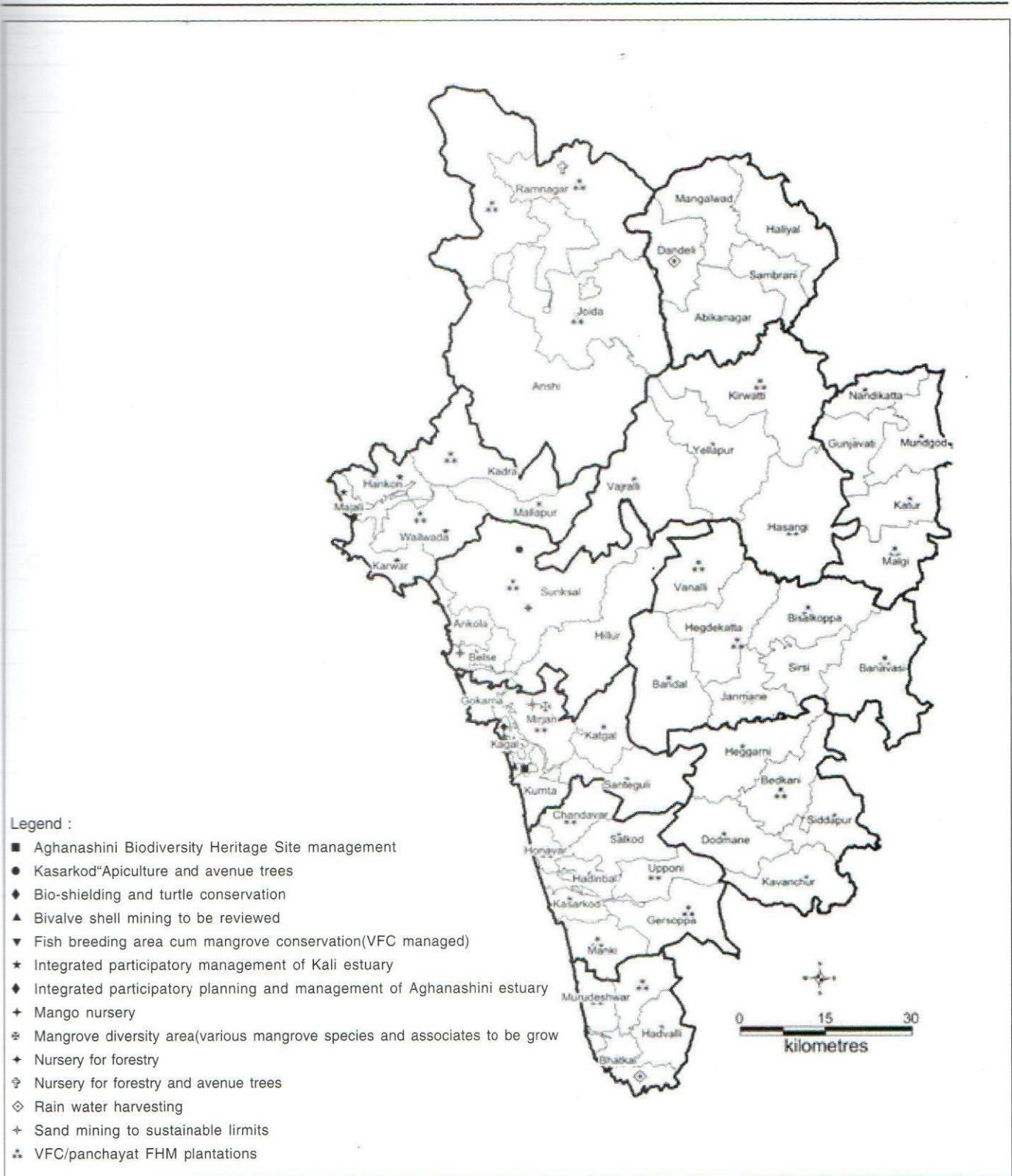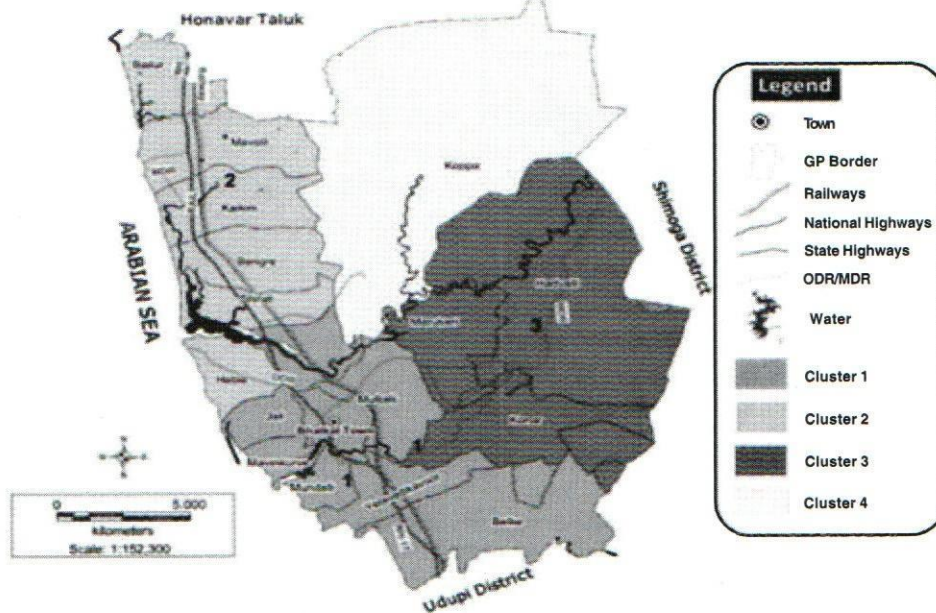
– Tom Clark

Legend :

■ Aghanashini Biodiversity Heritage Site management
● Kasarkod"Apiculture and avenue trees
◆ Bio-shielding and turtle conservation
▲ Bivalve shell mining to be reviewed
▼ Fish breeding area cum mangrove conservation(VFC managed)
★ Integrated participatory management of Kali estuary
◆ Integrated participatory planning and management of Aghanashini estuary
✛ Mango nursery
✤ Mangrove diversity area(various mangrove species and associates to be grow
✦ Nursery for forestry
✿ Nursery for forestry and avenue trees
◇ Rain water harvesting
✛ Sand mining to sustainable lirmits
⁂ VFC/panchayat FHM plantations

Figure 1: Cluster-based developmental approaches for Uttara Kannada district

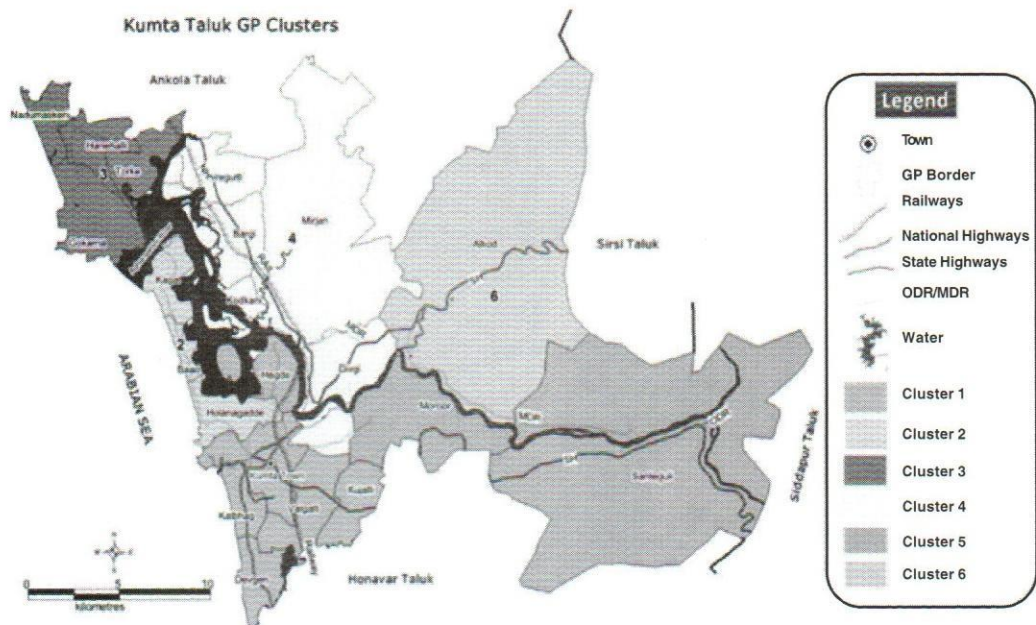**Figure 2.1: Clusters for taluks in the Coastal agro-climatic zone**

ANKOLA	Agro-climatic Zone : Coast
	Ankola Taluk GP Clusters

Clusters	Activities
Cluster 1	Biopesticides, food products, gem and jewellery, readymade garments; training centre for fashion technology; watermelon cultivation; fish products; home stays; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	Beekeeping and bee-nurseries; VFC/panchayat FHM plantations, home for elderly; medicinal plants cultivation & processing; watermelon cultivation; mango pulp; mango nursery; incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 3	Beekeeping, livestock and dairying, gobargas, VFC/panchayat FHM plantations; vegetable dyes; VFC-managed health tourism; Motigudda home stays and tree houses; mango pulp; hospital services, incentives for rare traditional cultivars, rewards and/or incentives to certified organic farmers; incentives for community/private sacred groves in good condition; sericulture
Cluster 4	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes; nursery for forestry, avenue trees; herbal toilet soaps; hospital services, incentives for rare traditional cultivars, rewards and/or incentives to certified organic farmers; incentives for community/private sacred groves in good condition; sericulture

BHATKAL

Bhatkal Taluk GP Clusters

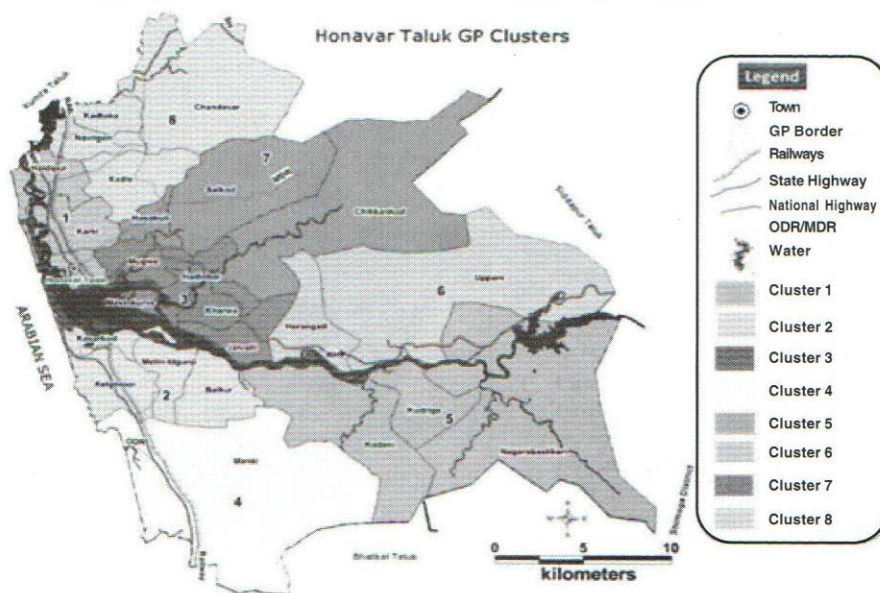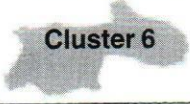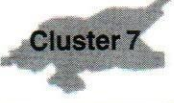| Clusters	Activities
Cluster 1	Beekeeping, VFC/panchayat FHM plantations, home for elderly; vegetable dyes, readymade garments; jasmine cultivation, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	VFC/panchayat FHM plantations; biopesticides and bio-fertilizers; VFC/individuals managed home stay tourism, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 3	Beekeeping, livestock and dairying, gobargas, VFC/panchayat FHM plantations; medicinal plants cultivation and processing; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 4	Beekeeping and bee nurseries; livestock and dairying, gobargas, VFC/panchayat FHM plantations; vegetable dyes; herbal toilet soaps, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; VFC-managed home stay tourism

KUMTA

Kumta Taluk GP Clusters

Clusters	Activities
Cluster 1	Vegetable dyes; Coconut products (virgin coconut oil; purified oil; spray-dried coconut milk powder, desiccated coconut, coconut vinegar), hand-made paper; cloth and paper bags; wood carving; metal inlaid wood carving; training centre for handicrafts; jewellery development and training centre; organic lime industry; Alvekodi onion expansion and storage, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	Dry fish, marine algae products; coastal home stay tourism; training in tourism management; training in making palm-bamboo cottages; training in stone carving; Pandanus leaf products; Integrated, participatory planning and management of Aghanashini estuary; bio-shielding and turtle conservation programmes; bivalve processing and canning; Aghanashini Biodiversity Heritage site management; bivalve shell mining to be reviewed; sand mining to sustainable limits, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 3	Vegetable dyes; home stay tourism; iodized salt, confectionery, bakery; bakery training centre for women; beekeeping; training centre for beekeeping; arts and handicrafts museum and trade centre; sale of organic products; certified organic eateries, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 4	Beekeeping, VFC/panchayat FHM plantations, home for elderly; cloth and paper carry bags; mangrove study tourism, bird watching and sport fishing; estuary interpretation centre, VFC-run estuarine holiday home; fish breeding area cum mangrove conservation (VFC-managed); mangrove diversity area (various mangrove species and associates to be grown); estuarine crab fattening area; integrated, participatory planning and management of Aghanashini estuary; sand mining to sustainable limits, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; sericulture

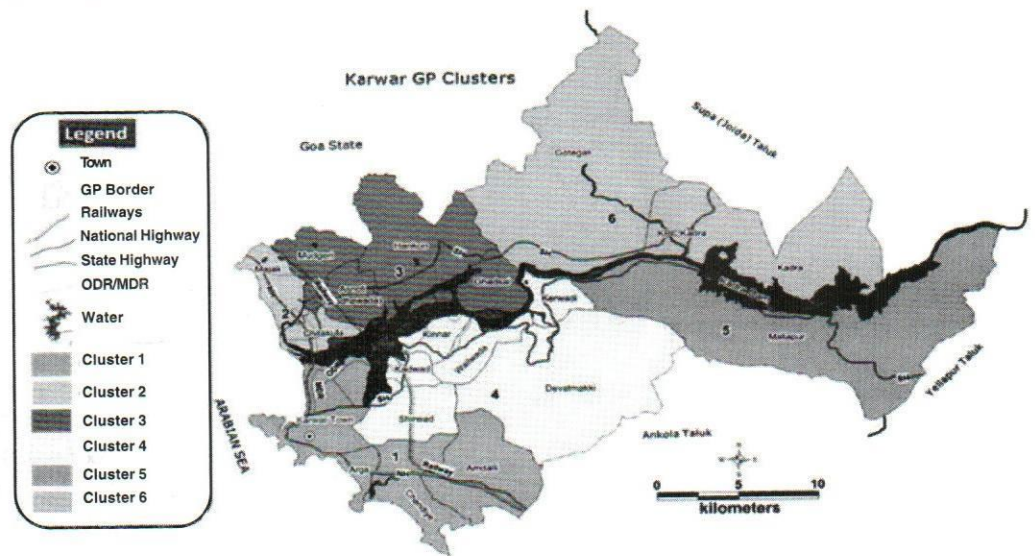| Clusters	Activities
Cluster 5	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; poultry, poultry feed, powdered eggs, vegetable dyes, kokum products, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; sericulture
Cluster 6	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, vegetable dyes, medicinal plants cultivation and processing; pickles from wild berries etc; cane and palm leaf products; VFC-managed holiday home palm houses; Yana trekking and bird watching; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition

HONNAVAR

Honavar Taluk GP Clusters

Clusters	Activities
Cluster 1	VFC/panchayat FHM plantations; organic products certification; honey testing lab; medicinal plants cultivation & processing; organic coconut hair oil; coconut oil natural soap; Calophylluminophyllum cultivation and biodiesel; wood carving; metal inlaid wood crafts, incentives to certified organic farmers; tour operators
Cluster 2	Beekeeping, VFC/panchayat FHM plantations, dry fish, home stay tourism; academy for Yakshagana and performing arts; Calophylluminophyllum cultivation, incentives for rare traditional cultivars, incentives to certified organic farmers; cloth and paper bags
Cluster 3	Beekeeping, VFC/panchayat FHM plantations; cattle feed; coir products; training centre for coir products; backwater tours in native crafts; river front home stays, incentives for rare traditional cultivars; incentives for certified organic farmers
Cluster 4	Coastal home stay tourism; training in making palm-bamboo cottages; Beekeeping, VFC/panchayat FHM plantations; Calophylluminophyllum cultivation, incentives for rare traditional cultivar, incentives for certified organic farmers;
Cluster 5	Beekeeping, VFC/panchayat FHM plantations; woodland holiday homes of bamboo and palms; trekking trail to Govardhanagiri (Kanur fort) and bird watching; hospital services, incentives for rare traditional cultivars, incentives for certified organic farmers; areca-spathe products

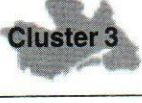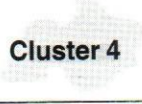|	
Cluster 6	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers
Cluster 7	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes; cane and palm leaf products; hospital services, incentives for rare traditional cultivars, incentives for certified organic farmers
Cluster 8	Beekeeping, VFC/panchayat FHM plantations; vegetable dyes; medicinal plants cultivation & processing, incentives for rare traditional cultivars, incentives for certified organic farmers

KARWAR

Karwar GP Clusters
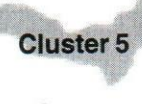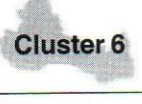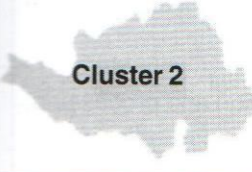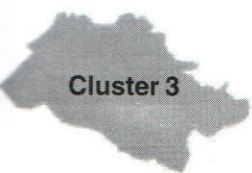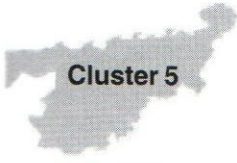
Clusters	Activities
Cluster 1	IT-related development; vegetable dyes; medicinal plants cultivation & processing; gems and jewellery, ornament designing centre, Tulsi cultivation and extracts; integrated participatory management of Kali estuary; tour operators
Cluster 2	Dry fish; coastal home stay tourism; training in making palm cottages; medicinal plants cultivation; Noni cultivation; Tulsi cultivation and extracts; integrated participatory management of Kali estuary; cloth and paper bags; turtle conservation
Cluster 3	Beekeeping, VFC/panchayat FHM plantations, home for elderly; coir products; backwater tours in native crafts; river front home stays; integrated participatory management of Kali estuary, incentives for rare traditional cultivars, incentives for certified organic farmers
Cluster 4	Beekeeping, VFC/panchayat FHM plantations; medicinal plants cultivation & processing; coir products; hospital services; integrated participatory management of Kali estuary, incentives for rare traditional cultivars, incentives for certified organic farmers
Cluster 5	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes, incentives for rare traditional cultivars, incentives for certified organic farmers; sericulture
Cluster 6	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes, incentives for rare traditional cultivars, incentives for certified organic farmers; areca-spathe products; sericulture

Figure 2.2: Clusters for taluks in the hilly agro-climatic zone

SIDDAPUR
Siddapur Taluk GP Clusters
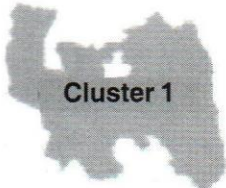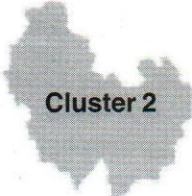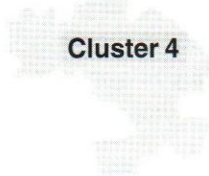
Clusters	Activities
Cluster 1	VFC/panchayat FHM plantations, sericulture, home for elderly; organic products certification; microwave assisted hot air and vacuum drying of food & spices, ayurvedic medicines; sun-dried fruits and vegetables; training centre for beekeeping and honey testing lab, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	Beekeeping and bee nurseries; livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; vegetable dyes; palm sugar; aromatic plants and essential oil distillation; orchids and cut flowers, indoor plants, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; cloth and paper bags
Cluster 3	Beekeeping, VFC/panchayat FHM plantations; medicinal plants cultivation & processing; handmade paper products; palm sugar; aromatic plants and essential oil distillation; wild mango pickles; orchids and cut flowers, indoor plants; home-made organic chocolates; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; VFC/individual managed home stay tourism
Cluster 4	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; vegetable dyes; fruits and vegetables preservation; wild mango pickles; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 5	Beekeeping, VFC/panchayat FHM plantations; indoor plants and orchids; medicinal plants cultivation and processing; organic village home stay tourism; handmade paper products; palm sugar; wild mango pickles; home-made organic chocolates; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition

SUPA (JOIDA)

Supa(Joida) Taluk GP Clusters

Clusters	Activities
Cluster 1	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; vegetable dyes; handmade paper; cloth and paper bags; sports goods-making; leather products; computer training centre; weaving with palm leaves, cane and bamboo works; training in making bamboo products; Pandanus leaf products; trekking and bird watching to Sintheri Rocks and Kavala caves, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	Beekeeping, organic and forest honey sales, medicinal plants cultivation and processing; VFC-managed home stay tourism; wildlife tourism Anshi National park; Ulavi pilgrimage; tourist cottages in Ulavi; training in tourism management; VFC-managed holiday home bamboo cottages; pickles from wild berries; Tulsi cultivation and extracts; bamboo mat painting; incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 3	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes; water-sports training; VFC-managed home stay tourism in forest villages; holiday home bamboo cottages; monsoon trail to Dudhsagar Falls; aromatic plants and essential oil distillation; orchids and cut flowers; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 4	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; vegetable dyes; nursery for forestry and avenue trees; bamboo products; orchids and cut flowers; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; VFC/individual managed holiday homes

YELLAPUR	
	Yellapur Taluk GP Clusters

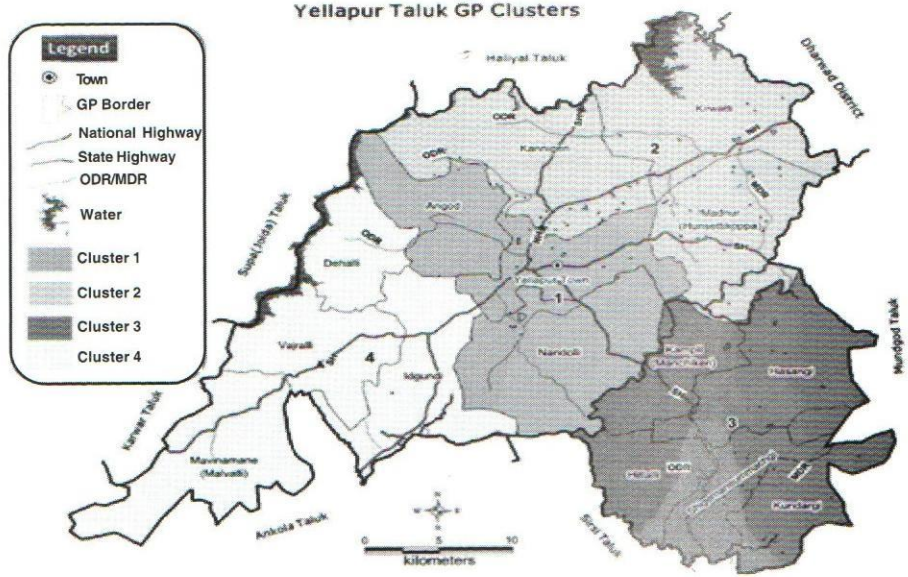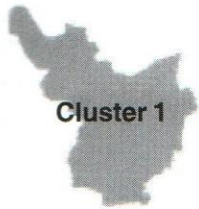| Clusters	Activities
Cluster 1	Beekeeping, training centre for beekeeping; forest honey; honey testing lab; livestock and dairying, gobar gas, VFC/panchayat FHM plantations, home for elderly; handloom units; VFC/individual run home stay tourism; holiday home bamboo-palm cottages; training in making bamboo-palm cottages; Pongamia plantations and biodiesel unit, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	Beekeeping, fish farming, VFC/panchayat FHM plantations, sericulture; vegetable dyes; bamboo products; Pongamia plantations; aromatic plants and essential oil distillation, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; cloth and paper bags
Cluster 3	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; Pongamia plantations; desiccated banana, jackfruit, papaya etc., incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 4	Beekeeping and honey certification; livestock and dairying, gobar gas, VFC/panchayat FHM plantations; vegetable dyes; medicinal plants cultivation & processing; home stay tourism; orchids and cut flowers; home-made organic chocolates; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
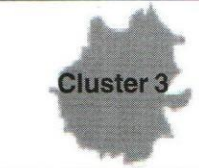
SIRSI

Sirsi Taluk GP Clusters

Legend
⊙ Town
— GP Border
— State Highway
ODR/MDR
Water
Cluster 1
Cluster 2
Cluster 3
Cluster 4
Cluster 5
Cluster 6
Cluster 7
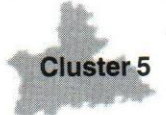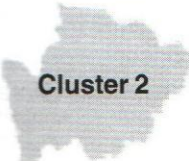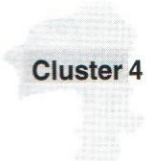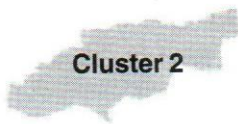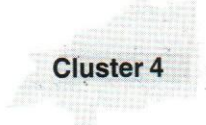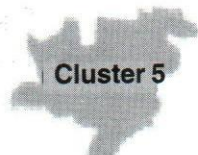
Clusters	Activities
Cluster 1	IT-related activities, livestock and dairying, gobar gas, fish farming, home for elderly; vegetable dyes, food products; entrepreneur development institutes; incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators
Cluster 2	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; mulberry nursery; sericulture training institutes; home stay tourism; hybrid seeds, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 3	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; hybrid seeds, incentives for rare traditional cultivars; incentives for community/private sacred groves in good condition
Cluster 4	Beekeeping, livestock and dairying, gobar gas, VFC/panchayat FHM plantations; aromatic plants and essential oil distillation; medicinal plants and processing units; home-made organic chocolates, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 5	Beekeeping, VFC/panchayat FHM plantations, incentives for rare traditional cultivars, incentives to certified organic farmers, incentives for community/private sacred groves in good condition; cloth and paper bags
Cluster 6	Beekeeping, VFC/panchayat FHM plantations; vegetable dyes; medicinal plant cultivation and processing; holiday home woodland cottages; orchids and cut flowers; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 7	Beekeeping, VFC/panchayatFHM plantations; vegetable dyes; orchids and cut flowers; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; areca products

Figure 2.3: Clusters for taluks in the plains agro-climatic zone

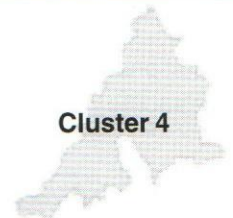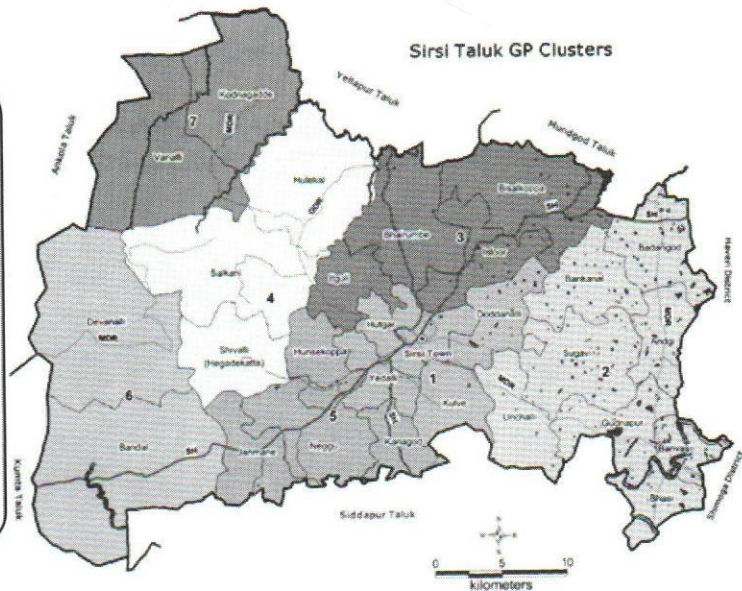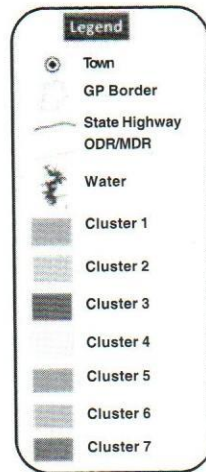| Clusters	Activities
Cluster 1	Beekeeping, livestock and dairying, gobar gas, sericulture, home for elderly; vegetable dyes; medicinal plants cultivation and processing; bamboo products; Tulsi cultivation and extracts; hybrid seeds, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 2	Beekeeping, sericulture; vegetable dyes; handmade paper products; home stay tourism; bamboo products; Pongamia plantations, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; VFC/individual managed home-stay tourism; training in making bamboo cottages
Cluster 3	Beekeeping, fish farming, livestock and dairying, gobar gas, sericulture; Pongamia and neem plantations; biodiesel and bio-pesticides; tamarind plantations and products; poultry; hospital services, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 4	Beekeeping, fish farming, livestock and dairying, gobar gas, sericulture; mulberry nursery; Pongamia and neem plantations; bio-pesticides and biodiesel; purified neem oil; hybrid seeds; poultry, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 5	Beekeeping, fish farming, livestock and dairying, gobar gas, sericulture; poultry feed; Pongamia and neem plantations; biodiesel and bio-pesticides; bio-fertilizers; purified neem oil; hybrid seeds; poultry and powdered eggs; tamarind products, tamarind nursery, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; tour operators

MUNDGOD

Mundgod Taluk GP Clusters
Dharwad District

Legend
- Town
- GP Border
- State Highway
- ODR/MDR
- Water
- Cluster 1
- Cluster 2
- Cluster 3
- Cluster 4
- Cluster 5

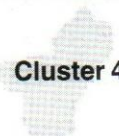| Clusters	Activities
Cluster 1	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; CFTRI-based ragi products; organic tomato sauce, poultry, powdered eggs; training institute for handloom and wool-weaving; mango pulp; home stay (linked to mainly Tibetan colony visits), incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 2	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture, poultry, tamarind farms and tamarind products (concentrates etc.); mango pulp; incentives to certified organic farmers; incentives for community/private sacred groves in good condition; training in making bamboo cottages
Cluster 3	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; vegetable dyes; tamarind farms and tamarind products (concentrates etc.), incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition; cloth and paper bags
Cluster 4	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; vegetable dyes; mint cultivation & encapsulation; hybrid seeds, incentives for rare traditional cultivars, incentives to certified organic farmers; incentives for community/private sacred groves in good condition
Cluster 5	Beekeeping, fish farming, livestock and dairying, gobar gas, VFC/panchayat FHM plantations, sericulture; medicinal plants cultivation & processing; hybrid seeds; hospital services, incentives for rare traditional cultivars, incentives for certified organic farmers

The Technical Efficiency of Sago and Starch Industry Cluster

E. BHASKARAN

Salem District of Tamil Nadu manufacturer's Sago and Starch is India's fastest growing market. For inclusive growth and sustainable development, Sago and Starch Industries (SSI) in Salem have adopted the Cluster Development Approach (CDA). The objective is to study the valuechain analysis, correlation analysis and data envelopment analysis by finding technical efficiency ($\emptyset$), peer weights (λi), input slacks (S^-) and output slacks (S^+) of Sago and Starch Industry Cluster (SSIC). The methodology adopted is using data envelopment analysis of output oriented Banker Charnes Cooper (BCC) model by taking the number of bags produced in lakhs and sales value in lakhs, as inputs, and revenue of state government in lakhs and net profit in lakhs, as outputs. The non-zero λi represents the weights for efficient clusters. The $S > 0$ obtained reveals the excess number of bags or sales value (S^-) and shortage in Government revenue or net profit (S^+). To conclude, the variables are highly correlated and for inclusive growth and sustainable development, the inefficient SSI should increase their net profit or decrease the number of bags or sales value. Moreover, for sustainable development, the SSIC should strengthen infrastructure, technology, procurement, production and marketing interrelationships to decrease costs, and to increase productivity and efficiency to compete in the indigenous and export markets.

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1. INTRODUCTION

Sago serve was established in 1981 at Salem with the objective of helping Sago and Starch manufacturers of Tapioca-growing districts by way of marketing their products, thereby ensuring fair and remunerative prices for them. Before its formation, the Sago and Starch manufacturers, especially small scale units, suffered in the hands of middlemen who exploited them in the absence of organized marketing. To ameliorate their sufferings in marketing their products, the Sago serve was established. Besides marketing its member products, it also arranges financial assistance and extends warehousing facilities to them.

In order to improve its testing facility, the Sago serve has set up a testing laboratory as a Common Facility Centre in the name of Sago and Starch Industry Cluster under Micro and Small Enterprises-Cluster Development Programme (MSE-CDP) of Govt. of India. Further, in order to widen the growth opportunity and access in the global market and to conduct the auction in a transparent manner, with the adoption of perfect and technically developed system, it has set up an e-Auction facility at Sago serve which was inaugurated on 12.12.2018. After establishing the e-Auction facility, Sago serve has achieved a sales percentage of 149 per cent in excess of the average sales in a month.

2. LITERATURE SURVEY

Sago/Starch manufacturers formed the Salem Starch and Sago Manufacturers Service Industrial Co-operative Society Ltd, Salem, in 1981. This society, popularly known as Sago serve, is functioning under the administrative control of the Director of Industries and Commerce, Government of Tamil Nadu. The district offers good raw material, cheap

labour and good sunshine for a longer period of the day throughout the year; helping manufacturers to produce more tapioca finished products. Therefore, the district of Salem is known as the land of Sago even in international forums. In and around Salem, the yield of tapioca is about 25–30 t/ha, the highest in the world. The national average is 19 t/ha while the world's average production stands at 10 t/ha.

To eliminate the small scale industrial unit holders producing sago and starch from the tapioca tubers grown largely in the 8 districts including Salem, Namakkal, Dharmapuri, Erode, Tiruvannamalai, Villupuram, Perambalur and Trichy, from the clutches of middlemen, and to get them fair and remunerative prices for their produce, a central marketing servicing society known as "Sagoserve" was registered on 21.7.1981 and started functioning from 20.7.1982, with 577 small scale sago Industrial unit holders as its members.

After the formation of "Sago serve", the starch and sago produced by the small scale industrial unit holders are sold in the open market by conducting daily tender-cum-auction sale, by which the SSI unit holders are able to get fair and remunerative price for their produce. Besides, Sago serve is extending credit facilities at a nominal rate of interest and warehousing facilities for the SSI unit holders manufacturing sago and starch. About 70,000 workers in the SSI industrial units and 5 lakh agricultural labourers engaged in planting the tapioca tubers are provided with employment. The total share capital of Sago serve is Rs.9.27 crores, which includes government's share contribution of Rs.99.83 lakhs. The government has levied Goods and Services Tax (GST) 5 per cent on sago and 12 per cent on starch with effect from 1.7.2017. The Means of Finance for SSIC is shown in Figure 1.
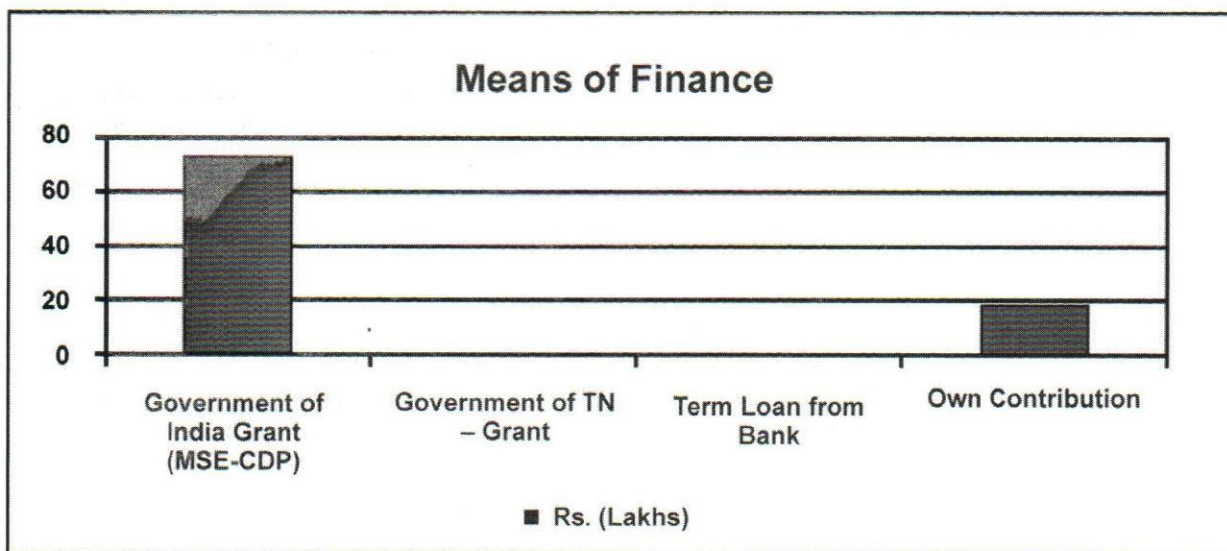
Source: Department of Industries and Commerce

Figure 1. Means of Finance

The composition of products that can be manufactured by Sago and Starch Industries are below:

1. Tapioca flour (starch) is used as feedstock by industries making products such as glucose, soup, candy, pudding, sausages, bread, ice creams, noodles, vermicelli and other fancy foods.

2. Tapioca flour is used for making glue, which is an important raw material for the plywood industry. It becomes sticky, and then it is mixed with hot water and certain chemicals. The industrial glues are Dextrin and Oxidized starch.

3. In paper industry, surface treatment is required in the production of quality papers. A solution made from tapioca flour and other substances like sizing agent and pigment particles are used in the surface treatment process.

4. Tapioca flour is used by the textile industry in treating yarn prior to weaving, and in fabric processing. This makes the fabric smoother and increases its tensile strength.

5. In modern times, priority has been given to alcohol along with other non-oil energy sources like wind,

solar & bio-gas. Tapioca flour is used to produce alcohol and is used as fuel too.

Various studies have been done and it has been proven that cluster development approach (CDA) helps to reduce cost and increase productivity. The infrastructure, technology, procurement, production and marketing interrelationships take place among them and there is sustainable development in efficiency after the implementation of the CDA. Hence, there is a need for study of technical efficiency of SSIC in Salem, before and after CDA, for benefit of the manufacturers (SSI) and policy makers.

3. OBJECTIVES OF THE STUDY

The objectives are:

1. To study the value chain & correlation analysis of Sago and Starch Industry Cluster (SSIC) in Salem District of Tamil Nadu.

2. To study the technical efficiency (∅), peer weights (λi), input slacks (S⁻), output slacks (S⁺), weightage and projections of SSIC in Salem.

3. To develop SSIC Model in Salem.

4. METHODOLOGY

The methodology adopted is collection of primary data from Sago Serve and collection of secondary data from Ministry of Micro, Small and Medium Enterprises (MSME), Government of India[5], Micro, Small and Medium Enterprises Department, Government of Tamil Nadu[6], Department of Industries and Commerce, Government of Tamil Nadu and analyzing with value chain analysis, correlation analysis and data envelopment analysis of BCC-O model by taking number of bags produced in lakhs, sales value in lakhs, as inputs, and revenue of State Government in lakhs and net profit in lakhs, as outputs.

4.1 Physical Performance of SSIC, Before (B) and After (A) CDA

The physical performance of SSIC before CDA (2009–10 to 2013–14) (1 to 5) and after CDA (2014–15 to 2018–19) (1 to 5) are shown in Figure 2.

Figure 2. reveals there is increasing trend in number of bags after CDA, except for few years.
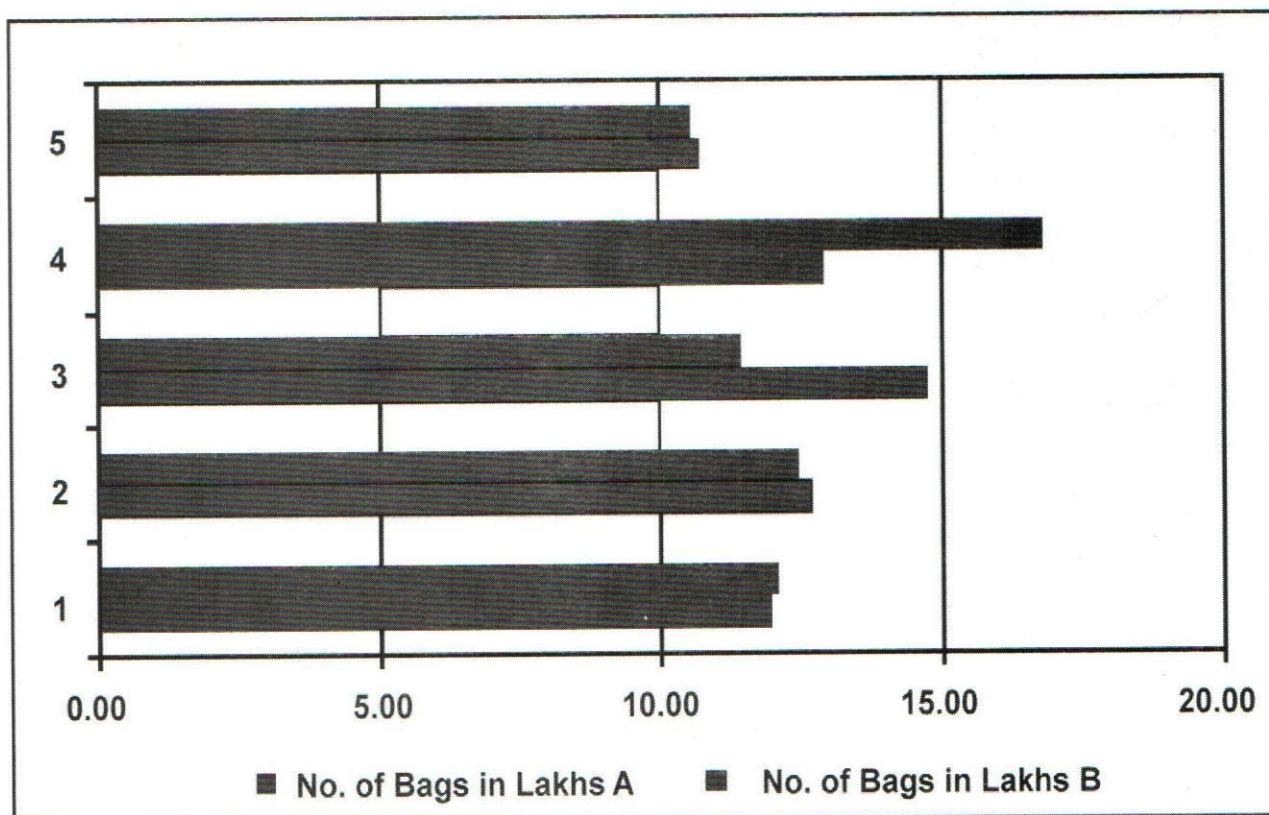
Source: Sago Serve

Figure 2. Physical Performance of SSIC

4.2 Financial performance of SSIC, before (B) and after (A) CDA

The financial performance of SSIC before CDA (2009–10 to 2013–14) (1 to 5) and after CDA (2014–15 to 2018–19) (1 to 5) are shown in Figures 3, 4 and 5.

Figures 3, 4 and 5 reveal that there is increasing trend in sales value, revenue of State government and net profit after CDA except for few years.
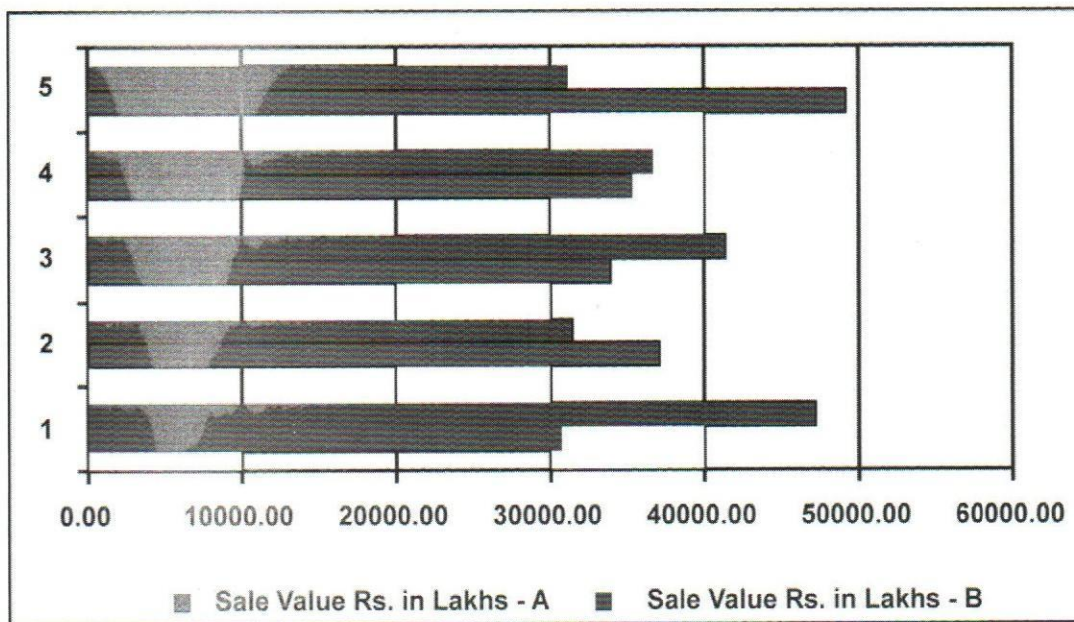
Source: Sago Serve

Figure 3. Sales value in Rs. Lakhs
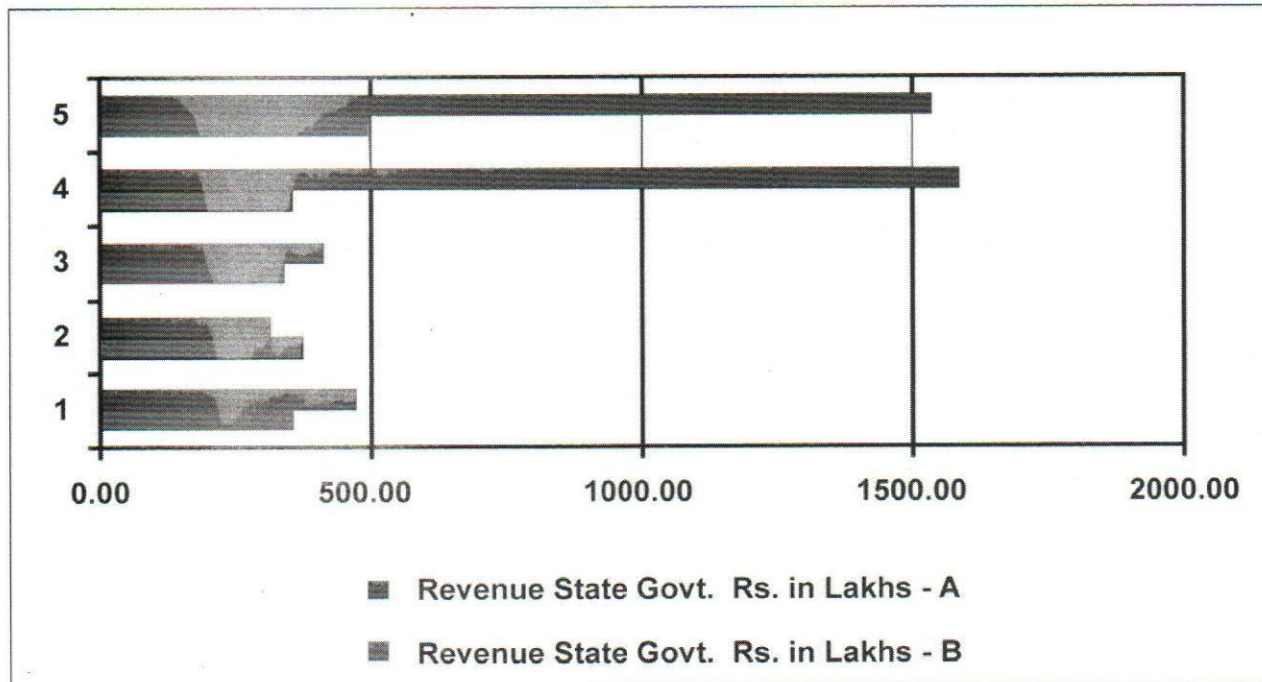
Source: Sago Serve

Figure 4. Revenue of State Government in Rs. Lakhs
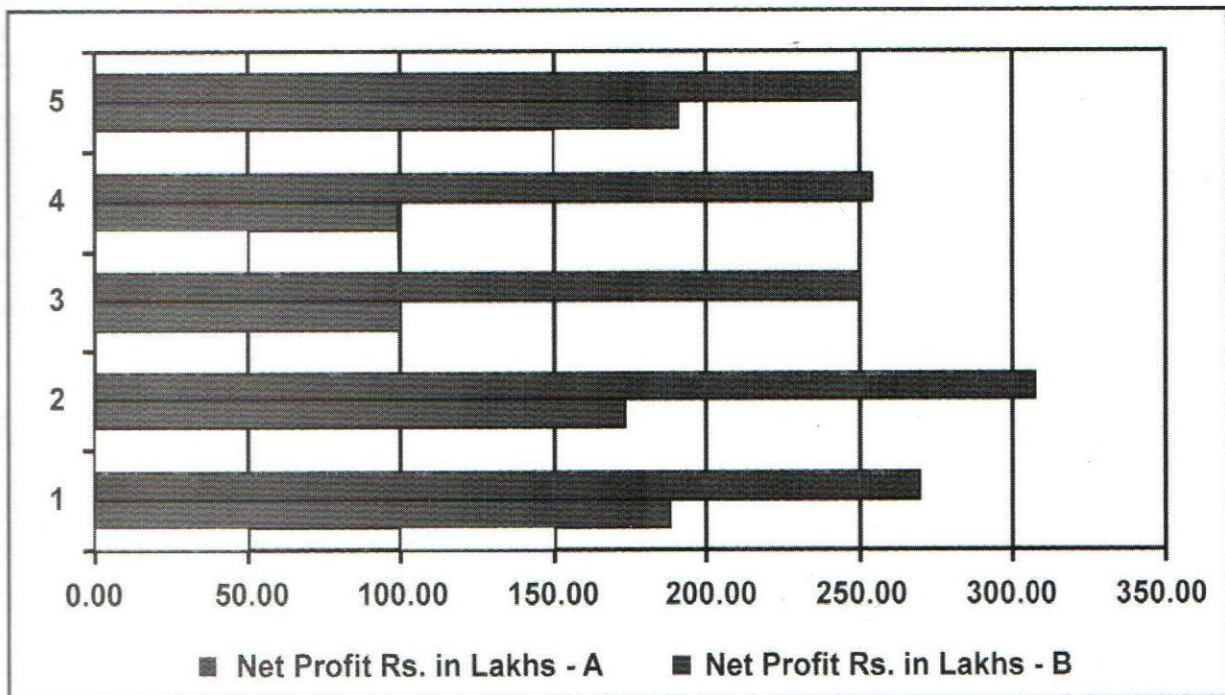
Figure 5. Net profit in lakhs

5. VALUE CHAIN ANALYSIS

The value-chain concept has been used to distinguish between cooperative strategies according to the type of resources pooled by the partners. This study is based on the value chain concept and integrated approach developed by the researcher on cluster development as shown in Figure 6.

It has been discussed that the cluster approach is a major motivating factor, and enterprises are keen to accept the challenge to maximize their profits. Majority of the enterprises are moderately satisfied with the infrastructure, technology, procurement, production and marketing interrelationships after the CDA.

5.1 Descriptive Analysis

The descriptive analysis is given in Table 1.

There is an average increasing trend in number of bags and revenue state government, while net profit and sale value needs improvement.

5.2 Correlation Coefficient Analysis

The correlation analysis is given in Table 2.

There is a positive and high degree of relationship that exists between the number of bags and the revenue of state government after CDA. Net profit and sale value need improvement.

5.3 Data Envelopment Analysis

5.3.1 BCC-O Model

$$\rightarrow\rightarrow$$

$$\text{Max} \qquad Z_0 = \emptyset + \varepsilon \ 1 \ S^+ + \varepsilon \ 1 \ S^-$$

$$\emptyset, \lambda, S^+, S^-$$

Subject to

$$\emptyset \ Y_0 - Y \ \lambda + S^+ = 0$$

$$X \ \lambda + S^- = X_0$$

$$\rightarrow$$

$$1 \ \lambda \geq 1 , \quad \lambda, S^+, S^- \geq 0$$

5.3.2 Model Description

The scalar variable $\emptyset$ appears in the primal problem is the reduction applied to all inputs of Decision Making Units (DMUs) to improve efficiency. This reduction is applied simultaneously to all inputs and results in a radial

SUPPORT ACTIVITIES	**Infrastructure**	With Government of Tamil Nadu, through TANSIDCO and Government of India assistance created Common Facility Centre (CFC). Facilities at CFC are ware house, laboratory etc.				**Infrastructure interrelationships**	**PROFIT**
	Human Resource Management	Cluster based human resource strategy is also implemented where the recruitment, retention, replacement, internal career development and skill development training of individual firms is taken care. Training centre has laboratories and skill development centre to train and impart technical skills to employees.					
	Technology Development	Technology awareness / training programmes and technology transfer schemes including joint ventures and quality upgradation are conducted and thereby, technology interrelationships have taken place. Testing laboratory to carry out mechanical, chemical and physical tests for the raw materials and products. High precision laboratory with latest technology is available in SSIC.				**Technology interrelationships**	
	Procurement	The common raw material bank (consortia) created under Public Private Partnership (PPP) concept leads to best quality inputs with low input costs and Just in Time (JIT) model. The industrial estate has got raw material depot and through them the industries have got raw materials like Tapioca roots (Sago) with less cost (10 per cent to 20 per cent) compared to open market.				**Procurement interrelationships**	
	Primary Activities	Members' Sago samples tested in the ratio of 5:1. Conducting 9 Tests as per by-laws of Sagoserve. FSSAI Norms–3 Tests (T. Ash, Ins. Ash, HCN). As per the Gazette of India dated 04.11. 2015, there is no HCN test for Tapioca Sago. Self-Imposed Tests 6: pH, Chloride, Sulphate, Maize, OPW and Smell test. Passed samples allowed for sale in tender. If fails any test, the goods will be handed over to the district designated officers. On request, private samples are also tested. Sending Samples to RTL, Sona Lab and Food Analysis Laboratory for Cross verification. Action is being taken to get NABL accreditation status for Sago serve lab.			Common product display centre, website design and development and partnership exchange for business linkages with reputed companies, auction centre and related international fairs and exhibitions are conducted. Visiting of trade and investment delegations were conducted. Moreover, inter-firm exposure and inter-cluster exposure takes place in the cluster. The members also got loan from banks due to CDA.		
		Inbound Logistics	**Operations**	**Outbound Logistics**	**Marketing/ Sales**	**Services**	
		Production Interrelationships			**Marketing Interrelationships**		

Source: Developed by Researcher

Table 1: Descriptive Analysis

	Before CDA				After CDA			
	No. of bags in lakhs	Sale value Rs. in lakhs	Revenue govt. Rs.in lakhs	Net profit Rs. in lakhs	No. of bags in lakhs	Sale value Rs. in lakhs	Revenue state govt. Rs. in lakhs	Net profit Rs. in lakhs
Max	14.76	49281.88	492.53	191.09	16.81	47205.88	1585.00	306.71
Min	10.74	30722.62	339.15	98.71	10.58	31226.69	314.65	250.10
Average	12.61	37319.87	382.17	150.12	12.67	37626.82	863.56	266.08
SD	1.32	6342.48	56.08	41.91	2.16	6079.63	570.80	21.53

Source: Computed Data using DEA Solver

Table 2: Correlation Analysis

	Before CDA				After CDA			
	No. of bags in lakhs	Sale value Rs. in lakhs	Revenue state govt. Rs. in lakhs	Net profit Rs. in lakhs	No. of bags in lakhs	Sale value Rs. in lakhs	Revenue state govt. Rs. in lakhs	Net profit Rs. in lakhs
No. of bags	1.00				1.00			
Sale value Rs.	-0.62	1.00			0.01	1.00		
Revenue state govt. Rs.	-0.79	0.95	1.00		0.40	-0.41	1.00	
Net profit Rs. profit Rs.	-0.81	0.37	0.58	1.00	-0.03	-0.25	-0.58	1.00

Source: Computed Data using DEA Solver

movement towards the envelopment surface. The presence of non-Archimedean (Infinitesimal constant) ε in the primal objective function effectively allows the maximization over $\emptyset$ to pre-empt the optimization involving the slacks. Thus, the optimization can be computed in a two-stage process with

i) maximal reduction of inputs being achieved first via $\emptyset$

ii) then in the second stage, movement on to the efficient frontier is achieved via the positive input and output slack variables (S^-, S^+)

Here, the constraint

$\rightarrow$

$1 \lambda \geq 1$ is known as convexity constraints, which will admit variable returns-to-scale (VRTS). The above discussion leads to form the following statement: A ((DMU is efficient if and only if $\emptyset = 1$, b) All slacks are zero. $S^- = 0$ and $S^+ = 0$.

5.3.3 Computing Methodology

Initially, we consider Final Year as the studied DMU and the Linear Programming (LP) Model is formulated as given below:

Max $\emptyset_0$

Subject to

$269.45\lambda_1 + 306.71\lambda_2 + \ldots\ldots\ldots\ldots 250.10\lambda_5 \geq 269.45$

Output Constraints

$470.97\lambda_1 + 314.65\lambda2+\ldots\ldots\ldots\ldots 1534.36\lambda_{5e}.470.97$

Output Constraints

$47205.88\emptyset_0 \quad - \quad 47205.88 \ \lambda_1 \ - \ 31551.20\lambda_2-$
$\ldots\ldots 31226.69\lambda_5 \geq 0$ \qquad Input Constraints

$12.08\emptyset_0 - 12.08\lambda_1 - 12.47_{\lambda2} - \ldots\ldots 31226.69\lambda_5 \geq 0$

Input Constraints

$\lambda_1 + \lambda_2 + \ldots \ \lambda_5 = 1.$

$\lambda_1, \lambda_2, \ldots \ \lambda_5 \geq 0$, $\emptyset_0$ is unrestricted.

By solving the above equations and continuously changing the studied DMUs, the value of λ_i's and $\emptyset_i$'s for each DMU is obtained.

5.3.4 Efficiency Scores

The value of λ_i's (being the weights of the enterprises) (not given) and $\emptyset_i$'s (being the efficiency scores of the enterprises) were found using DEA Solver, is given in the Table 3, and the graph is given in Figure 7 as before and after CDA.

As per table 3 and Figure 7, the SSI has a score $\emptyset i = 1$ and rank=1, and it is highly efficient. The efficiency and rank of SSI which has $\emptyset < 1$ are also given. It has to perform well to attain 100 per cent efficiency and rank 1. The overall technical efficiency of SSI is 0.94 before CDA and 0.96 after CDA, and there is increase in Technical Efficiency of 2.13 per cent after CDA.

Table 3: Technical Efficiency of Sago Industry Cluster

DMU	$\emptyset_B$	Rank	$\emptyset_A$	Rank	$\emptyset_A - \emptyset_B$
1	1	1	0.91	4	-0.09
2	0.92	3	1	1	0.08
3	0.89	5	0.91	5	0.02
4	0.91	4	1	1	0.09
5	1	1	1	1	0
	0.94		0.96		0.02

Source: Computed Data using DEA Solver
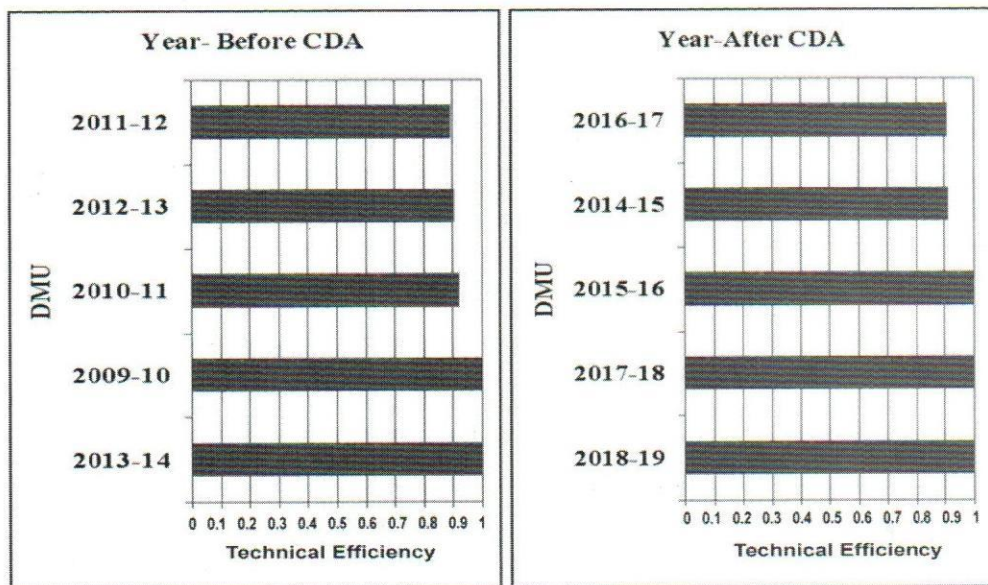
Source: Computed Data using DEA Solver

Figure 7. Technical Efficiency of Sago and Starch Industry Cluster

Table 4: Slack Variables-Before CDA

DMU	Score	Excess no. of bags S-(1)	Excess sale value Rs. S-(2)	Shortage revenue state govt. Rs. S+(1)	Shortage net profit Rs. S+(2)
1	1.00	0.00	0.00	0.00	0.00
2	0.92	1.15	0.00	0.00	1.54
3	0.89	3.02	0.00	0.00	76.73
4	0.91	1.28	0.00	0.00	79.87
5	1.00	0.00	0.00	0.00	0.00

Table 5: Slack Variables-After CDA

DMU	Score	Excess no. of bags S-(1)	Excess sale value Rs. S-(2)	Shortage revenue state govt. Rs. S+(1)	Shortage net profit Rs. S+(2)
1	0.91	0.00	15721.64	50.66	0.00
2	1.00	0.00	0.00	0.00	0.00
3	0.91	0.00	10045.71	531.10	0.00
4	1.00	0.00	0.00	0.00	0.00
5	1.00	0.00	0.00	0.00	0.00

Source: Computed Data using DEA Solver

5.4 Input and Output Slacks of SSIC

The Input and Output Slacks of SSIC before and after CDA are given in Tables 4 and 5.

The DMU is efficient by having $\emptyset = 1$, $S^- = 0$ and $S^+ = 0$. The other DMU needs improvement by either decreasing the inputs or increasing the outputs to become efficient like other DMUs. The $S > 0$ obtained for other DMU reveals the excess number of sale value (S^-) or number of bags (S^-) or revenue state government (S^+).

The projections and difference on variables are also obtained. The individual DMU should follow up the projection and difference to achieve 100 per cent efficiency.

5.5 Weightage given on variables

The weightage given to different variables are also obtained. The weightage given to different DMU helps in identifying the input and output weightage.

5.6 Weighted Data

The weighted data is also obtained. The efficient DMU has got equal weight for all the input and output variables. Other DMU should achieve the equal weight.

5.7 Variable Returns-to-Scale (VRTS)

The variable returns-to-scale is given in Table 9.

DMU has Increase in Returns-to-Scale (IRS), Constant Returns-to-Scale (CRS) and Decrease in Returns-to-Scale (DRS) are given in Table 10.

5.8 Sago and Starch Cluster Model

The SSI Cluster Model as shown in Figure 8, indicates the cluster level linkages of all actors namely, TIIC—Tamil Nadu Industrial Investment Corporation, SIDBI—Small Industries Development Bank of India, EXIM Bank—Export Import Bank, SIDCO—Small Industries Development Corporation, SAGOSERVE, TANSTIA—Tamil Nadu Small

Table 6: Projections and Difference on variables

No.	DMU / I/O	Before CDA Score / Data	Projection	Difference	%	After CDA Score / Data	Projection	Difference	%
1		1.00				0.91			
	No. of bags	11.95	11.95	0.00	0.00	12.08	12.08	0.00	0.00
	Sale value (Rs.)	30722.62	30722.62	0.00	0.00	47205.88	31484.24	-15721.64	-0.33
	Revenue state govt. (Rs.)	355.02	355.02	0.00	0.00	470.97	566.34	95.37	0.20
	Net profit (Rs.)	188.05	188.05	0.00	0.00	269.45	295.03	25.58	0.09
2		0.92				1.00			
	No. of bags	12.68	11.53	-1.15	-0.09	12.47	12.47	0.00	0.00
	Sale value (Rs.)	37141.46	37141.46	0.00	0.00	31551.20	31551.20	0.00	0.00
	Revenue state govt. (Rs.)	370.76	402.58	31.82	0.09	314.65	314.65	0.00	0.00
	Net profit (Rs.)	172.74	189.10	16.36	0.09	306.71	306.71	0.00	0.00
3		0.89				0.91			
	No. of bags	14.76	11.74	-3.02	-0.20	11.43	11.43	0.00	0.00
	Sale value (Rs.)	34005.34	34005.34	0.00	0.00	41418.34	31372.63	-10045.71	-0.24
	Revenue state govt. (Rs.)	339.15	379.34	40.19	0.12	412.80	985.81	573.01	1.39
	Net profit (Rs.)	100.01	188.59	88.58	0.89	250.16	275.56	25.40	0.10
4		0.91				1.00			
	No. of bags	12.92	11.64	-1.28	-0.10	16.81	16.81	0.00	0.00
	Sale value (Rs.)	35448.04	35448.04	0.00	0.00	36732.00	36732.00	0.00	0.00
	Revenue state govt. (Rs.)	353.37	390.03	36.66	0.10	1585.00	1585.00	0.00	0.00
	Net profit (Rs.)	98.71	188.82	90.11	0.91	254.00	254.00	0.00	0.00
5		1.00				1.00			
	No. of bags	10.74	10.74	0.00	0.00	10.58	10.58	0.00	0.00
	Sale value (Rs.)	49281.88	49281.88	0.00	0.00	31226.69	31226.69	0.00	0.00
	Revenue state govt. (Rs.)	492.53	492.53	0.00	0.00	1534.36	1534.36	0.00	0.00
	Net profit (Rs.)	191.09	191.09	0.00	0.00	250.10	250.10	0.00	0.00

Source: Computed Data using DEA Solver

Table 7: Projections and Difference on variables

	Before CDA						After CDA					
DMU	Score	V(0)	V(1)	V(2)	U(1)	U(2)	Score	V(0)	V(1)	V(2)	U(1)	U(2)
1	1.00	0.00	0.03	0.00	0.00	0.00	0.91	-0.25	0.11	0.00	0.00	0.00
2	0.92	0.34	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
3	0.89	0.38	0.00	0.00	0.00	0.00	0.91	-0.27	0.12	0.00	0.00	0.00
4	0.91	0.36	0.00	0.00	0.00	0.00	1.00	0.79	0.00	0.00	0.00	0.00
5	1.00	0.00	0.09	0.00	0.00	0.00	1.00	0.00	0.09	0.00	0.00	0.00

Source: Computed Data using DEA Solver

Table 8: Weighted Data

	Before CDA						After CDA					
DMU	Score	VX(0)	VX(1)	VX(2)	UY(1)	UY(2)	Score	VX(0)	VX(1)	VX(2)	UY(1)	UY(2)
1	1.00	0.00	0.31	0.69	1.00	0.00	0.91	-0.25	1.34	0.00	0.00	1.00
2	0.92	0.34	0.00	0.74	1.00	0.00	1.00	0.00	0.00	1.00	0.04	0.96
3	0.89	0.38	0.00	0.74	1.00	0.00	0.91	-0.27	1.37	0.00	0.00	1.00
4	0.91	0.36	0.00	0.74	1.00	0.00	1.00	0.79	0.00	0.21	1.00	0.00
5	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00

Source: Computed Data using DEA Solver

Table 9: Variable Returns-to-Scale

	Before CDA			After CDA		
DMU	Score	RTS	RTS of Projected DMU	Score	RTS	RTS of Projected DMU
1	1.00	Constant		0.91		Constant
2	0.92		Constant	1.00	Constant	
3	0.89		Constant	0.91		Constant
4	0.91		Constant	1.00	Decreasing	
5	1.00	Constant		1.00	Constant	

Source: Computed Data using DEA Solver

and Tiny Industries Association, NSIC—National Small Industries Corporation, MSMEDI—Micro, Small and Medium Enterprises Development Institute, RTC—Regional Testing Centre, DIC—District Industries Centre, APEDA— Agriculture Processing Export Promotion Agency, ITPO— Industrial Trade Promotion Organization and MOFPI— Ministry of Food Processing Industry involved effectively in the formation and the supporting activities of SSIC.

Table 10: Variable Returns-to-Scale

RTS	Before CDA			After CDA		
	Efficient	Projected	Total	Efficient	Projected	Total
No. of IRS	0	0	0	0	0	0
No. of CRS	2	3	5	2	2	4
No. of DRS	0	0	0	1	0	1
Total	2	3	5	3	2	5

Source: Computed data using DEA Solver

From the outcome of the present study, it is obvious that SSIC has significant interrelationships among the enterprises. One location of the clusters plays a crucial role in the integrated study as shown in Figure 8. Constant involvement of industrial units in the cluster will improve their performance. The costs of the industrial units have considerably reduced due to the intervention, and the profits increased sizeably. The policy planners can identify the parameters of industrial growth in different locations of the region using CDA. The outcome of CDA will attract financial investors to concentrate more on specified industrial centres for investment. This will improve the economic status of the region for overall development. The SSIC model indicates the cluster level linkages of all actors involved effectively in the formation and the supporting activities of SSIC.

6. FINDINGS, SUGGESTIONS AND CONCLUSIONS

Benefits to MSE after CDA are

- Reduction in cost by10–20 per cent,
- Quality enhancement and competitiveness,
- Testing & Measuring facility enables micro players to keep quality standards besides savings in time and cost, and
- Skill development for semi-skilled workers

Benefits / Purpose of CFC after CDA

- Micro units purchasing from traders is replaced by common raw material bank.
- High handling cost / transportation cost are reduced.
- Consistency in availability of quality RM.
- High price fluctuation reduces.
- Domination of traders is removed.

- The buyers of Tapioca Starch & Sago are registered as dealers in Sago serve, by collecting a tender deposit of Rs. 5.00 lakhs for regular merchant, Rs. 3.00 lakhs for small merchant (Category I) and Rs. 1.50 lakhs for small merchant (Category II) with bag limit of 1000, 500 and 250 respectively.

- On receipt of the goods from the members along with tags, every consignment is assigned a 'lot number' and stacked in the godowns.

- Dealer number is assigned and they are allowed to participate in daily tender.

- Based on request made by the member producers, the samples of Starch and Sago consignments are displayed for tender sale in daily tender system by 9.00 AM.

- Dealers can view variety of samples under one roof and quote rates in secret tender system. After tabulation, results are announced around 1.00 PM.

- The top rate and confirmation details are informed to the members and merchants concerned through SMS and Email.

- The member-producer has the option to confirm the highest rate offered against his/her goods.

- Financial assistance to its members by paying 60 per cent advance for unsold lots.

- Once a member confirms the tender sale, society pays an another 40 per cent advance with reference to the selling rate after keeping an amount deductible for the society's service charges, godown rent, interest etc.
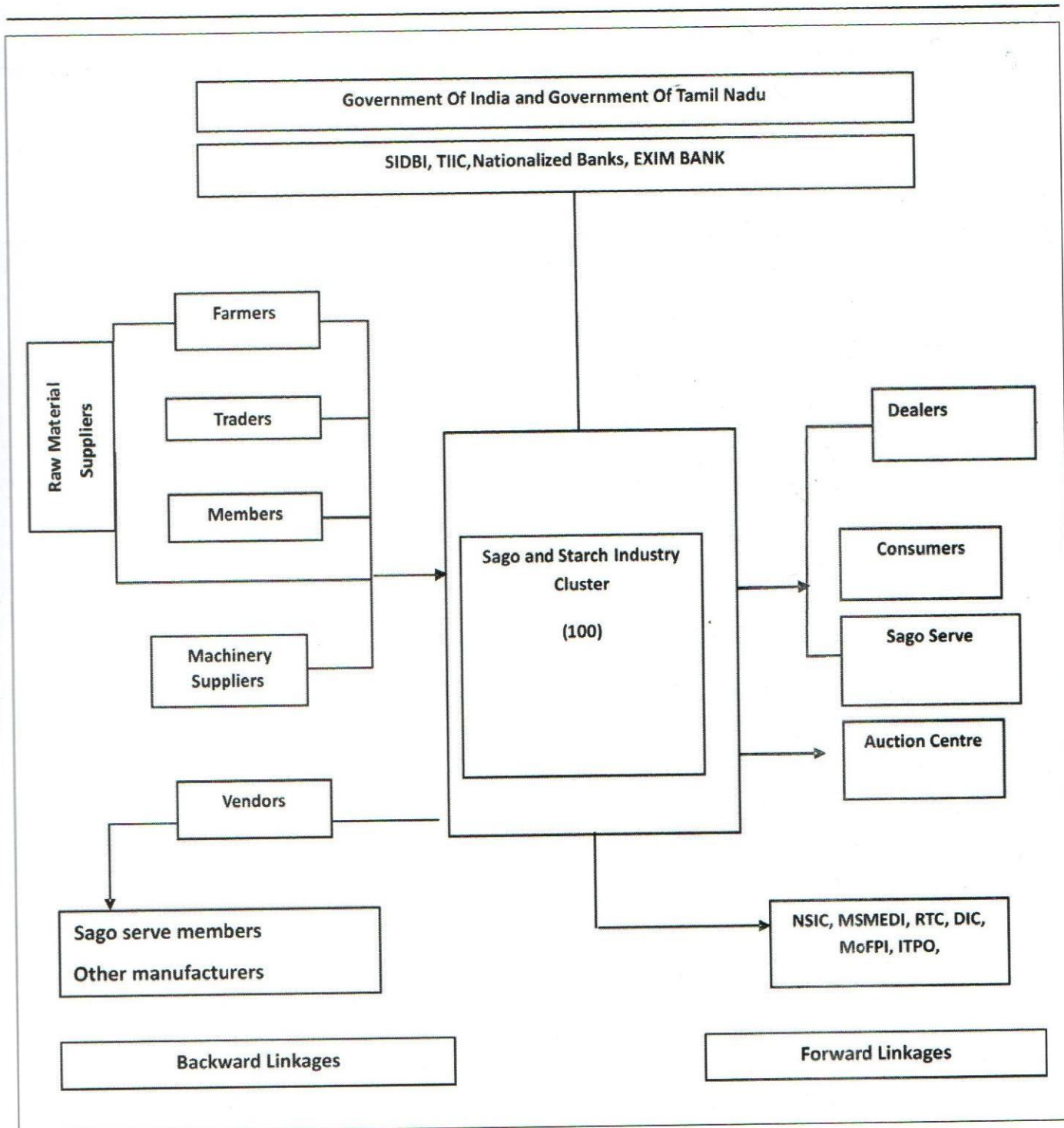
Figure 8. Sago and Starch Cluster Model

- Final settlement is paid to the member concerned after taking delivery by the merchants concerned.

The Value Chain Analysis reveals there is strong infrastructure, technology, procurement, production and marketing interrelationships after CDA. The correlation coefficient exposes that there is strong relationship between the studied variables, except a few. Based on the technical efficiency obtained using BCC model, it is found there is an increase in average technical efficiency after CDA for Sago and Starch Industry Cluster. The input

and output slack variables gives information about what the cluster should follow to increase their technical efficiency. There are increase, decrease and constant returns-to-scale for SSIC.

It is suggested that for inclusive growth and sustainable development, this Sago and Starch Industries should increase their net profit. It is also suggested that the SSIC should further strengthen infrastructure, technology, procurement, production and marketing interrelationships.

To conclude, SSIC in Salem district of Tamil Nadu should plan for growth according to Food Processing Policy of Government of India and Tamil Nadu, and also should get benefit out of Micro, Small and Medium Industries policy of Government of Tamil Nadu which will lead to increase in productivity and efficiency of Sago and Starch Industries for sustainable business development.

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"The country that is more developed industrially only shows, to the less developed, the image of its own future. "

– Karl Marx

Measuring an Agro-Based Cluster's Productivity

ANUPAM AND SUNIL SHARMA

This paper endeavours to develop a framework for measuring the productivity, more popularly called 'vibrancy', of agro-based clusters. Clusters, being 'complex adaptive systems', need to be assessed through an integrated framework of not only outputs but also processes that shape clusters. The authors have attempted to operationalize the constructs of social capital, firm productivity, entrepreneurship and innovation in context of agro-based clusters. While entrepreneurship, innovation and firm productivity present the output of clusters, social capital tends to have a two-way relationship with the cluster performance. The tool presented can be useful for cluster practitioners to assess the effectiveness of their cluster development initiatives.

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1. Introduction

A number of scholars including Porter (1990), Schmitz and Nadvi (1999) in the late 20th century hailed clusters as engines of economic growth and competitive advantage of the nations. Owing to this push, the words 'cluster' and 'cluster development' became buzzwords in research as well as policy circles. A number of cluster development initiatives were designed and implemented in both developed and developing countries (Solvell, Lindqvist, and Ketels, 2003) (Ketels, Lindqvist, and Solvell, 2006) (Lindqvist, Ketels, and Solvell, 2013). However, there lies a striking difference in cluster development initiatives between advanced and developing countries. While the initiatives in advanced economies focus on 'high-tech', 'innovation-driven' and 'traded' clusters, the focus of such initiatives in developing countries remains more on 'basic industry (such as agriculture, textiles, etc.)', 'resource-based' clusters.

In India, agriculture is the most important 'basic' industry owing to its elephant's share in employment and GDP. Agriculture, along with its backward and forward linkages, collectively referred to as 'agribusiness', contributes around 30 per cent towards India's GDP (Iyer and Singhi, 2012). Agriculture and allied activities employ around 46.1 per cent of Indian workforce (Government of India, 2016). In the secondary sector, agro-based industries engage around 40 per cent of the industrial workforce and contribute 20 per cent of manufacturing value added (Government of India, 2017). However, different elements of this agribusiness system tend to work in silos leading to inefficiencies that are manifested in the form of product losses in terms of quantity and quality and large price spread along the value chain. Such a scenario necessitates the acknowledgement of systems approach towards development of agribusiness. Such an approach shall aim at strengthening the linkages between

agricultural production and consumption by adopting a multi-sectoral approach (Pingali et al., 2019). 'Agro-based Clusters' which manifest this systems approach by combining the dimension of value-networks with another dimension that is 'geographical co-location', have been hailed by scholars as a great tool to spur development. A number of specialized schemes such as National Programme for Rural Industrialization, NABARD's Cluster Development Scheme, Mega Food Park Scheme and Scheme of Fund for Regeneration of Traditional Industries (SFURTI) were launched by Government of India to boost agribusiness. Working group on clustering and aggregation for the 12th Five Year Plan advocated development of agro-based clusters. The group suggested selection of agro-based clusters for intervention on a pilot basis to create impact. In order to develop agro-industry linkages, strategic placement of food processing units in agricultural zones depended upon the raw material availability, labour, product utilization and marketing. The most recent Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters (SAMPADA) (later renamed to Pradhan Mantri Kisan SAMPADA Yojana) was launched in 2017 with an allocation of Rs. 6000 crores for 360-degree development of agricultural value chains encompassing cluster-based development approach. The scheme aims not only at the strengthening of existing clusters but also the creation of new clusters.

The concept of 'Agro-based Clusters' (Figure 1) defined as, "a concentration of producers, agro industries, traders and other private and public actors engaged in the same industry and inter-connecting and building value networks, either formally or informally, when addressing common challenges and pursuing common opportunities", is basically the employment of the concept of 'clusters' to agricultural value chains.
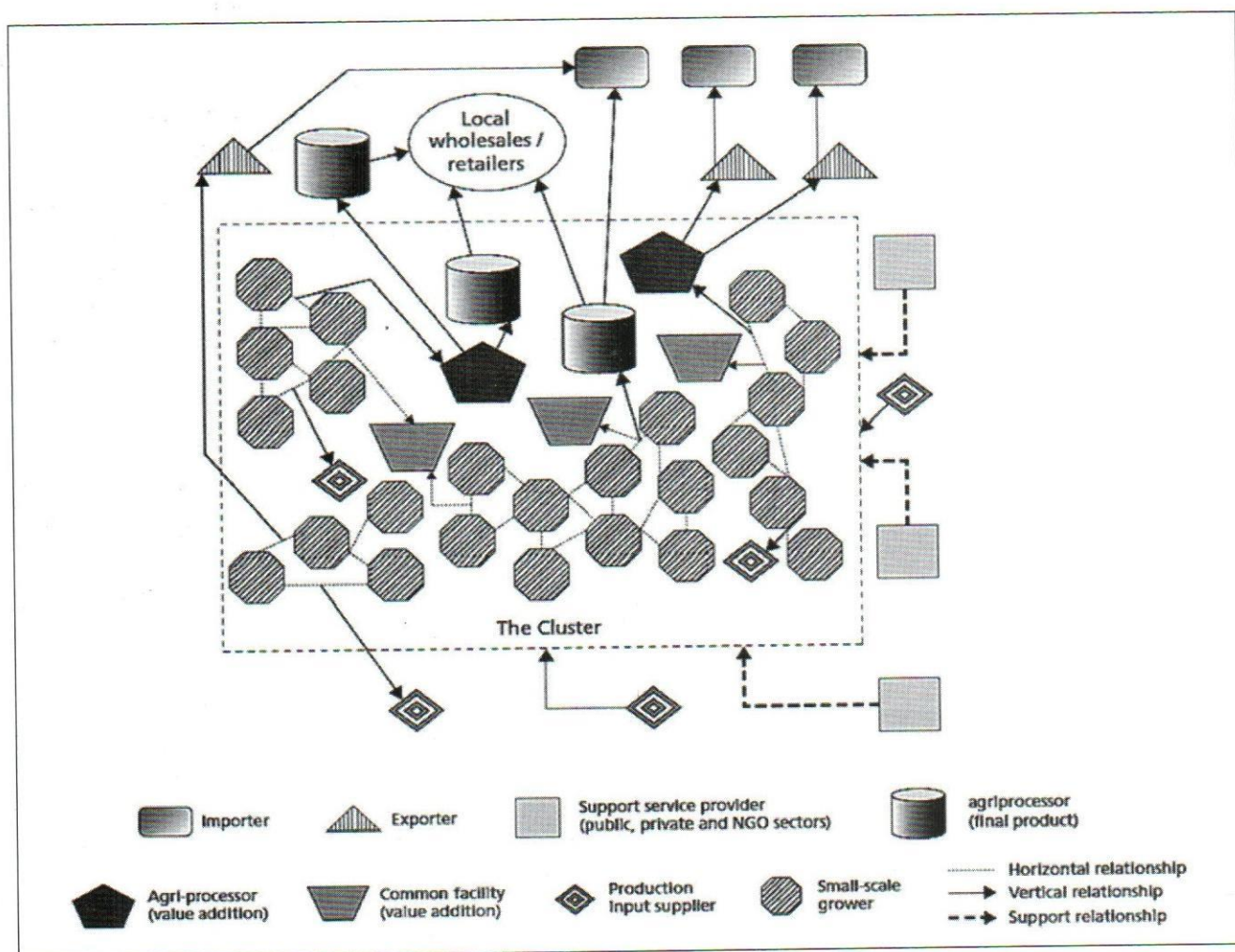
Figure 1: An illustrative Agro-based Cluster (Source: Galvez-Nogalez, 2010)

Despite being an extension of the concept of clusters, agro-based clusters differ from other industrial clusters in many aspects. One aspect pertains to the nature of produce dealt by the agro-based clusters. Agro-based clusters deal in agricultural and forest produce which tends to be more perishable, seasonal, bulky, irregular in supply, and non-uniform in quality, making its handling and transportation a cumbersome task. Secondly, agriculture and allied activities involve high involvement of state and developmental agencies owing to their direct bearing on rural livelihoods and food security. Also, agro-based clusters involve not only similar firms in same sector but multiple stakeholders from primary (i.e., agriculture) and secondary (i.e., industry) sectors of economy. Thus, there is a need to develop new frameworks or adapt existing frameworks to suit the context of agro-based clusters echoing the words of Goodman (1997) who asserts that many concepts and generalizations have been incorporated into the domain of agro-food studies without due integration. Further, Wardhana et al. (2017) argue that researchers looking to examine industrial concentration should analyze agriculture separately from other economic sectors because of its specificity to agricultural production system and its direct dependence on natural resources.

The present paper is an endeavour to develop a framework for measuring the vibrancy of an agro-based cluster. The framework can act as a tool for researchers and practitioners in understanding and measuring the cluster initiative impacts on agro-based clusters.

2. Methodology

The present research involves a review of literature to look into the operationalization of different concepts pertaining to productivity of clusters. Relevant research papers were reviewed using databases such as EBSCO, JSTOR, SAGE, Emerald, Google scholar etc. An enquiry has been made into the indicators used by various authors in measuring the constructs. Accordingly, indicators based on their suitability have been suggested in order to measure productivity of agro-based clusters.

3. Literature Review

There are two types of literature on clusters. One thrives on how clusters shape competition, while the other thrives on the factors that shape clusters' business environment which ultimately shapes the competition. The first type of literature involves studies on relationship between clustering and entrepreneurship, clustering and innovation, clusters and firm productivity.

3.1 Clusters and Firm Productivity

One of the most cited works on clusters belongs to Porter (1998), who sums up the way clustering shapes the competition in three dimensions: (a) increase in productivity of the firms, (b) catalysing the innovation processes and, (c) formation of new businesses i.e. entrepreneurship. Porter (1998) argues that firms in clusters tend to be more productive owing to the externalities generated by clustering such as better access to suppliers and employees, better access to information, complementarities, and access to institutions and goods which lead to decrease in transaction costs. Delgado et al. (2014) investigated the role of agglomeration in regional economic performance and found that industries located within a strong cluster are associated with higher employment growth, wage growth, as well as new firm formation and therefore, play a crucial role in the economic development of a region.

3.2 Clusters and Entrepreneurship

Delgado, Porter, and Stern (2010) provide an evidence of positive relationship between clustering and entrepreneurship using longitudinal secondary data. The authors establish that industries located in strong clusters experience higher growth in new business formation and start-up employment.

3.3 Clusters and Innovation

Innovation is an ongoing process rather than an output, and it can be measured in terms of its own inputs and outputs. Cozzens and Kaplinsky (2009) define innovation as, "the introduction of new or adapted products, produced with new or adapted equipment and in new or adapted forms of organization, and utilizes new or adapted organizational procedures." Further, they distinguish the forms of innovation as 'product', 'process', 'functional' and 'value chain' innovation. Humphrey and Schmitz (2002) use another word, 'upgrading', synonymous to innovation in context of clusters and value chains. Product innovation/upgrading pertains to moving into superior product lines, process innovation/upgrading using newer, more efficient ways of producing products, functional upgrading refers to taking up new/superior functions in the value chain and value chain innovation/upgrading refers to diversification into different sectors. Such kind of innovation/upgrading

can be 'radical' i.e. discontinuous events or disruptions arising as a consequence of deliberate R&D efforts in the form of inventions or it can be 'incremental' i.e. continuous improvement in products and processes owing to suggestions of those involved in the production process (learning by doing) as well as of those involved in usage of the products i.e. customers (learning by using) (Freeman & Perez, 1988).

Clusters are considered the catalysts of the process of innovation owing to the Marshallian 'passive' externalities in the form of knowledge spillovers owing to proximity as well as 'active' externalities in the form of cooperation among the cluster actors termed 'joint action' by Schmitz (1995).

3.4 Clusters and Social Capital

Expressed in terms of 'interfirm networks' and their quality i.e. 'trust', 'norms' and 'values', social capital is deemed to be a significant asset of clusters. Porter (1998) refers to social capital as a 'social glue' that binds the cluster and ensures access to important resources and information by conferring the actors an insider status. The concept of 'collective efficiency' (Schmitz, 1995), defined as "competitive advantage derived from external economies and joint action" recognizes the role of social capital in upgradation of a cluster. Further, the literature brings out two types of social capital, namely, 'bonding' and 'bridging' social capital. Bonding social capital refers to strong social ties based on common identity such as family and kinship, gender, ethnicity and religion while bridging social capital refers to weak social ties developed across the societies. Thus, bonding social capital tends to be intragroup while bridging social capital tends to be intergroup. Notwithstanding such distinctions, social capital is both an input and an output in the process of shaping clusters (Figure 2).
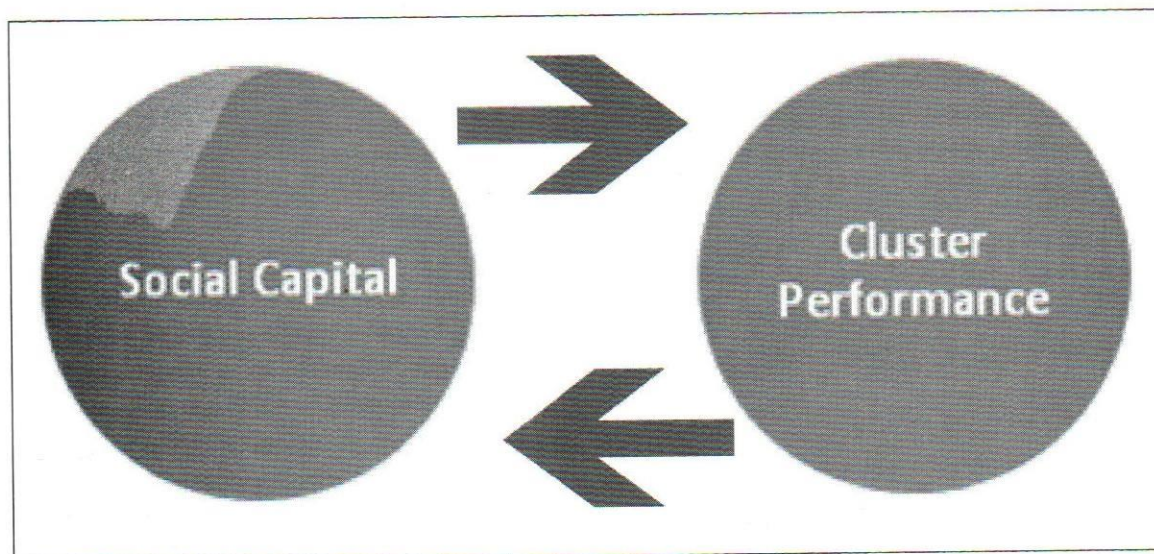
Figure 2: Two-way relationship between Social Capital and Cluster Performance

3.5 Towards a Framework for Measuring Cluster performance

Clusters are 'complex adaptive systems' made up of numerous elements woven into interrelated functions to form a system with a unique identity. Assessing them with traditional approaches measuring outputs shall give only a snapshot or a partial picture of the clusters at a particular point of time. Thus, it makes it necessary that cluster performance be measured not only in terms of quantitative outputs such as entrepreneurship, innovation and firm productivity but also in terms of qualitative processes such as social capital formation which translates into interfirm rivalry and cooperation, and ultimately into the outputs in the form of entrepreneurship, innovation and firm productivity (Figure 3).

3.6 Measuring Firm Productivity

A number of researchers have tried to test this argument by measuring productivity in clusters through varied constructs such as revenue growth, firm survival, etc.
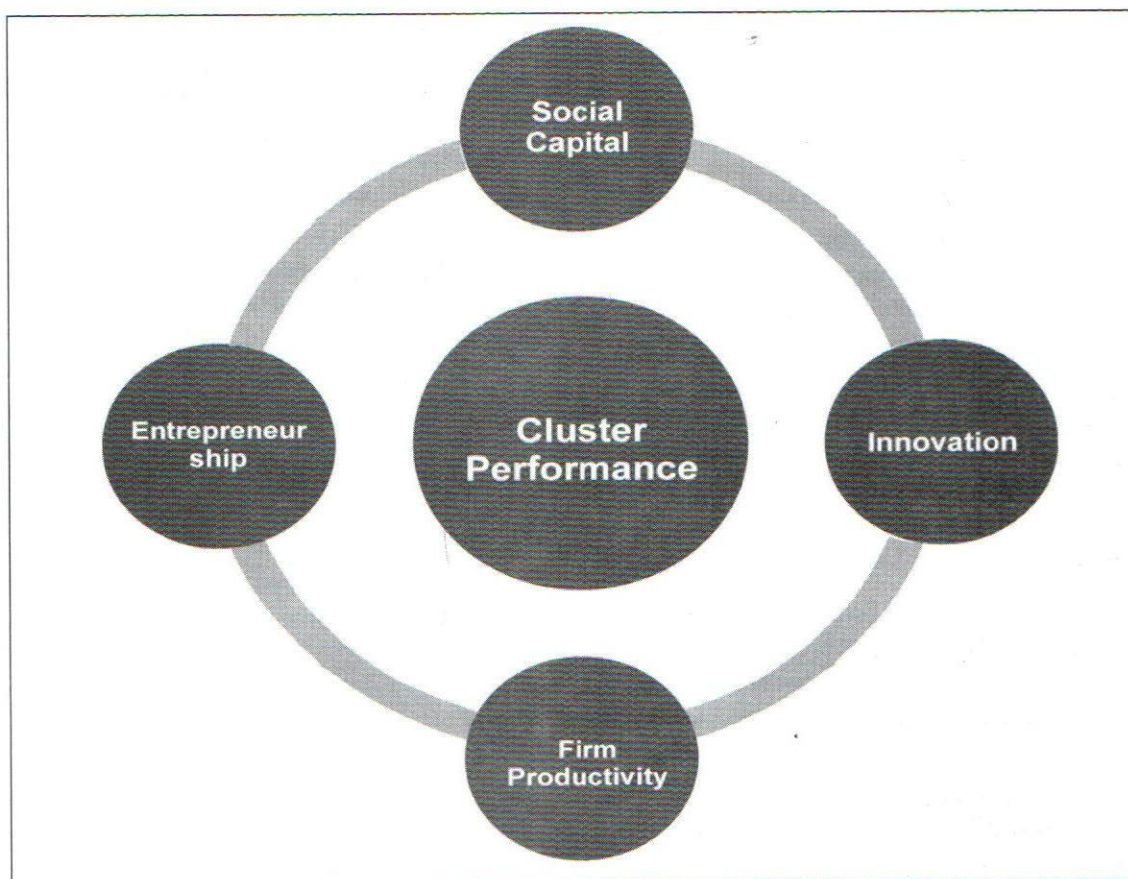
Figure 3: Framework for measuring agro-based cluster's performance

Table 1: Measurement of firm productivity in literature

Author	Construct	Indicators
(Steinfield, Scupola, & López-Nicolás, 2010)	Market Performance	Increase in sales Reduction in Cost/unit Introduction of new products Entry to new markets
(Folta, Cooper, & Baik, 2006)	Firm survival	Bankruptcy Sell-off
(Canina, Enz, & Harrison, 2005)	Firm Performance	Revenue growth

Table 2: Measurement of Entrepreneurship

Author	Construct	Indicators
(OECD, 2009)	Entrepreneurship Performance	Employer enterprise birth rates Employer enterprise death rates Employment creation by enterprise births Employment destruction by enterprise deaths
(Rocha & Sternberg, 2005)	Total Entrepreneurship Activity	Start-up activity New firm activity (Firms younger than 42 months)

Steinfield et al. (2010) identify performance in terms of profitability and cost reduction. A summary of indicators used to measure firm productivity is present in Table 1.

3.7 Measuring Entrepreneurship

Rocha & Sternberg (2005) using 97 German planning regions find a positive relationship between clustering and entrepreneurship. In order to measure entrepreneurship, they use total entrepreneurship activity (TEA) index. Similarly, OECD (2009) uses the construct 'Entrepreneurial Performance' to measure entrepreneurship in terms of firm-based, employment-based and other indicators. A summary of indicators used in measuring entrepreneurship is provided in Table 2.

3.8 Measuring Innovation in Context of Agro-based Clusters

Agro-based clusters involve a number of stakeholders which may be categorized broadly into 'enterprises' and 'support groups'. Enterprises in an agro-based cluster shall include farms as well as industries. The industries can be both 'food' and 'non-food' processing industries. Research indicates that food-processing industries tend to thrive through process innovation and depend upon new technologies developed by upstream industries. Further, innovations in food industries tend to be incremental rather than radical owing to conservative consumer behaviour. Thus, R&D intensity as an indicator shall provide a poor picture of innovation in clusters. Further, agricultural systems which include farms clearly distinguish between 'innovation generators' and 'innovation adopters' wherein innovation generators tend to be R&D institutions, universities and other upstream agro-input supplier companies. Thus, measuring innovation in agro-based clusters shall involve not only internal innovation capabilities of firms such as R&D intensity but also innovation adoption by the firms in the cluster. Thus, process innovations are as important as product innovations in case of agro-based clusters. Indicators to measure innovation in clusters are summarized in Table 3.

Table 3: Indicators for measurement of Innovation

Author	Construct	Indicators
(Bhattacharya & Bloch, 2004)	Innovation	Introduction of new products and services Modification of products and services
(Capitanio, Coppola, & Pascucci, 2009)	Innovation	Improvements in products Improvement in processes Introduction of new products Introduction of new processes
(Günther, 2010)	Innovation Capital	R&D Expenses in relation to sales Number, structure and (residual) useful life of property rights and patents Patents and similar intellectual property rights filed for application Net sales of products introduced in the last three years in relation to total net sales
(Baptista & Swann, 1998)	Innovation	Total number of innovations introduced by a company in a specific period
(Youli & Huiwei, 2011)	Innovation Performance	Process innovation Sales of innovative products Margins of innovative products R & D expenses to total expenditure ratio Number of patents

3.9 Measuring Social Capital

Nahapiet and Ghoshal (1998) provide three interrelated dimensions of social capital, namely, structural, relational and cognitive dimensions. Structural dimension involves mapping of actors and presence or absence of linkages among these actors, network configuration or morphology in terms of density, connectivity and hierarchy, and appropriable organization i.e. existence of networks

created for one purpose but may be used for other. Relational dimension involves assets leveraged through relationships such as trust, norms, identity, obligations and expectations. The cognitive dimension pertains to resources that provide shared representation, interpretation and systems of meanings among the parties such as shared language and codes, shared narratives and shared values and beliefs. Indicators to measure social capital can be summarized as per Table 4.

Table 4: Indicators for measurement of Social Capital

Author	Construct	Indicator
(Kaasa, 2009)	Informal networks	Frequency of meeting socially Importance of friends
	Formal networks/ social participation	Membership in voluntary organizations Importance of voluntary organizations
	Civic participation	Voting
	General Trust	Trust in fairness Trust in helpfulness
	Institutional Trust	Trust in legal system Trust in political system Satisfaction with government
	Norms of Civic Behaviour	Norm of helping and care Norm of loyalty Norm of obeying laws Norm of supporting
(Knorringa & Staveren, 2006)	Trust	Perception of risks of trusting behaviour Presence or absence of institutional sanctions on cheating Reputational jeopardy-fear of damage of reputation Future non-cooperation and interdependence
	Network Participation	Local embeddedness versus isolation Range of business partners External linkages
	Associational Membership	Number of organizations Reasons for membership
	Collective Action	Cooperation with other producers on: exchange of information; sharing machines and tools; joint purchasing of inputs; joint marketing; joint product development Lobbying the State

4. Integrated Framework for Measurement of an Agro-based Cluster's Productivity

In the previous sections, we tried to extract the indicators for different drivers of cluster productivity namely, social capital, firm productivity, entrepreneurship and innovation.

Further, these drivers do not operate in isolation but tend to be independent and need to be studied in an integrated manner. This brings us to develop an integrated framework for measurement of an Agro-based cluster's productivity, summarized in Table 5.

Table 5: Integrated Framework for measuring an Agro-based Cluster's productivity

Author	Construct	Indicator
Firm Productivity	Firm Productivity	Increase in sales/revenue Reduction in cost/unit
Innovation	Innovation capability (Input)	R&D expenses in relation to sales
	Innovation (output)	Improvements in products Improvement in processes Introduction of new products Introduction of new processes Sales of innovative products Patents
Entrepreneurship	Entrepreneurship	Enterprise birth and deaths Employment in new firms
Social Capital	Informal Networks	Family, friendship and kinship ties Ties outside the cluster
	Formal Networks	Membership in voluntary organizations Importance of voluntary organizations
	Trust	Trust in fairness Trust in helpfulness Reputational jeopardy
	Norms	Norm of helping and care Norm of loyalty Norm of obeying laws Norm of supporting
	Collective Action	Horizontal Inter-organisational resource exchange Vertical-Collaborative effort with suppliers and customers: Training and development of suppliers Training and development of customers and vice versa Joint participation in trade expositions/fairs

5. Conclusion

The authors have tried to develop an integrated framework to measure productivity (more popularly known as 'vibrancy') of agro-based clusters by tailoring the concepts of entrepreneurship, innovation, firm productivity and social capital as per their applicability in the context of agribusiness. While entrepreneurship, innovation and firm productivity present the output of clusters, social capital tends to have a two-way relationship with cluster performance. The present tool can be useful for cluster practitioners, in its present form or modified as per the need, to assess the effectiveness of their cluster development initiatives.

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> *"The clustering of technological innovation in time and space helps explain both the uneven growth among nations and the rise and decline of hegemonic powers."*
>
> – Robert Gilpin

Promoting Agripreneurship through Cluster Development in Mizoram: An Analysis of Economics of Sericulture in Saitual Cluster

LALZUITLUANGI AND RAMA RAMSWAMY

Sericulture is an agro-based activity which offers various avenues for employment generation in India. Sericulture is a highly profitable activity and its profitability depends on the production of quality mulberry leaves and its conversion into quality cocoons at economic costs. Over the years, sericulture is playing a vital role in development of the rural economy of Mizoram, in terms of employment opportunities. This paper is based on the mapping of Saitual cluster located about 77 kilometres from Aizawl, the capital city of Mizoram. The primary data was collected through a structured questionnaire, administered to all the agripreneurs (180) engaged in sericulture in Saitual cluster from December 2016 to February 2017. This paper attempts to assess the financial performance of the agrienterprises in Saitual and the impact of subsidies on the returns to the sericulturists in the cluster. Sericulture has emerged as a sustainable livelihood option in Saitual cluster, giving remarkable returns to the agripreneurs in the cluster. The cluster development initiative of the Government of Mizoram has provided an impetus to the business by means of subsidy in terms of providing rearing infrastructure, and construction of rearing house and New Land Use Policy (NLUP). Saitual has emerged as a role model of organic silk farming for other clusters in the region to emulate.

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1. Introduction

Sericulture is an agro-based activity which offers various avenues for employment generation in India. This may be attributed to the fact that it is a highly labour intensive industry providing high returns to the sericulturists. Sericulture is a highly profitable activity and its profitability depends on the production of quality mulberry leaves and its conversion into quality cocoons at economic costs. Sericulture plays a vital role in rural development, as it integrates well with the farming systems and has the potential to generate attractive income throughout the year. It needs low capital and provides year-round employment (Hanumappa and Erappa, 1985).

Over the years, sericulture is playing a vital role in development of the rural economy of Mizoram, in terms of employment opportunities. Mizoram occupied the 17th place in respect of area under mulberry, cocoon and silk raw production in India during 2011–2012 (Rathnam, Narasaiah and Murthy, 2013). The economy of Saitual is basically agrarian in nature and the major agricultural crops are corn, sugarcane and vegetables. Sericulture has become an important occupation in recent years after the cluster started taking its shape in 2009. Saitual, which has been identified as one among 10 sericulture clusters in Mizoram, is an ideal place for taking up sericulture activities with vast tracts of land under cultivation of mulberry leaves. In view of this, it is imperative to understand the economics of sericulture and estimate the returns that accrue to the sericulturists in Saitual.

"Cluster Promotion Programme" (CPP) was launched by Central Silk Board and implemented during XI plan jointly with state sericulture departments, selecting 50 sericulture clusters covering both mulberry

400

Promoting Agripreneurship through Cluster Development in Mizoram: An Analysis of Economics of Sericulture in Saitual Cluster

and *Vanya* sectors spread over 17 states for the promotion of sericulture, especially the bivoltine.

In pursuance of the suggestion from the Planning Commission and Ministry of Textiles, Government of India, Central Silk Board (CSB) and Departments of Sericulture (DOS) of selected states initiated Cluster Promotion Programme during 2007–12. The CBS and DOS have jointly identified 45 model sericulture clusters in pre-cocoon sector during 2008–09 and 2009–10, in 16 States including Mizoram. The sericulture department of Government of Mizoram selected 10 clusters under the 'Cluster Area Development Project' (CADP) namely Khamrang, Saitual, Darlung, Kanghmun, Khawhai, Serchhip, Zobawk, Rotlang, Bawktlang and Lungbun as on 2011–12 (Directorate of Sericulture, Government of Mizoram, 2012). This paper attempts to assess the financial performance of the agrienterprises in Saitual and the impact of subsidies on returns to the sericulturists in the cluster.

2. Data and Methodology

The study was conducted in Saitual Cluster located at about 77 kilometres from Aizawl, the capital city of Mizoram. For the purpose of the present study, an agripreneur is any person who is engaged in rearing of silkworms on a commercial basis. The present study relies on the primary as well as secondary data. The primary data was collected through a structured questionnaire, administered to all agripreneurs (180 in number) engaged in sericulture in Saitual cluster during the period December 2016 to February 2017.

3. Saitual Sericulture Cluster

Saitual is located in Aizawl district at a distance of 77 kms from the capital city Aizawl. The cluster comprises of seven villages viz; Saitual, Keifang, Rulchawm, Maite, North Lungpher, Mualpheng and Sihfa. Sericulture has become an important occupation in recent years after the cluster started taking its shape in 2009. During the pilot survey in May 2014, the researcher found that 180 households had undertaken sericulture activities on a commercial basis in Saitual. It was observed that two types of silkworm were mainly produced namely – the Mulberry silkworm and the Muga silkworm.

It is clear from Table 1 that 22.22 per cent of the farmers practicing sericulture owned less than one acre of land and 47.8 per cent farmers owned one to two acres and around 30 per cent farmers owned above two acres. The researcher has estimated the cost incurred and the returns for one acre in the present study.

Table 2 presents a snapshot of the total expenditure incurred and the net returns to the agripreneurs on one acre of rain-fed mulberry garden.

The success of sericulture enterprise depends on the level of profits it enjoys. The returns obtained by sericulturists act as a measure in determining the economic viability of sericulture activity. Therefore an attempt is made to analyze the cost and net returns from the sericulture enterprise in the study area. Table 2 gives a clear picture of the costs and returns on one acre of irrigated mulberry garden. It is evident from Table 2 that the total expenditure is Rs.16,770 during the year. The quantity of cocoon produced on an average for 100 Disease Free Layings (DFLs) is 60 kgs of cocoon and average number of rearing is 5 times, hence, around 600 kgs of cocoons were produced in a year.

It is clear from Table 2 that the amount of returns through sale of cocoon is Rs.1,20,000 in a year. However, after deducting all the expenditure incurred, the net returns is Rs.1,03,230 for one acre of mulberry land. In a study conducted by Rani (2006), in Anantapur district, the net returns is Rs. 30,045 for acre of mulberry land, which is lesser. This may be attributed to the fact that the expenditure incurred by the farmers in this cluster is lesser

Table 1: Categorization of sample farmers according to their mulberry land holdings

Land holding of Agripreneurs	No. of farmers	Per cent
Upto 1 acre	40	22.22
1 to 2 acres	86	47.8
Above 2 acres	54	30
Total	180	100

Source : Field Data

Table 2: Costs and returns on one acre of rain-fed mulberry garden

Sl. No.	Particulars	Rs.
A.	Expenditure	
a.	Production of mulberry leaf	13,250
b.	Silkworm rearing	3,520
c.	Total	16,770
B.	Quantity of cocoons produced (in kgs)	600 kgs
C.	Returns in Rs. through sale of cocoon at Rs.200/ per kg	1,20,000
D.	Net returns (in Rs.)	1,03,230

Source: Field Data

as the farmers do not have to incur expenses on factors such as Farm Yard Manure (FYM), chemical fertilizers, irrigation facilities and rearing appliances. As mentioned earlier, 80 per cent of the rearing appliances were sanctioned by the government of Mizoram in Saitual cluster.

In a study conducted among the farmers of rain-fed conditions in Chamarajanagar district of Karnataka state, the cost of cocoon production for 100 DFLs per acre per year was Rs. 8,370 for small farmers, Rs. 8,552 for medium farmers and Rs. 8,875 for large farmers; while the net returns were Rs. 4,349, Rs.5,561 and Rs.6,870 respectively. In Saitual cluster, by rearing 200 DFLs in one acre, the average production of cocoons was 120 per crop with a net return of Rs. 1,03,230.

It is evident that sericulture has emerged as a successful economic activity giving remarkable returns to the agripreneurs. Rs. 1,20,000 is the return that accrues to the farmers having a land holding of one acre and it may be estimated to be Rs. 2,40,000 for two acres and Rs. 3,60,000 for more than two acres. It was observed that the maximum land holding in Saitual was 5 acres, with most of the large farmers (54) having a land holding of about 3 acres.

Table 3 further gives details of the silkworm reared in one acre of mulberry plantation in Saitual Cluster.

In Saitual cluster, around 200 DFLs were reared per crop in one acre of mulberry and the total number of crops per year is 5 times. As seen in Table 3, 1000 nos. of DFLs were reared a year in one acre of mulberry. As

Table 3: Economics of silkworm rearing in one acre of mulberry plantation

Particulars	Quantity
No. of crops per year	5 times
No. of DFLs to be reared per crop	200 nos.
No. of DFLs reared in a year	1000 nos.
Quantity of cocoon per 100 DFLs	60 kgs
Quantity of cocoon per 200 DFLs	120 kgs
Production of cocoon per year	600 kgs
Annual income from sale of 600 Kgs cocoons @200 per kg	Rs.1,20,000

Source: Field Data

402

Promoting Agripreneurship through Cluster Development in Mizoram: An Analysis of Economics of Sericulture in Saitual Cluster

mentioned earlier, worms are introduced through DFLs (Disease Free Layings, i.e. eggs). In Saitual cluster, DFLs were supplied by the government according to the requirements of the farmers. For one acre of mulberry garden, around 200 DFLs were reared in Saitual. Normally, for one acre of land, the weight of cocoons obtained from 100 DFLs is around 50–70 kgs of cocoons which are produced with an average number of rearing between 4 to 5 times in a year, and the quantity of cocoon produced per 100 DFLs were 60 kgs. Hence, the total production of cocoon in one year was estimated at 600 kgs. The farmers sell these cocoons to the cocoon collection centre in Saitual where the cocoons are dried, and weighed and categorized into different grades according to their weights. The rates of the cocoons differ according to the category it falls under.

The average rate for the cocoons in Saitual cluster was around Rs. 200 per kg. It is evident from Table 3 that with a total production 600 kgs of cocoons in a year, the annual income from silkworm rearing in one acre of mulberry plantation was estimated at Rs. 1,20,000.

The present study has made a detailed analysis of the expenditure incurred on production of mulberry leaves and silkworm rearing as shown in Table 4.

As mentioned earlier, sericulture as an economic activity comprises two main activities:

Production of mulberry—which includes establishment of mulberry garden (initial stage) and recurring expenditure from second year onwards, and silkworm rearing—which includes expenditure involved in rearing of silkworms.

4. Production of Mulberry

4.1. Establishment of Mulberry Garden: (Initial stage)

Mulberry is a perennial crop and the establishment of mulberry garden is a crucial factor in the success of the sericulture enterprise, and hence the initial establishment cost is vital. Profitability from the enterprise largely depends on the quantity of mulberry leaves produced, which will impact the production of cocoons. As mentioned earlier, the average size of mulberry land holdings in Saitual was two acres. The researcher has adopted one acre as the economic unit for cocoon production for analysis of profitability of the enterprise. The data relating to the establishment cost was collected from the farmers during the field visit and has been presented in Table 4. The table

presents estimated cost for establishment of one acre of mulberry farm. The researcher has estimated the expenditure incurred for cultivation of mulberry leaves in detail under the heads:

a) Land development

b) Raising of plantation

c) Rearing infrastructure and

d) Miscellaneous

Table 4 shows the various costs involved in the establishment and management of one acre of mulberry garden in Saitual. The total estimated cost of establishment and management of one acre was Rs.1,77,260. However, as the farmers have received subsidies amounting to Rs. 77,760 in the form of rearing and Rs.50,000 under NLUP scheme from the Government of Mizoram, the actual cost incurred was Rs. 49,500.

4.1.1. Land development

The farmers in Mizoram follow jhumming cultivation for land development which mainly involves clearing of jungle, and burning for land preparation. It is evident from the table that a total of around 50 man days at a rate of Rs. 350 per man day was utilized in the initial year for carrying out land development activities and the total cost was estimated to be Rs.17,500.

4.1.2. Raising of Plantation

Land development is followed by raising of plantation which involves activities such as cutting, pit digging, planting of sapling and weeding. Generally, pit system of planting with wider spacing is usually adopted for rain-fed mulberry, while row system with closer spacing is adopted for irrigated mulberry (Krishnaswami, 1986). As the mulberry plantations in Saitual are rain-fed, pits were dug by the farmers. These pits were filled with soil, preferably mixed with some cattle manure in which the cuttings or rooted saplings were planted. Pit digging and planting of sapling required an estimated 50 and 40 man days in a year at a rate of Rs.350 per man day respectively. Notably, the cost of manure is 'nil' in Table 4, which may be attributed to the fact that the soil of Mizoram is naturally suitable to grow a healthy mulberry garden without the help of fertilizers and farm yard manure. It was found during the field study that none of the farmers applied fertilizers to the farm.

Making the field weed-free, especially during the initial stage for good growth and yield of plant is critical.

Table 4: Estimated cost of initial establishment and management of one acre mulberry farm

Sl. No.	Particulars	Qty.	Rate per man day (Rs.)	Total Amount (Rs.)
a.	Land Development Clearing of jungle, burning, land preparation, etc. (Wages for man days)	50 man days	350	17,500
	Sub-Total			17,500
b.	Raising of Plantation			
i.	Cost of plantation			
	a) Pit digging and spacing	70 man days	350	24,500
	b) Planting of sapling/cutting	40 man days	350	14,000
	c) Cost of manured)	-	-	-
	d) Weeding (4 times a year)	90 man days	350	31,500
	Sub-Total			70,000
c.	Rearing Infrastructure			
i.	Construction of rearing house - Assam type 24'x15' (Subsidy given by Government)	1	40,000	40,000
ii.	Rearing appliances			
	a) Sintex*	1	5000	5000
	b) Plastic trays (2x3 feet)	50	350	17,500
	c) Mountages (3x2 feet)	80	60	4,800
	d) Rearing stands	15	300	4,500
	e) Bed cleaning nets	80	50	4000
	d) Sprayers	3	190	570
	f) Disinfectant	5	150	750
	g) Other appliances (Hydrometer, chopping board, towel etc)	1 each		590
	Sub-total			77,760
d.	Miscellaneous		12000	12000
	Total expenditure incurred:			1,77,260
e.	Subsidies received:			
	i) Rearing infrastructure and appliances ii) NLUP		77,760 50,000	1,27,760
	Total expenditure incurred by farmers = (a+b+c+d-e)			**49,500**

Source: Field data

404

Promoting Agripreneurship through Cluster Development in Mizoram: An Analysis of Economics of Sericulture in Saitual Cluster

Weeding was done four times in a year at an interval of two to three months, with a total man days of 90 at the rate of Rs.350 per man day. The total cost of raising of plantation which included pit digging, planting of sapling/ cutting and weeding was estimated at Rs. 70,000 in the first year of establishment of a mulberry farm of one acre in Saitual cluster.

As mentioned in Table 4, subsidies given to the sericulturists in Saitual by the government of Mizoram as part of cluster development initiatives were as mentioned below:

i) Rearing infrastructure which included — Construction of rearing house and rearing and water storage equipments. The rearing of mulberry silkworms was fully domesticated in Saitual. A silkworm-rearing house is the place where the silkworms are reared to produce cocoons. The cocoon quality and yield are adversely affected if the optimal environmental conditions i.e. temperature, relative humidity, ventilation, illumination, hygiene, etc. are not maintained. The rearing house should be rationally designed in order to keep the micro-climatic and environmental conditions for rapid and healthy growth of the silkworms. It should, therefore, have facilities for creation and maintenance of the optimal environmental conditions inside the silkworm-rearing house. The rearing house should also provide sufficient space and healthy environment for the workers attending the silkworm rearing (Central Silk Board). Interestingly, in Saitual cluster, each of the farmers have availed Rs.40,000 on average from the government to construct a rearing house (Assam type) 24'x15'as subsidy (Table 4).

The rearing house is usually equipped with different rearing equipment viz. Chandrika mountages[1], rearing stands[2], plastic trays, bed cleaning nets[3], sprayer, disinfectant towels, hydrometer and net towels, knives and leaves chopping board and one Sintex (500 L) tank.

As shown in Table 4, the total cost for construction of rearing house and for rearing equipment was estimated at Rs.77,760 which was entirely subsidized by the Government of Mizoram.

ii) NLUP—It is pertinent to note that each of the farmers of the cluster received Rs.50,000, on an average, from the government under the NLUP scheme. As mentioned earlier, Saitual is an "induced cluster" where entrepreneurship has emerged as an outcome of cluster development activities initiated by Government of Mizoram through NLUP and Cluster Area Development Project (CADP).

The main aim of the NLUP was to develop suitable and stable trades for the farmers in the state. The policy also aimed at providing the village farmers self-sufficiency in rice, vegetables etc. and subsidies to enable them to take up occupation on farm-based work. The number of farmers covered under NLUP were 2096 in 2011–12 in Mizoram, and it has been observed that an overwhelming number of farmers in Saitual sericulture cluster were also selected under NLUP.

Saitual cluster started to take its form in 1994 with one farmer engaging in sericulture for commercial purposes. The period between 2009–14 witnessed the birth of majority of the units (76 per cent). This period coincided with the launching of the CADP which included Saitual cluster as on 2011–2012. Hence, the farmers of the cluster also received Rs. 50,000 under the NLUP scheme to start up their sericulture units.

Hence, the estimated cost actually incurred by the farmers the initial year was Rs. 49,500 (28 per cent of the total estimated cost of Rs.1,77,260). The mulberry garden, once established, is expected to give yield for 12 to 15 years. It was observed that during the first year, the number of crops harvested was not optimum and the productivity of the crop is also low. Over the years, however, the sericulturists in Saitual have gained knowledge and experience and improved their performance and productivity levels.

The researcher has further estimated the recurring expenditure on one acre of established mulberry garden from the second year onwards (Table 5).

4.2. Recurring expenditure from second year onwards

The sericulture farmer incurs a significant expenditure in the first year of establishing. Thereafter, the agripreneur incurs only the recurring expenditure which has been examined in Table 5. Recurring expenditure on rearing broadly includes a) Cultivation expenses; b) Irrigation; c) Farm yard manure; d) Cost of chemical fertilizer; e) Leaf harvest and f) Miscellaneous.

4.2.1. Cultivation expenses

As mentioned earlier, the rearing of silkworms involves cultivation of mulberry trees, which provide a regular supply

Sl. No.	Particulars	Man days (Qty)			Rate per man day (Rs.)	Amount (Rs.)		
		Family labour	Hired	Total		Family labour	Hired	Total
a)	Cultivation expenses	45	20	65	350	15.750	7000	22,750
b)	Irrigation	-	-	-	-	-	-	-
c)	Farm yard manure	-	-	-	-	-	-	-
d)	Cost of chemical fertilizer	-	-	-	-	-	-	-
e)	Leaf harvest	40	15	55	350	14,000	5250	19,250
f)	Miscellaneous	-	-	-	-	-	1000	1000
	Total	85	35	120		29,750	13,250	43,000

Source: Field Data

of leaves. The success of good quality cocoon yield depends upon proper planning and maintenance of mulberry garden/plant and cultivation is a crucial process. It is evident from Table 5 that the farmers incurred the highest expenditure on the process of cultivation. This may be attributed to the fact that the number of man days involved in cultivation is the most (55 per cent) as compared to other activities. The total cost of cultivation is estimated at Rs.22,750. As shown in Table 5, out of the total 65 days required, a significant share (45 days) is contributed by family labour which reduces the cost of labour considerably and the actual expenditure incurred on hired labour for cultivation was Rs. 7,000 (31 per cent).

4.2.2. Irrigation

Saitual cluster is also endowed by nature with a congenial climate for sericulture which reduces the dependence on irrigation facilities considerably, for mulberry cultivation. The researcher observed that the mulberry farms in Saitual cluster were rain-fed and none of the agripreneurs depended on irrigation facilities. This is reflected on the cost of irrigation facilities estimated to be NIL.

4.2.3. Farm yard manure

As shown in Table 5, the cost incurred on Farm yard manure is nil since the soil of Mizoram is naturally suitable to grow a healthy mulberry garden without the help of manure. All the farmers in Saitual cluster are dependent on organic farming.

4.2.4. Cost of chemical fertilizer

Notably, all the farmers in Saitual followed organic farming which reduced the cost considerably. As shown in Table 5, none of the agripreneurs were treating their land with fertilizers and hence the expenditure on fertilizers was also nil.

4.2.5. Leaf harvest

Silkworms feed on mulberry leaves and the success of silkworm rearing depends on the quality of leaf that is fed to silkworms. Silkworms prefer fresh, healthy mulberry leaves. Harvesting of mulberry leaves from the mulberry garden include: (a) leaf picking, (b) shoot-harvest and (c) branch cutting. Harvesting the leaves depends on the type of rearing method adopted. The first leaf harvest is usually done after 8 months of planting. In Saitual cluster, the farmers harvest leaves five times in a year, which required a total man days of 55 as shown in Table 5. The cost of leaf harvesting was around Rs. 19,250 which includes family and hired labour. However, the actual expenses incurred on hired labour was Rs. 5,250.

The total cost of recurring expenditure on one acre of established irrigated mulberry garden from second year onwards was Rs.43,000, including miscellaneous expenditure. However, the actual expense on hired labour is Rs. 13,250. It is evident that the expenditure is reduced considerably due to the involvement of family labour. In a similar study conducted by Rani (2006) in Anantapur district, the cost incurred for application of farm yard

406

Promoting Agripreneurship through Cluster Development in Mizoram: An Analysis of Economics of Sericulture in Saitual Cluster

manure (FYM) and chemical fertilizer is Rs. 3,870 which is nil in Saitual. Hence, the recurring expenditure on one acre of established garden is considerably lower in Saitual.

5. Silkworm Rearing

The researcher has further estimated the quantity of silkworms reared per household. Rearing starts with the purchase of silkworm eggs called disease-free-layings (DFLs) or industrial seed, normally at a cost of Rs. 250 per hundred DFLs. Sericulturists usually buy these eggs from government grainages or licensed seed-producers (Rani, 2006). In other words, worms are introduced through DFLs. In Saitual cluster, the DFLs were supplied by the government according to the requirements of the farmers. For one acre of mulberry garden, around 200 DFLs were reared in Saitual. Normally, for one acre of land, the weight of cocoons obtained from 100 DFLs is around 50–70 kgs of cocoons which are produced with an average number of

rearing between 4 to 5 times in a year. On an average, all the sericulturists harvest five crops per year. From Table 6, it is evident that the annual production of silkworm from 200 DFLs for mulberry size of one acre is around 600 kgs. In other words, the annual production of cocoon for one acre is estimated at 600 kgs of cocoon, for a landholding of 2 acres it is estimated to be 1200 kgs and so on.

It is pertinent to note that organic farming is enabling the agripreneurs in Saitual to produce 600 kgs of cocoon which compares favourably to cocoon production in Erode district of Tamil Nadu where the average cocoon production was 804.62 kgs on average from one acre in a year (Prakasam, 2014). The farmers here incurred a cost of Rs. 7076.87 for fertilizers and Rs. 3576.87 annually per acre per year on plant protection chemicals, whereas no such fertilizers or plant protection chemicals were used to mulberry leaves in Saitual cluster. However, a study conducted in Murshidabad, West Bengal, revealed that

Table 6: Quantity of silkworms reared per household for 200 DFLs

Size of mulberry Landholdings (in Acre)	Average quantity reared per crop	Average No. of rearings	Annual quantity (in kgs)
Upto 1	120 kgs.	5	600
1 to 2	240 kgs.	5	1,200
>2	360 kgs.	5	1,800

900 kgs of cocoons were produced per acre/year (Trivedi & Sarkar, 2015).

The success of sericulture in Saitual can become a role model for other states to follow and emulate. Organic farming retards degradation of land and enables longevity of fertility of the land.

Silkworm passes through four distinct stages egg, larva, pupa and adult during its life cycle. The duration of life cycle may usually last 6–8 weeks depending upon racial characteristics and climatic conditions (Mahesha, 2008). These stages can also be classified as First Instar to Fifth Instar. As seen in Table 7, from the third instar to fifth instar, labour are employed by the farmers at a rate of Rs.60 per man day. Due to the delicate nature of the silkworms, the rearing activity demands utmost care and skill during these stages. Hence, sericulturists have to depend on skilled labour. The rearing activity is labour intensive and accordingly the estimated expenditure on

the labour component is also higher than the other inputs involved in this activity. The involvement of family labour considerably reduces the expenditure on labour. Table 7 shows the average expenditure incurred by farmers on hired workers in a year; on an average, the cost involved for rearing of 150 DFLs works out to Rs. 2,520. The DFLs are provided by the government, therefore, the expenses is nil throughout the year.

The expenditure on labour is Rs.2,520. The miscellaneous expenditure is estimated to be Rs. 1000, which includes expenses of farmers on purchasing extra plastic trays, sprayer, net, disinfectant as per their requirements. As mentioned earlier in Table 4, almost all the rearing equipment were provided by the government; however, sometimes the farmers are faced with the need of buying extra rearing equipment other than the ones supplied by the government. Accordingly, the total expenditure incurred on rearing in a year is estimated to be Rs.3,520.

Table 7: Expenditure involved in rearing of 100 DFLs in a year

Sl. No	Description	Man days	
1.	Cost of DFLs	-	NIL
	a) Rs. Per 100 DFLs		
2.	Cost of Labour wage		
	a) First & Second instar	-	-
	b) Third instar	12	720
	c) Fourth instar	16	960
	d) Fifth instar	20	1,200
	e) Collection of ripened worm and mounting	-	
	Paraffin paper formalin, news paper		
3.	Transportation charges etc		
4.	Miscellaneous	-	1000
	Total		3,520

Source: Field Data

In summation, the sericulturist incurs Rs.49,500 in the initial year for establishing one acre of mulberry farm (Table 4), Rs. 13,250 on recurring expenses on one acre from the second year (Table 5) and earns Rs. 1,20,000 from sale of 600 kgs of cocoon annually. The net returns that accrue to the sericulturist from one acre of mulberry farm is Rs. 1,03,230.

6. Conclusion

Sericulture has emerged as a sustainable livelihood option in Saitual cluster, giving remarkable returns to the agripreneurs in the cluster. Moreover, the cluster development initiative of the Government of Mizoram has provided an impetus to the business by means of subsidy in terms of providing rearing infrastructure in the form of construction of rearing house and supply of rearing equipments and NLUP. This has lowered the actual cost incurred by the agripreneurs per acre to Rs.49,500. The total recurring expenditure incurred on one acre of mulberry farm was Rs.16,770 (Table 2) and the returns that accrued to the agripreneurs was Rs.1,20,000 (Table 3). The net returns for the agripreneur per acre/year was estimated at Rs.1,03,230. It is evident that sericulture is giving remarkable returns to the agripreneurs. Sustained cluster development initiatives by the Government of Mizoram will ensure the success and prosperity of this industry in Mizoram. Saitual has emerged as a role model of organic silk farming for other clusters in the region to emulate.

Notes:

[1] The most important device that helps or supports the silkworms (larvae) for comfortable spinning their cocoon is called cocoonage or mountage.

[2] Silkworms are reared in bamboo or plastic trays which are arranged one over the other in tiers on rearing stands.

[3] Bed cleaning nets are essential to remove unused mulberry leaves and silkworm litters accumulated in the rearing bed.

408

Promoting Agripreneurship through Cluster Development in Mizoram: An Analysis of Economics of Sericulture in Saitual Cluster

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"The strong live and the weak die. There is some bloodshed, and out of it emerges a much leaner industry, which tends to survive."

– Ratan Tata

Influence of Indian Automobile Industry in Modern Production Method: A Critical Review

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The aim of this paper is to study the influence of automobile industry in modern production methods in the context of Indian industry. The automotive industry is a pillar of the industrial economy and a key motive force of macroeconomic growth and technological advancement. It is a consistent, direct and indirect contributor to GDP, foreign investment, employment and innovation in many countries including Germany, United States, Japan, South Korea, Italy and most recently, China. The development of the automobile industry is a prime policy focus of governments in these nations. In India, the automobile industry is a powerful engine of industrial growth which contributes 7.1 per cent of total GDP and employs approximately 32 million people in direct and indirect ways. Automobile industry provides vehicle for quick transport of goods and passengers. Trucks, buses, cars, motorcycles, scooters, three-wheelers and multi-utility vehicles are manufactured in India at various locations. Furthermore, this industry attracted US$ 16.5 billion in foreign direct funding between April 2000 and December 2016, and is slated to attract about US$ 8–10 billion more in local and foreign funding by 2023. The study also shows that the rapid improvement of electronic systems in automotive motors has been driven for decades with the aid of continuously growing necessities of legislation for environmental protection, as well as rising needs of the consumer to enhance fuel economy, protection, riding consolation and driving excitement. The manufacturers of mobile networked machines additionally see themselves increasingly confronted with these requirements. The prime objective of this paper is to examine the advantages and also to study the trends in Indian automobile industry. After liberalization, the entry of new and contemporary models stimulated the demand for vehicles in the market, which led to the healthy growth of the industry including passenger cars, two and three-wheelers.

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1. INTRODUCTION

Since the early 1990s, the growth of the automobile industry in India is a shining example of how business prowess supported by progressive policies and country-wide economic growth can yield rewards to all stakeholders. The industry is more than 100 years old. It started in Germany and France, and came of age in the US in the era of mass production. Vehicle volumes, efficiency, protection, features and preference have grown progressively throughout the industry's history. It is synonymous with 20th century industrial improvement, and so intertwined with its dual marvels of mass production and mass consumption, that it has been called the "Industry of Industries." The automobile industry is the main industrial and economic force worldwide. It makes 60 million cars and trucks a year, and they're responsible for nearly half the world's consumption of fuel. The enterprise employs 32 million people directly, and a lot more through indirect employment. While the reality is that many large companies have issues with excess capacity and low profitability, the automotive industry has very strong impact and importance. The industry also presents well-paying jobs with proper benefits, has heavy linkages with supplier industries (which offers it an outsized function in economic development), and has a robust political affect.

Globally, the Indian auto industry was the 4th largest with increasing sales of 9.5 per cent year-on-year to 4.02 million units (excluding two wheelers) in 2017 and it was also the seventh largest manufacturer of commercial vehicles. The two-wheeler segment dominates the market in terms of volume owing to a growing middle class and youth population. Moreover, the increasing interest of the companies in exploring rural markets, similarly, aided the booming of the sector. India is one of the prominent auto exporters and has strong export growth expectations for

the near future. Automobile exports grew 15.54 per cent during April 2018 to February 2019. It is expected to grow at a CAGR of 3.05 per cent during 2016 to 2026. In addition, several initiatives taken by the Government of India and major automobile players in the Indian market are expected to make India a leader in the two-wheeler and four-wheeler markets across the world by 2020. The market size of the domestic automobile production increased at 7.08 per cent CAGR between the financial years 2013–2018 with 29.07 million vehicles manufactured in the country during the financial year 2018. During April 2018-January 2019, automobile production increased 9.84 per cent year-on-year to reach 26.26 million vehicle units. Overall domestic automobiles sales increased at 7.01 per cent CAGR during the financial years 2013–2018 with 24.97 million vehicles getting sold in the financial year 2018. During April 2018-January 2019, highest year-on-year growth in domestic sales among all the categories was recorded in commercial vehicles at 22.79 per cent followed by 14.79 per cent year-

on-year growth in the sale of three-wheelers. Premium motorbike sales in India crossed one million units in the financial year 2018. During January-September 2018, in India, BMW registered a growth of 11 per cent year-on-year and its sales reached to 7,915 units. Mercedes Benz ranked first in sales satisfaction in the luxury vehicles segment according to J D Power 2018 India sales satisfactory index (luxury). The sale of electric two-wheelers is estimated to have crossed 55,000 units in the year 2017–18. In order to keep up with the increasing demand, several auto makers have started investing heavily in various segments of the industry during the past few months. As per Department of Industrial Policy and Promotion (DIPP), the industry has attracted Foreign Direct Investment (FDI) worth US$ 20.85 billion during the period April 2000 to December 2018. The industry had experienced a quantum jump in less than 15 years. FDI brought in new technology and aligned the industry with global developments.

2. CURRENT PROFILE OF THE INDUSTRY
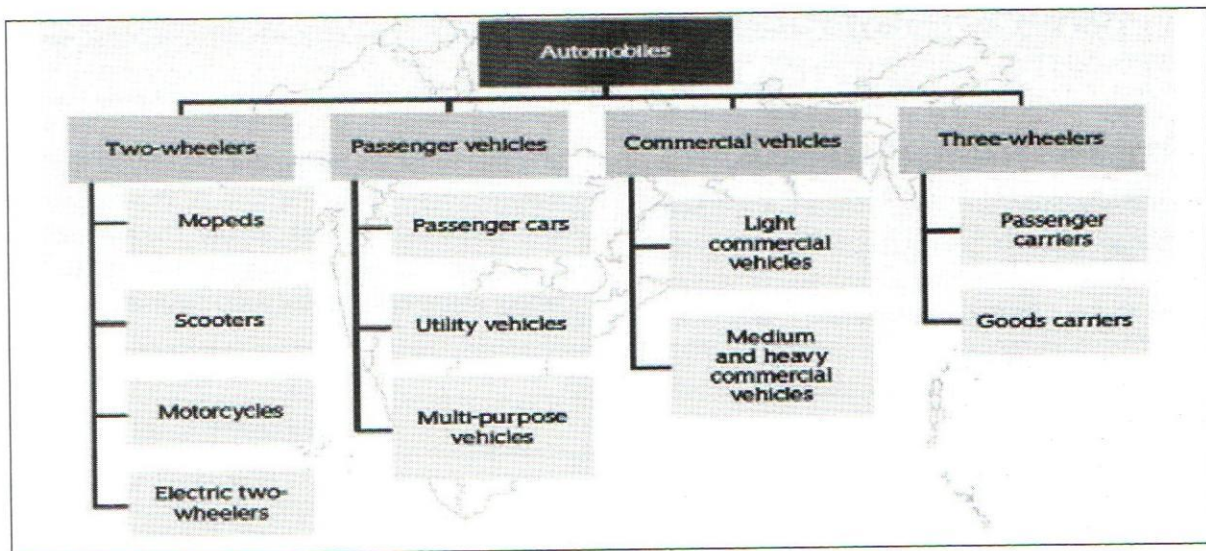
Source: India Brand Equity Foundation

Figure I: Automobile Industry Profile

3. OBJECTIVES OF THE STUDY

- To know the advantages of the Indian automobile Industry

- To study the performance of key players of the Indian automobile industry

- To analyze the future trend of key players of the Indian automobile industry

4. METHODOLOGY OF THE STUDY

The present study is mainly on the secondary data which were collected from the Automobile Manufacturers Association of India (AMAI), Society of Indian Automobile Manufacturers (SIAM) and India Brand Equity Foundation (IBEF). Apart from this, information was also gathered through journals, magazines and related websites.

5. GROWING ADVANTAGES IN THE SECTOR

India is a world leader in the automobile sector, backed by its domestic manufacturing capacity, market size and exports. The Indian automotive industry is a primary employment creator, GDP contributor and FDI earner. India is a distinguished automobile manufacturer and exporter with relatively optimistic expectations of growth for the foreseeable future. India holds massive ability in the automobile market including the auto element sector owing to its technological, cost and manpower advantages. India has a well-advanced, globally competitive auto-ancillary industry and established vehicle testing and R&D (Research & Development) centres.
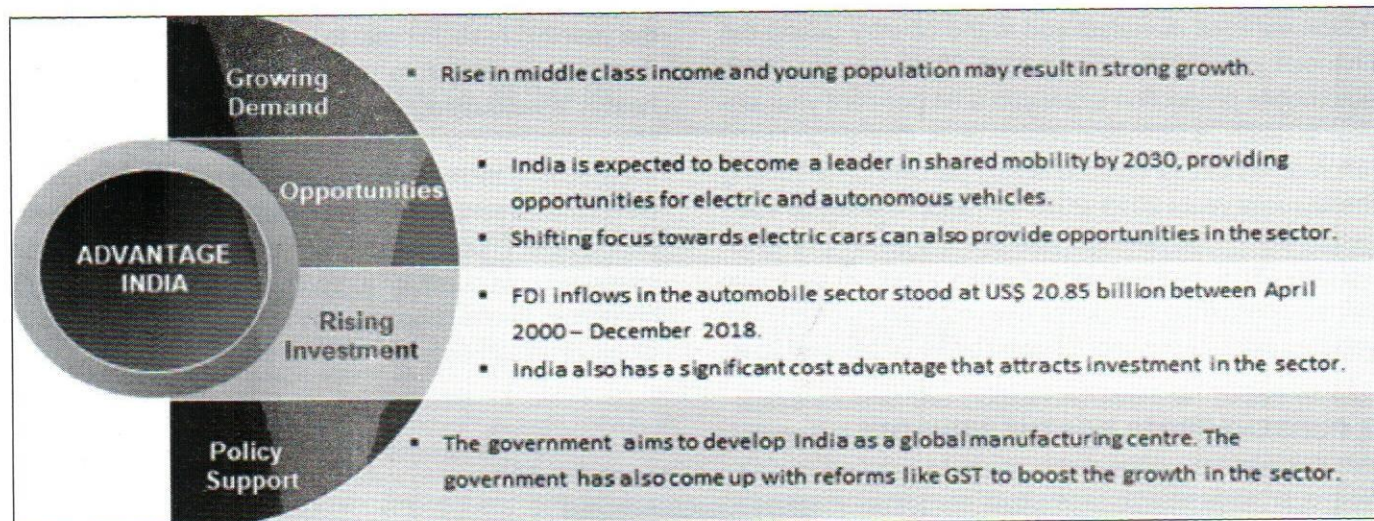
Source: www.ibef.org

Figure II: Advantages of Auto Industry

6. RECENT TRENDS IN AUTOMOBILE INDUSTRY

The automotive industry is currently weathering a perfect storm of change. With multiple new technology innovations and market shifts hitting the industry at the same time, automakers are facing one of the most challenging environments of the last century. The automobile industry is supported by various factors such as availability of skilled labour at low cost, robust R&D centres and low-cost steel

Table 1: Top 10 Car Companies in India

Company Name	Market Capitalization (Rs. Cr) (2018–19)
Tata Motors	123,058.92
Eicher Motors	48,804.99
Ashok Leyland	26,680.09
Tata Motors (D)	7,906.44
Force Motors	3,968.69
SML Isuzu	1,878.06
Maruti Suzuki	127,846.32
M&M	79,226.54
Hind Motors	157.96

Source: www.siamindia.com

Influence of Indian Automobile Industry in Modern Production Method: A Critical Review

production. The industry also provides great opportunities for investment, and direct and indirect employment to skilled and unskilled labour. Indian automobile industry, including component manufacturing, is expected to reach Rs 16.16–18.18 trillion (US$ 251.4–282.8 billion) by 2026. Two-wheeler segment was expected to grow at 9 per cent by mid-2019 but it has not happened.

7. AUTOMOBILE PRODUCTION TRENDS

During April 2018-March 2019 period, the auto industry produced 30,915,420 automobiles along with passenger motors, business automobiles, three-wheelers, two-wheelers and quadricycle as against 29,094,447 during April 2017-March 2018, registering a boom of 6.26 per cent over the same period. The trends in production of various types of vehicles reflect the overall performance of the automobile industry.

8. A VIEW ON DOMESTIC SALES

Currently, India is one of the largest global markets as far as automobile sales is concerned. Car manufacturers raised a toast for the financial year 2017–18 as it turned out to be one of their best in terms of sales; the sale of passenger vehicles grew by 2.70 per cent in April-March 2019 over the same period last year. During the year April-March 2019 over the same period within the passenger vehicles, the sales of passenger cars, utility vehicle & vans grew by 2.05 per cent, 2.08 per cent and 13.10 per cent respectively. The overall commercial vehicles segment registered a growth of 17.55 per cent in April-March 2019 as compared to the same period last year. There was a growth of 14.66 per cent for medium & heavy commercial vehicles (M&HCVs) while light commercial vehicles grew by 19.46 in April-March 2019 over the same period last year. Three-wheeler sales

Table 2: History of Production of Vehicles

(Automobile Production Trends)   (Number of Vehicles)

Category	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19
Passenger vehicles	3,087,973	3,221,419	3,465,045	3,801,670	4,020,267	4,026,047
Commercial vehicles	699,035	698,298	786,692	810,253	895,448	1,112,176
Three wheelers	830,108	949,019	934,104	783,721	1022,181	1,268,723
Two wheelers	16,883,049	18,489,311	18,830,227	19,933,739	23,154,838	24,503,086
Quadricycle			531	1,584	1,713	5,388
Grand Total	21,500,165	23,358,047	24,016,599	25,330,967	29,094,447	30,915,420

Source: www.siamindia.com

Table 3: History of Sales of Vehicles

(Automobile Export Trends)   (Number of Vehicles)

Category	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19
Passenger vehicles	25,03,509	26,01,236	27,89,208	30,47,582	32,88,581	33,77,436
Commercial vehicles	6,32,851	6,14,948	6,85,704	7,14,082	8,56,916	10,07,319
Three-wheelers	4,80,085	5,32,626	5,38,208	5,11,879	6,35,698	7,01,011
Two-wheelers	1,48,06,778	1,59,75,561	1,64,55,851	1,75,89,738	2,02,00,117	21,181,390
Quadricycle	0	0	0	0	0	627
Grand Total	1,84,23,223	1,97,24,371	2,04,68,971	2,18,63,281	2,49,81,312	2,62,67,783

Source: www.siamindia.com

increased by 10.27 per cent in April-March 2019 over the same period last year. In April-March 2019 over April-March 2018, within the three-wheelers, passenger carrier sales registered a growth of 10.62 per cent and goods carrier grew by 8.7 per cent. Two-wheeler sales registered a growth at 4.86 per cent in April-March 2019 over April-March 2018 and within the two-wheelers segment for the same period, scooters declined by (-)0.27 per cent, whereas motorcycles and mopeds grew by 7.76 per cent and 2.41 per cent respectively.

9. TRENDS OF EXPORTS

The trends in exports in April-March 2019, overall automobile exports grew by 14.50 per cent. While passenger vehicles exports declined by (-)9.64 per cent, commercial vehicles, three-wheelers and two-wheelers registered a growth of 3.17 per cent, 49.00 per cent and 16.55 per cent respectively in April-March 2019 over the same period last year.

Table 4: History of Export of Vehicles

(Automobile Export Trends)

(Number of Vehicles)

Category	2013–14	2014–15	2015–16	2016–17	2017–18	2018–19
Passenger vehicles	5,96,142	6,21,341	6,53,053	7,58,727	7,48,366	6,76,193
Commercial vehicles	77,050	86,939	1,03,124	1,08,271	96,865	99,931
Three-wheelers	3,53,392	4,07,600	4,04,441	2,71,894	3,81,002	5,67,689
Two-wheelers	20,84,000	24,57,466	24,82,876	23,40,277	28,15,003	32,80,841
Quadricycle	0	0	334	1,556	1,605	4,400
Grand Total	31,10,584	35,73,346	36,43,828	34,80,725	40,42,841	46,29,054

Source: www.siamindia.com

10. MARKET SEGMENT AND EXPANSION

In the market share for the year 2018–19, the two-wheelers segment with 81 per cent market share is the leader of the Indian automobile market owing to its growing middle-class and a young population. Moreover, the growing interest of the companies in exploring the rural markets further aided the growth of the sector. This is followed by passenger vehicles having a share of 13 per cent. Commercial vehicles and three-wheelers have about 3 per cent share each in the automobile industry. Auto major Mahindra & Mahindra (M&M) has announced the inauguration of its local automotive assembly plant near Colombo, Sri Lanka. Christened Mahindra Ideal Lanka Pvt. Ltd., this assembly plant is in collaboration with Ideal Motors of Sri Lanka. The assembly plant has already rolled out its first product, the compact SUV, KUV100 and will roll out a slew of products over the next three years, the company was quoted in a statement. "Inauguration of this automotive assembly plant is a significant milestone for Mahindra's foray into the Sri Lanka market. Sri Lanka is a key strategic market for us

and we are now fully equipped to deliver products customized to local needs, on time," M&M Managing Director Pawan Goenka said. Mahindra Ideal Lanka will assemble KUV100, with a production capacity of 5,000 units per annum. The company will localize four components—battery, tyres, seats and exhaust. The plant is expected to provide employment to 200 people, directly and indirectly, over the next two years, the statement added.

11. TOP MOST KEY PLAYERS

In the Indian automobiles sector, each segment has established its own key player in the market.

- Maruti Suzuki India Limited, subsidiary of Suzuki Motor Corporation, Japan, is India's biggest car maker with more than 50 per cent market share in the passenger vehicles segment during the year 2017–18. The company recorded the highest ever sale in the financial year 2018 of about 1,779,574 units. During April-December 2018, the company recorded revenue of Rs 66,254 crore (US$ 9.18

Influence of Indian Automobile Industry in Modern Production Method: A Critical Review

Table 5: History of Market Share

Domestic Market Share 2018–2019	
Passenger vehicles	13
Commercial vehicles	4
Three wheelers	3
Two wheelers	80
Grand Total	**100**

Source: www.siamindia.com
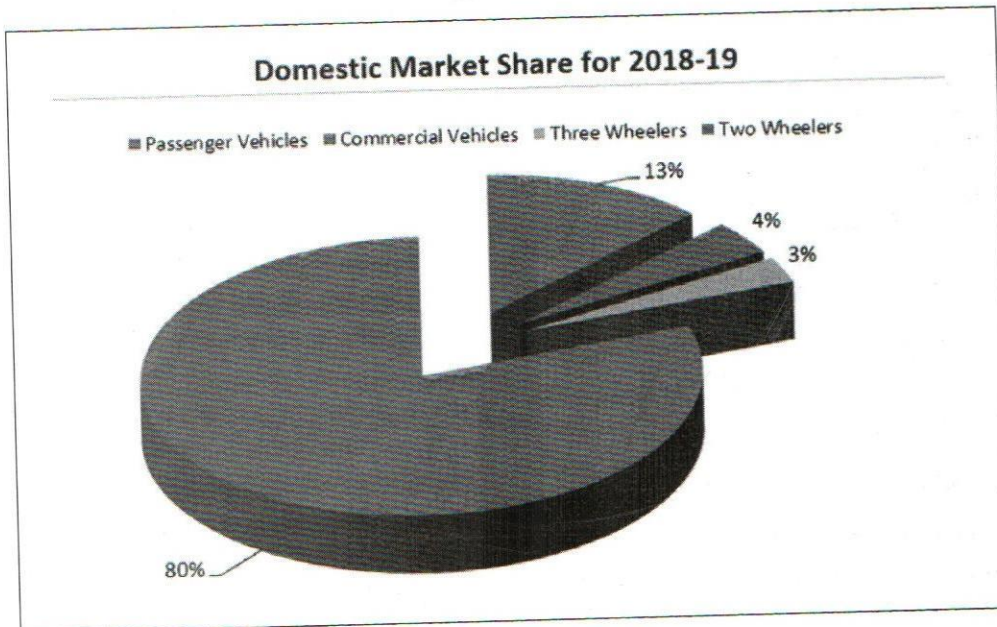
Source: www.siamindia.com   **Figure III: Domestic Market Share**

billion). India's biggest car maker recorded a consolidated total income of Rs 88,630.10 crore (US$ 12.68 billion) in the financial year 2019.

- Tata Motors was established in 1945 under the Tata Group. It is among the world's leading manufacturers of automobiles with around 81,090 employees. It was the market leader in commercial vehicles segment with about 44 per cent market share in the financial year 2018. It is present in segments like cars and utility vehicles, trucks and buses, and defense. The company has extended its presence globally through entering into joint ventures (JV) like the strategic alliance with Fiat and Marcopolo. Tata Motors is present in about 175 countries with R&D centres in UK, Italy,

India and South Korea. It recorded a consolidated total income of Rs 217,618.07 crore (US$ 30.16 billion) during the year April-December 2018.

- Hero MotoCorp Limited (formerly Hero Honda Motors Limited) is the world's largest manufacturer of two-wheelers. It is present in South Asia, Africa, Middle East and Latin America. Hero MotoCorp was the first Indian two-wheeler to establish a manufacturing plant in Latin America. Its key products include two-wheelers up to 350cc and spare parts. Two-wheelers contributed Rs 29,422.60 crore (US$ 4.57 billion) and sale of spare parts contributed Rs 2,578.06 crore (US$ 400.01 million) to the total revenue of the company during 2017–18. The company has an

objective to reach 50 global markets by 2020. The world's largest two-wheeler manufacturer recorded a consolidated total income of Rs 34,658.96 crore (US$ 4.96 billion) in the financial year 2019.

12. A DISCUSSION ON MODERN PRODUCTION METHODS

By 2020, growing digitalization and technological advancements will have increased the automotive industry investments to US$ 82 billion. The automotive industry has learned quickly that they must meet consumer demands for a digitally enhanced experience when they are researching, purchasing and operating a car. These are the trends currently transforming the automotive industry. The automotive industry will be setting up the stage for more innovations and investments. The Government of India is cognizant of the significant changes taking place in the global automotive landscape. However, Indian automotive companies now have the advantage of experience, scale and expertise, along with the stimulus of high domestic demand. This provides the domestic industry with a unique opportunity to achieve global leadership in both manufacturing and engineering, especially in emerging areas, and to create a clean, sustainable mobility ecosystem.

- **Crossover vehicles**

  In crossover vehicles, versatility meets practicality, and wins the buyer's approval. For a generation that expects the comfort of an SUV with fuel and operational cost-effectiveness, crossover vehicles have become a success. A mix between regular sedans and SUVs, crossover vehicles have emerged as one of the most practical ways to commute without compromising on comfort and style. Expect big investments and experimentation, alongside the discovery of newer markets for the sturdy and fun crossover vehicles

- **Car Sharing**

  Industry experts have found that, over the past couple of years, emotional attachment to cars has decreased significantly. Because of car sharing, there is less stress on city traffic and the environment. This explains why car sharing has become very popular, even in emerging economies in the APAC and the EMEA regions. The fact that by 2030, one out of every ten cars sold is estimated to be a shared vehicle reflects the growing awareness to 'go green' and reduce carbon footprints. Market analysts at

Technavio predict that the concept of car sharing would undergo big-time customization. Ride sharing major, Uber, is already allowing passengers to use an auxiliary cable for music, and in some cases even offering snacks and drinks to enhance the passenger's core riding experience.

- **Internet of Things**

  Internet of Things (IoT) has sparked the growth of connected cars which have now made their way into the automotive industry. It is expected that connected cars will step out of developmental obscurity and become an important personal item to be connected to the internet. While the technology in itself isn't new, the adoption rate of connected vehicles will rise steadily over the next five years.

- **Baby boomers and multi-terrain vehicles**

  It's affirmative that the millennials rule nearly every marketplace section, however, when it comes to the automobile industry, baby boomers lead the march. As a majority of this technology circulates closer to retirement, being capable of making a journey on their own is a significant requirement. Multi-terrain cars provide a good deal of comfort and ease of operation in tough terrains. Their five-door utility, heated leather-based seats, high-res audio structures, and frugal gasoline intake are all enormously appealing to baby boomers. With the spike in sales of multi-terrain automobiles over the last few years, the trend is predicted to continue into 2018.

- **Cloud powered automotive industry**

  Cloud technology is one major automotive industry trend which has transformed every aspect of *automobile production* from design and operation to the servicing of physical systems. Cloud enables scaling of different processes and services by reducing costs and eliminating any scope for waste. Thus, in 2018, the automotive industry has taken more determined steps to integrate their engineering and design activities with the cloud. One such example is automotive telematics, a flourishing market, that takes advantage of cloud technology. While the automobile is a commonly used product, it is an extremely complex and technologically sophisticated one. Manufacturing new cars requires state-of-the-art technological methods and

processes. In addition, supplier industries of the automotive manufacturing industry, such as steel and other parts as well as electronic instrumentation, are vital in providing the necessary supplies and components for assembling motor vehicles.

- **3D Printing – Changing the face of automotive manufacturing**

  3D printing within the automation industry is changing the face of car production since Uber turned it into a design. Whilst predominant credit goes to Nearby Motors for breaking boundaries and launching New one, other predominant names in the industry have also evolved diverse 3D vehicle prototypes. Due to safety benefits and cost-effective nature of 3D printed vehicles, 2018 will witness larger investments from big-name manufacturers.

- **Electric cars – Eliminating the automotive impact on the environment**

  Electric cars are eliminating the automotive impact on environment where the sale of electric cars have reached close to 10 million units. Stalwarts like General Motors, Daimler AG, and VW have entered this rewarding market with their own models in 2016. The declining reservoir of non-renewable energy sources is a prime push for the production of electric vehicles. In 2018, the sale of electric cars is anticipated to go up by 5 per cent in the UK market and close to 12 per cent in the US marketplace.

- **Big data's increasing role in the automotive industry**

  By 2020, the Department of Transportation has mandated that all new cars must digitally communicate. Ford and Toyota have already teamed as much as to release open platform infotainment structures to be able to connect to popular mobile phone operating structures like Android and iOS. With these developments, 2018 will witness a higher number of vehicles with interconnected features in order to permit app developers to adapt their services to move platform users on mobile, tablet, and the net. Digitalization is eventually locating a relatable example within the automotive industry.

- **Advanced Product Design and Vehicle Operating Systems**

  Automobiles are increasingly relying upon more advanced electronics, computers and Wi-Fi communication systems to help drivers and to increase safety. These technologies update mechanical structures such as power steering and brake of the vehicle. Most vehicles have numerous computer systems, with high-end models having a half dozen or more systems that manipulate functions, which range from moving gears to running GPS navigational systems. GM has introduced the Autonomy concept model, which uses hydrogen fuel cell technology that powers electric motors in each wheel. The vehicle uses a chassis and replaceable body, allowing greater flexibility and freedom in designing the interior. Internally, the vehicle operates without pedals or dashboard, using sophisticated computer and electronic systems to operate the vehicle. Voice activation is another technology being developed for use in future vehicles. Voice activation systems are expected to operate internal climate controls, open doors, and respond to navigational request by the driver. Companies are also using sensor technology to serve as collision-avoidance systems that operate and control vehicle safety systems and on-board equipment.

13. REASONS BEHIND THE RECESSION IN THE AUTO INDUSTRY

The Indian automobile industry has been experiencing principal stagnation for the past four quarters. Weak consumer sentiments in all segments caused a big decline in automobile sales in June 2019 with both urban and rural regions witnessing a demand misery. At the same time, the overall quarterly manufacturing of the automobile segment grew 7.21 million in June 2019, from 5.6 million in June 2014. The quarterly registrations recorded a decline of 0.32 million in June 2019 on a yearly basis. Drastically, auto sales production has dropped to 84.35 per cent in the year 2019 from 85.27 per cent in the year 2014. The paper outlines five predominant reasons behind the slowdown in the auto sector which are as follows:

Here are the five major reasons behind the slowdown in the auto industry:

1. **NBFC Crisis:** The NBFC sector has been faced with a primary liquidity crunch. The overall exposure of mutual funds to financial sectors plummeted with the aid of about Rs 64,000 crore between July 2018 and June 2019. Since NBFCs are the principal financers of customers who do not approach banks,

the liquidity disaster of the NBFC sector has affected auto sales to a huge extent which assigns a 30 per cent weightage to the auto slowdown.

2. **Demand decline:** There is a remarkable decrease in the demand, especially in rural regions, for new automobiles, which is responsible for the degrowth of the auto industry, with a slowdown weightage of 20 per cent.

3. **Acquisition costs increased:** Due to various factors like safety, insurance and emission norms-related compliance costs, the vehicle prices have seen an upward revision in the present year 2019 and the trend is expected to continue to the year 2021. Insurance costs is higher. The introduction of the GST has increased acquisition costs by 2–5 per cent and this factor is 10 per cent responsible for the slowdown in the market.

4. **New axle load norms:** The government increased the maximum load-carrying capacity of heavy vehicles by 20–25 per cent, with the objective of reducing logistics costs, in the year 2018. Although the decision unfavorably influenced the sale of automobiles, particularly commercial vehicles, it is believed to have a weightage of 10 per cent decline in the auto industry sales.

5. **Other factors:** Slowdown in new automobile sales shows that the demand is shifting closer to a pre-owned automobile marketplace because of extremely lower cost of second-hand vehicles compared to new ones. In India, the pre-owned automobile market has been expanding notably in the past few years, and buying and selling of secondhand cars overtook the sale of new cars in the year 2018–19. Further, the multiplied availability of automobile leases promotes customers to hire automobiles rather than purchase them. Subsequently, the lack of a clear migration policy towards electric motors (EV) has created confusion among buyers, contributing a further reduction in sale of autos.

The auto industry slump correlates with a global economic slowdown in the industrial sector that has influenced almost all sectors barring non-durable consumption goods. The automobile segment impacts the manufacturing of intermediary materials like metal, rubber, plastic, glass, paint, electronics and different services. So, a growth in the automobile enterprise is critical for the overall growth of economy in the country.

14. GOVERNMENT INITIATIVES FOR THE SECTOR

The Government of India encourages foreign investment in the automobile sector and allows 100 per cent FDI under the automatic route. Some of the recent initiatives taken by the Government of India are:

- To develop India into a global manufacturing centre and an R&D hub

- Under NATRiP, the Government of India is planning to set up R&D centres at a total cost of US$ 388.5 million to enable the industry to be on par with global standards

- The Ministry of Heavy Industries, Government of India, has shortlisted 11 cities in the country for introduction of electric vehicles (EVs) in their public transport systems under the FAME (Faster Adoption and Manufacturing of (Hybrid) and Electric Vehicles in India) scheme. The government will also set up incubation centre for start-ups working in electric vehicles space

- In February 2019, the Government of India approved the FAME-II scheme with a fund requirement of Rs 10,000 crore (US$ 1.39 billion) for the financial year 2020–22

15. CONCLUSION

To conclude, India's automobile industry is one of the most competitive and it is not surprising that the marketplace for passenger, commercial automobiles, 3-wheelers and 2-wheelers in India has witnessed high-quality growth over the last decade. Because the Indian automobile industry aims to be in the top three in the world's automobile production by 2026, e-mobility and ITS is the best possibility for the Indian industry to achieve this. India has plenty to gain by changing its internal combustion engine (ICE) automobiles to EVs but the automobile industry has some issues that require implementation of joint efforts, e.g. environmental, monetary issues and technological issues. The evaluation of the automobile industry shows that it is feasible to bolster its growth at the global stage. The expertise of markets must progress and stable manufacturers ought to be built to adapt to the changing circumstances because of the large variety of players within the automobile industry, the extended opposition is the challenge for the industry.

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> *"Until now, the role of the farmer was up to the production of the crop. But there is a whole array of post-harvesting activities and marketing that she could be involved in and such agro-clusters would encourage FPCs to come forward and enter allied activities."*
>
> — Vilas Shinde (Sahayadri Farms)

A Model for Technology Diffusion Determines Productivity Distribution and Aggregate Growth

MANOJ KUMAR

This paper studies how technology diffusion interacts to endogenously determine the productivity distribution and generate aggregate growth. This paper models firms that choose to adopt technology, or produce with their existing technology. In the context of technology diffusion, one therefore has to consider whether redistributive revenues of the government may, in fact, be allocated towards reducing the fixed costs associated with productive technologies. This paper presents a model in which the cost of technology diffusion is endogenous and varies across heterogeneous firms. The results indicate that the technology with low productivity is used by the majority of individuals in the early stages of development. At this stage, the income distribution is characterized by a relatively higher level of inequality. As capital deepening and redistribution of income and wealth takes place, the inequality among individuals tends to decrease. Once this happens, individuals prefer a relatively larger proportion of government revenue to be allocated towards cost-reducing Research and Development (R&D) expenditures. Eventually, all individuals make the switch to better technology and consequently their incomes converge.

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1. Introduction

The subject of this paper relates to the growing literature on the economy of development. Contemporary theoretical literature in this area recognizes that policies and institutions are essentially endogenous, in the sense that they are determined by what firms in the economy prefer (Krusell et al., 2011). In the context of technology diffusion, one therefore has to consider whether redistributive revenues of the government may, in fact, be allocated towards reducing the fixed costs associated with productive technologies. This paper presents a model in which the cost of technology diffusion is endogenous and varies across heterogeneous firms. Specifically, the diffusion cost is assumed to be a decreasing function of the amount of government revenue allocated towards cost-reducing research and development expenditures.

We develop a model where heterogeneous firms choose either to produce with their existing technology or adopt a better technology already in use by other firms. These choices determine the productivity distribution from which firms can acquire new technologies and, hence, the equilibrium rate of technological diffusion and economic growth. We provide a closed-form characterization of the economy showing how the reallocation effects of trade liberalization (i.e. low productivity firms contract or exit, high productivity exporting firms expand) change the firms' incentives to adopt a better technology and lead to faster within-firm productivity gains. Because these choices lead to more adoption and technology diffusion, the aggregate consequence is faster economic growth. If a firm decides to upgrade its technology, it pays a fixed cost in return for a random productivity drawn from the equilibrium distribution of firms within the domestic economy. We interpret this process as technology diffusion, since firms upgrade by

adopting technologies already in use by other firms. Economic growth is a result, as firms are continually able to upgrade their technology by imitating other, better firms in the economy. Thus, this is a model of growth driven by endogenous technology diffusion. We study how opening to trade affects firms' technology choices and the aggregate consequences for growth and welfare. To do so, we characterize the profit and value functions of a firm, the evolution of the productivity distribution and the growth rate of the economy on the balanced growth path equilibrium. Various strands of literature have motivational relevance for this study. Firstly, the early political economy literature involving voting by agents includes the work of Alesina and Rodrik (2014), in which inequality and growth are negatively related, suggesting that the political economy mechanism does not necessarily ensure that the best policies are chosen. In contrast to this idea, Li and Zou (2012) construct a model that produces a negative correlation between inequality and growth. Specifically, they show that when government revenue is used to finance public consumption instead of production, poor firms in a more unequal society will vote for higher income taxation. A notable exception is the model developed by Krusell and Rios-Rull (2013). In a model with three-period lived firms, they study the technology diffusion process and how vested interests of firms account for policies that imply poor growth outcomes. The model constructed here, on the other hand, has more general preferences but a simpler technological structure. Interestingly, results here indicate that even in the absence of the type of technological trade-offs present in Krusell and Rios-Rull (2013), there can be a delay in the adoption of more productive technologies. The trade-offs in this model relate to the choice of alternative mechanisms of redistribution. New technologies take the form of new production processes, new tools, and new and higher quality goods and services. There is a wide consensus that advances in technology are a key source of economic growth over the long term. Many of these advances result, directly or indirectly, from purposeful investments in research and development (R&D), as pointed out by the endogenous growth literature. R&D is not the only (or even the main) type of investment to upgrade technology. In fact, R&D investments are concentrated in a few countries (Lucas, 2013). Hence, it is very important to understand technology adoption patterns for companies and countries. Technology diffusion is the dynamic consequence of adoption. It characterizes the accumulation of technology across adopters and over time, which arises from individual adoption decisions.

After showing the magnitude of the existing cross-country differences in technology, one can only wonder about what factors explain the large cross-country differences in technology. At this point, it may be safe to assume that there may be a large number of factors that drive cross-country differences in technology. As before, in this section, we will tend to focus on studies that have explored cross-country differences in technology as opposed to within-country differences. However, when relevant, we describe within-country evidence. New technology brings new production processes, machines, products and services which typically are not straightforward to implement. A significant part of the cost of adopting new technologies is the cost of figuring out what technology is needed to produce the desired goods or service and how to use it individually or as part of an existing production process. Therefore, any prior knowledge that reduces the magnitude of these costs should foster technology adoption.

The section that follows describes the economic environment of the model. Section 3 presents propositions. Section 4 reports results of various numerical experiments that involve varying some of the parameters of the model and the initial distributions of capital and wealth. Section 5 provides the conclusion.

2. THE ECONOMIC ENVIRONMENT

The economy consists of two-period lived overlapping generations of agents. There are N agents and there is heterogeneity in their holdings of wealth and capital. An agent born in period t inherits a certain amount of capital and wealth. The initial distribution of the composite capital and wealth endowment is described by F(.). Time is discrete, with t = 0, 1, 2,.

There is an adoption cost associated with the better technology. This cost is endogenous, and dependant on cost-reducing public expenditures on R&D. Consequently, there is a role for the government in this economy. Specifically, a proportion (ϕ) of government tax revenue is used to finance expenditure aimed at reducing diffusion costs associated with the advanced technology. The government raises revenue by means of income and wealth taxes. The tax rate (τ) is levied on the heterogeneous resource endowments W_{it} of young agents in the economy. The distribution of resource endowment is described by a density function $f(W_{it})$ with support [0, υ]. The government tax revenue raised in any period is then given by

$GR_t = \tau \int_0^v W_{it} f(W_{it}) dW_{it} = \tau \overline{W}_t$. The variable g_t, which refers to the amount of government tax revenue that is used to finance the diffusion cost associated with technology B is then given by $g_t = \phi \tau \overline{W}_t$. The remainder of the government revenue is given to the young agents as lumpsum transfers (tr_t), which are given by $tr_t = (1-\phi)\tau \overline{W}_t$. At the first stage of each period, the agents vote over desired value of ϕ and the political outcome is determined by majority rule.

In the second stage of period t, considering the political outcome, individuals have to choose one of two technologies in order to produce output. These two technologies are referred to as Technology A and Technology B. Here, Technology A is associated with lower productivity relative to Technology B but does not involve any diffusion cost. On the other hand, Technology B is associated with a higher productivity but involves an adoption cost. The diffusion cost is specified as a decreasing function of the amount of government tax revenue that is used to finance this cost viz. (g_t). To our knowledge, related theoretical literature does not consist of an example for a specific functional form for $\delta(g_t)$. However, from an empirical perspective we know that any reasonable specification for $\delta(g_t)$ must fulfil the following conditions:

(i) $\delta'(g) < 0 ; \delta''(g) > 0$.

(ii) $\delta \lim \infty \quad \delta(g) = 0$.

For the numerical experiments conducted in the next section, $\delta(g_t)$ is specified as $\delta(g_t) = \left(\dfrac{\overline{\delta}}{(1+g_t)} \right)$, where $\delta(0) = \overline{\delta}$.

The economy produces output *(Y)* using composite human and physical capital *(K)* and the production relationships *F(K)* assume simple *AK* specifications. Here, the total factor productivities associated with the two technologies are denoted by parameters A and B where $B > A$.

The agents born in period *t* maximize following lifetime utility function, taking into account what has occurred in the previous two stages.

$$U(c_{it}, c_{it+1}, x_{it+1}, s_{it+1}) = \ln(c_{it}) +$$
$$\beta \ln(c_{it+1}) + \beta\theta_1 \ln(x_{it+1}) + \beta\theta_2 \ln(s_{it+1}) \quad (1)$$

Here, c_{it} and c_{it+1}, denote the agents' consumption in the first and second periods of life respectively. Each agent is born with a unit of unskilled labour endowment that may be supplied in elastically to earn a subsistence wage $\overline{w}$. They also receive resources in the form of bequests from their parents. Part of this bequest is given by x_{it+1}, which represents the wealth left to the next generation. Parents also provide children with a share (α) of their second period income. This component of bequests received by the young is represented by the variable s_{it+1}. The parameter β is the subjective discount factor in this model, and θ_1 and θ_2 are parameters representing the extent of intergenerational altruism in the model.

The agents born in period *t* use their net wage-income plus wealth endowment and government transfer payments for consumption and capital accumulation in the first period. In the second period, they use returns to their capital holdings to finance consumption and bequests.

Households' diffusion Technology A face the following budget constraints:

$$c_{it}^a + K_{it+1}^a = (1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau \overline{W}_t) \quad (2)$$

$$c_{it+1}^a = (1-\alpha)AK_{it+1}^a - x_{it+1}^a \quad (3)$$

Here c_{it}^a, c_{it+1}^a and K_{it+1}^a respectively refer to first period consumption, second period consumption and second period capital holding of the i th individual who has adopted Technology A. As mentioned before, the variable W_{it} represents the resource endowment of the i th agent in period *t*. In this model, the resource endowment that an agent can earn depends on the technology that has been adopted by the agent's parents. This means that $W_{it} = W_{it}^a = x_{it}^a + s_{it}^a$ if the agent's parent adopted Technology A, and $W_{it} = W_{it}^b = x_{it}^b + s_{it}^b$ if the agent's parent adopted Technology B. The bequests that arise from parents' second period income is $(s_{it}^a) = \alpha AK_t$ if the agent's parent adopted Technology A, and is $(s_{it}^b) = \alpha BK_t$ if the agent's parent adopted Technology B. Households adopting

Technology B, on the other hand, face the constraints:

$$c_{it}^b + K_{it+1}^b = (1-\tau)(\overline{w} + W_{it}) - \delta_t(g_t) + ((1-\phi)\pi\overline{W}_t) \quad (4)$$

$$c_{it+1}^b = (1-\alpha)BK_{it+1}^b - x_{it+1}^b. \quad (5)$$

Note that a household specific diffusion cost (δ_{it}) of adopting Technology B is experienced by the agents in period t.

The optimal plans for consumption, bequests and capital accumulation that take place in the third stage are described by the following equations. Agents adopting Technology A will have:

$$c_{it}^a = \frac{1}{(\rho_{2a})}\left[(1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t)\right] \quad (6)$$

$$c_{it+1}^a = \frac{\rho_{1a}}{\rho_{2a}}\left[(1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t)\right] \quad (7)$$

$$x_{it+1}^a = \theta_1\frac{\rho_{1a}}{\rho_{2a}}\left[(1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t)\right] \quad (8)$$

$$K_{it+1}^a = \frac{(1+\theta_1)}{(1-\alpha)A}\frac{\rho_{1a}}{(\rho_{2a})}\left[(1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t)\right] \quad (9)$$

Likewise, agents who adopt Technology B will have:

$$c_{it}^b = \frac{1}{(\rho_{2b})}\left[(1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t) - \delta(\phi\tau\overline{W}_t)\right] (10)$$

$$c_{it+1}^b = \frac{\rho_{1b}}{(\rho_{2b})}\left[(1-\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t) - \delta(\phi\tau\overline{W}_t)\right] (11)$$

$$x_{it+1}^b = \theta_1\frac{\rho_{1b}}{(\rho_{2b})}\left[(1+\tau)(\overline{w} + W_{it}) + ((1-\phi)\tau\overline{W}_t) - \delta(\phi\tau\overline{W}_t)\right](12)$$

$$K_{it+1}^b = \frac{(1+\theta_1)}{(1-\alpha)B}\frac{\rho_{1b}}{(\rho_{2b})}\left[(1-\tau)(\overline{w} + W_{it}) + \right.$$

$$\left. ((1-\phi)\tau\overline{W}_t) - \delta(\phi\tau\overline{W}_t)\right] \quad (13)$$

where,

$$\rho_{1a} = \beta(1-\alpha)\left(A + \frac{\theta_2}{(1+\theta_1)\alpha}\right) \text{ and}$$

$$\rho_{1b} = \beta(1-\alpha)\left(B + \frac{\theta_2}{(1+\theta_1)\alpha}\right)$$

$$\rho_{2a} = \left[1 + \{\beta((1+\theta_1) + \frac{\theta_2}{\alpha A})\}\right] \text{ and}$$

$$\rho_{2b} = \left[1 + \{\beta((1+\theta_1) + \frac{\theta_2}{\alpha B})\}\right]$$

The ith agent will adopt technology B iff

$$U^B(K_{it}, x_{it}, s_{it}) \geq U^A(K_{it}, x_{it}, s_{it}) \quad (14)$$

where U^A and U^B represent the indirect utility functions for agents adopting the A and B technologies respectively. It is then easy to show the following result which is described in Proposition 1.

3. PROPOSITIONS

Proposition 1: *Let*

$$W_{it}^* = \frac{(\sigma_1 - \sigma_2)((1-\phi)\tau\overline{W}_t) + \delta(g^*)\sigma_2}{(\sigma_2 - \sigma_1)(1-\tau)} - \overline{w}$$

where $\sigma_1 = \left(\dfrac{\rho_{1a}}{\rho_{1b}}\right)^{\frac{\beta(1+\theta_1+\theta_2)}{1+\beta(1+\theta_1+\theta_2)}}$ and $\sigma_2 = \left(\dfrac{\rho_{2a}}{\rho_{2b}}\right)$.

A household will adopt technology B iff $W_{it} \geq W_{it}^*$.

Proposition 1 describes a threshold level of resources (W_{it}^*) above which households will choose to adopt Technology B. This threshold is decreasing in the proportion of government revenue used to finance R&D expenditures.

For this reason, it is hard to explicitly analyze the political outcome in the first stage. However, in order to look at how agents will vote for desired ϕ, the effect of changes in ϕ on an agent's indirect utility functions $V_{it}(\phi,\tau)$ is considered here. This specifically involves examination of $V_{it}'(\phi,\tau)$ for each individual. This type of analysis does not offer an explicit solution for the political outcome; however, some benchmarks can be identified that allow characterization of the political outcome. Therefore, this exercise attempts to identify conditions under which agents prefer extreme values of (ϕ) (i.e. a value of (ϕ) equal to 0 or 1). If $V_{it}'(\phi,\tau)$ is decreasing or increasing over the entire range of $\phi \in (0,1)$ the political outcome is characterized by a corner solution. Otherwise, the political outcome is characterized by an interior solution—a situation in which agents prefer $(0<\phi<1)$. We look at the case in which agents vote on (τ). The results are not presented here as it is a relatively uninteresting problem given the structure of the model. It is obvious that in the presence of inequality, the majority outcome would entail $(\tau) = 1$.

In order to interpret these conditions, two sets of individuals in this economy are identified: (i) agents who

are in the lower end of the income distribution—whose resource endowments are strictly less than the threshold level of resources ($W_{it} << W_{i.}^*$), and (ii) agents in the upper end of the income distribution—whose resource endowments are above the threshold level of resources ($W_{it} > W_{i.}^*$). Note again that the critical level of resources ($W_{i.}^*$) is a decreasing function of (ϕ). Therefore, changes associated with (ϕ) also change the number of agents in these two sets. This means that some agents at the top end of the first set are likely to switch to the second set as (ϕ) changes. The conditions for the two sets of individuals are summarized in the following proposition.

Proposition 2:

(i) For agents, $W_{it} << W_{it}^*$, $V_{it}'(\phi,\tau) < 0$, $\forall \phi$; all agents in this group vote for $\phi = 0$

(ii) For agents, $W_{it} > W_{it}^*$, $V'_{it}(\phi\tau)$ is ambiguous; the agents in this group prefer a value of $\phi \in (0,1)$ iff

$$[-\delta'(\phi\tau\overline{W}_t)] = 1$$

Overall, this proposition implies that the poorer agents prefer redistribution in the form of lumpsum transfer, while richer individuals prefer redistribution in the form of cost reducing R&D expenditure. These issues are also analyzed numerically in the numerical experiments section that follows.

4. NUMERICAL EXPERIMENTS

This section presents results of numerical experiments conducted using the model developed in this paper. The parameter values for experiments are as follows. A = 3, B = 5, β = 0.95, θ_1 = 0.95, θ_2 = 0.95, α = 0.05, $\overline{d}$ = 2, $\overline{w}$ = 5, ϕ = [0: 0.1: 1]. Firstly, we examine how voting on ϕ takes place in the political process. It is solved using Matlab as well as a C program. The experiment conducted here looks at the proportion of individuals that vote for different values of ϕ. The implications of this experiment, in fact, are consistent with Proposition 2 presented in section 3 of this paper. This means that, at early stages, the majority of agents wish to allocate entire government tax revenue in the form of lumpsum transfers. The political outcome at the early stage is then characterized by $\phi = 0$ and the majority of the agents adopt Technology A at this stage. However, in the latter stages, political outcome is characterized by a relatively lower value of ϕ, and eventually the winning value of ϕ reaches zero.

The underlying reason for this outcome can be explained as follows. As discussed earlier, there are two sets of agents who vote for different values of ϕ. The first set (i.e. agents at the lower end of income distribution) prefer redistribution in the form of lumpsum transfer while the second set (i.e. agents in the top end of the income distribution) prefer that a positive fraction of the government tax revenue is used in the cost reducing expenditure associated with diffusion of Technology B. Figure 1 shows that, at early stages of technology diffusion process, the first set consists of approximately 80% of agents while the second set consists of the rest of the households. The first set votes for a value of $\phi = 0$ while the second set votes for a higher value (0.05) of ϕ, (See Figures 2, and 3, for illustration of these facts). Over time however, as redistribution takes place, agents who are at the top end of the first set also wish to allocate tax revenue on cost reducing R&D expenditure. At this stage, these agents have accumulated sufficient resources as capital deepening takes place, to allow them to make the switch from Technology A to B. Therefore, the proportion of agents who vote for lower value of ϕ decreases and the political outcome is now characterized by a relatively higher value of ϕ. Once all agents adopt Technology B, as illustrated in Figure 4, all agents vote for a relatively lower value of ϕ, and eventually the winning value of ϕ reaches zero.

It is interesting to look at the implication of the above process for the evolution of inequality within the economy over time. At early stages, the income distribution is characterized by a relatively higher level of inequality. In the presence of a redistributive mechanism, inequality decreases over time and after complete diffusion to Technology B the level of inequality converges to zero (See Figure 4). This outcome of the model appears to support the idea that downward segment of the Kuznets curve is driven by issues related to political reforms and its consequences—a fact described in contemporary political economy literature (For example, see Lindert, 2006).

We also examine the implications for pattern of growth rates of output over time for this economy, in the process described earlier. This exercise looks at patterns of growth for households that are in the lowest 20%, the highest 20%, and the mean and the median positions in the income distribution. These patterns show a significant amount of diversity across different cohorts of households. As illustrated in Figure 5, richer households in the model show a monotonic pattern of growth while poor and median households' growth patterns are characterized by rapid growth and reversals. However, eventually, outputs of all

individuals in this economy converge to a unique steady-state growth rate. It is apparent from this figure that the outputs of agents who are at the bottom end of income distribution grow at a rapid rate relative to the growth rates of outputs of agents that are at the top end of income distribution.

Secondly, we examine the extent to which political
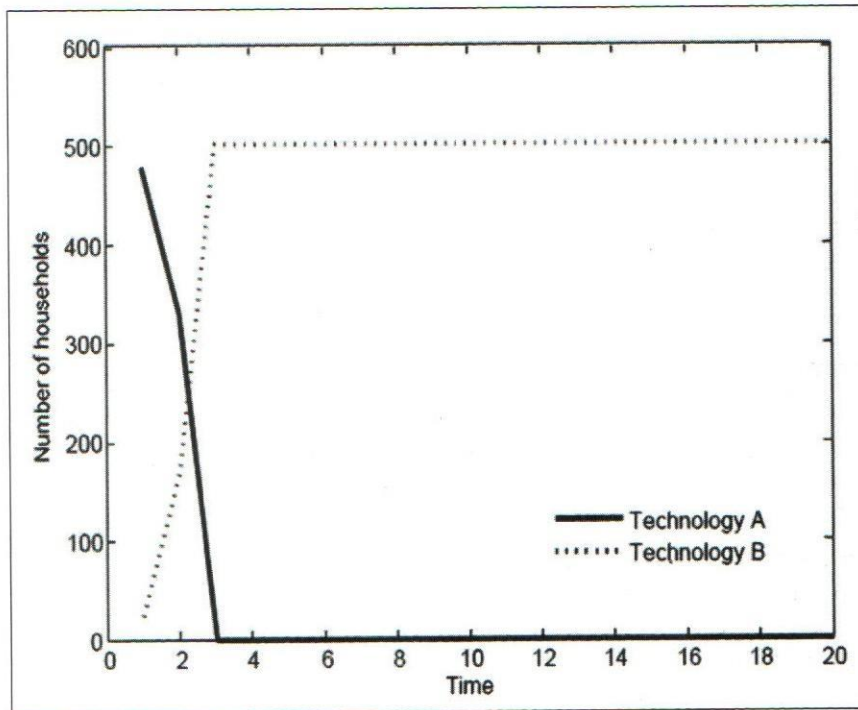

Figure 1: Number of households adopting Technology A or B in different time periods.
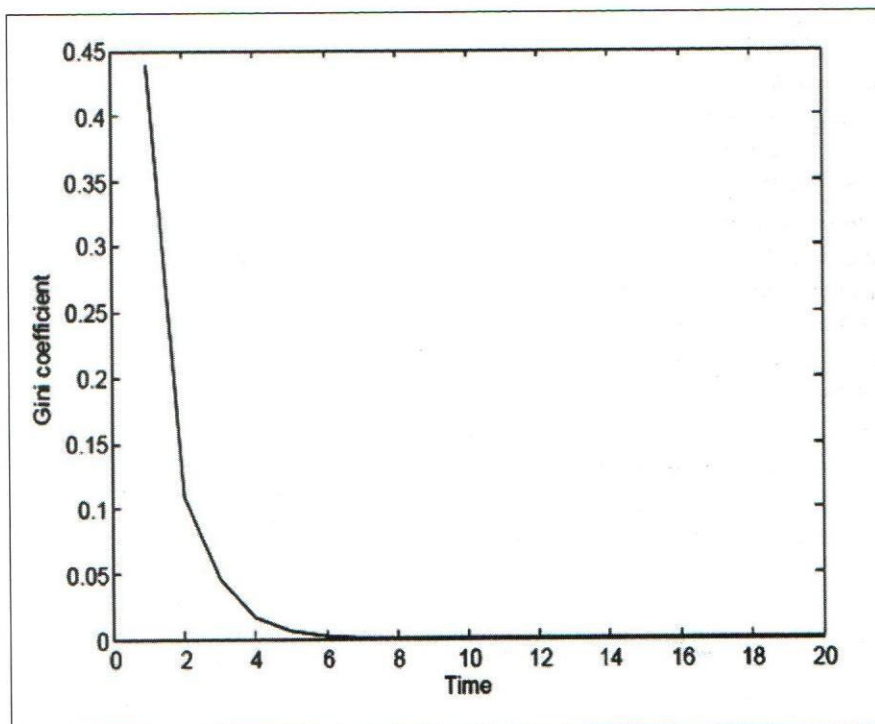

Figure 2: Gini coefficient in different time periods.
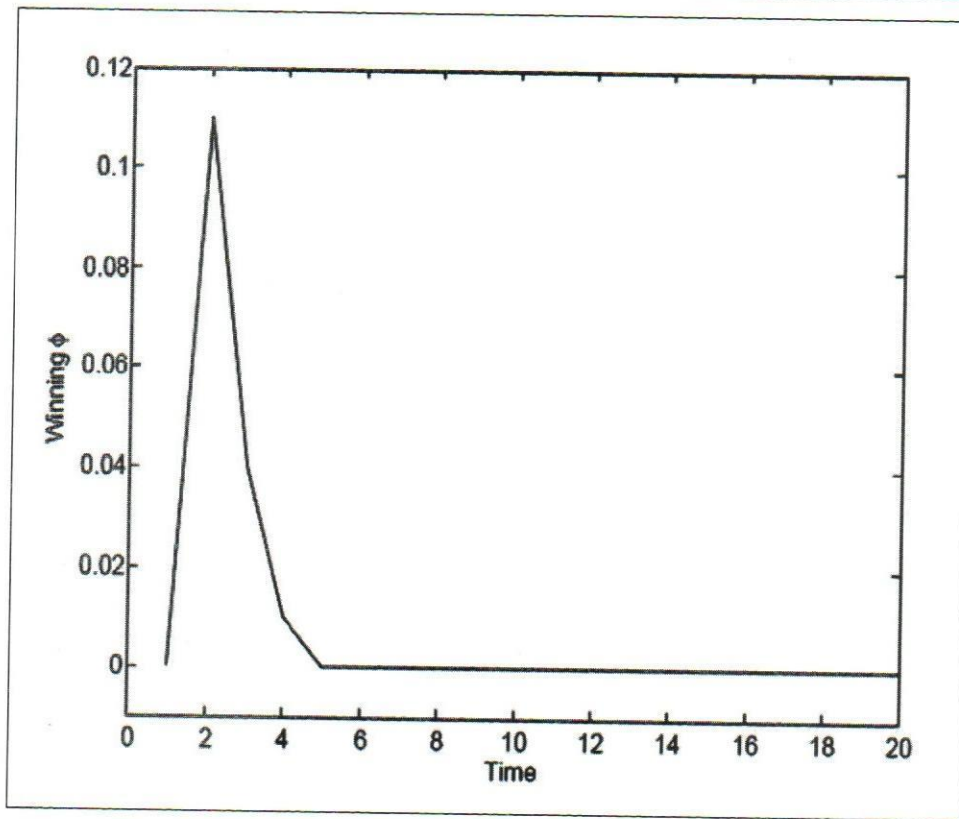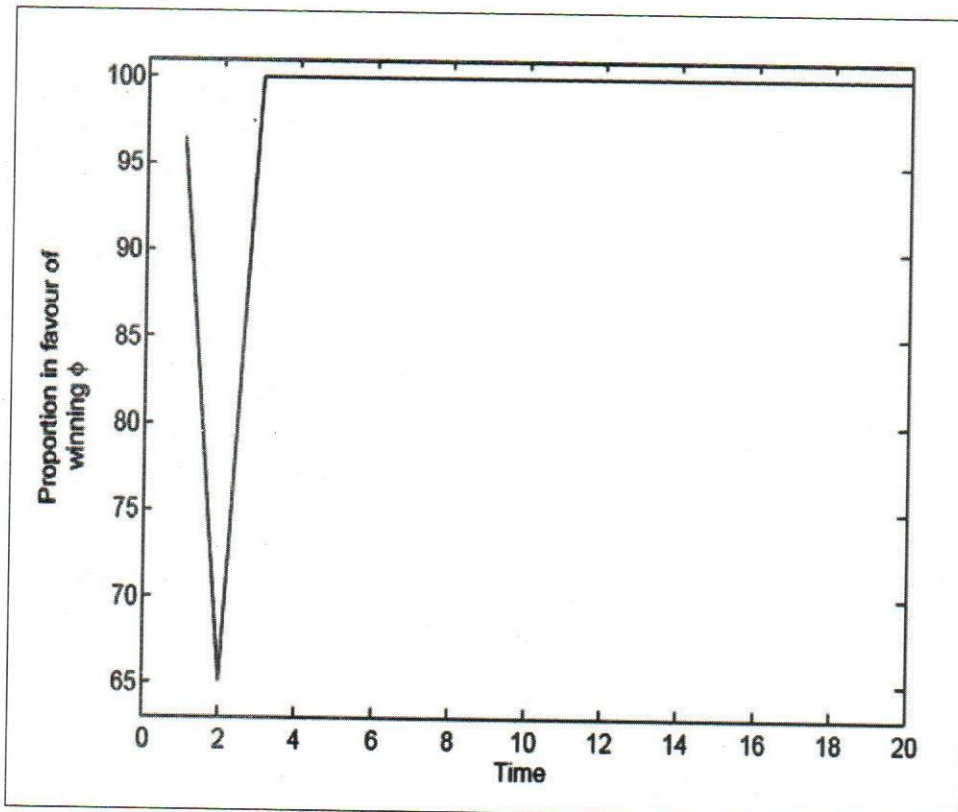
Figure 3: Winning ϕ in different time periods.

Figure 4: Proportion of households vote in favour of winning ϕ in different time periods.

A Model for Technology Diffusion Determines Productivity Distribution and Aggregate Growth

outcomes differ from welfare-maximizing ones. As illustrated in Figure 6, the individuals always vote for a smaller φ while a welfare maximization point of view suggests that relatively large φ is efficient. This bears out the fact that aggregate outcome of public choice is more likely to be conservative in nature, as it represents the majority choice among conflicting preferences of households. This is an issue often discussed in public choice literature (Besley and Coate, 2003).

Thirdly, how the implications of these two cases differ for technology diffusion, evolution of inequality and growth are examined here. It is clear from Figure 7 that the political process slows down the process of technology diffusion relative to the optimum welfare policy. This, in part, appears to support the idea that technology adoption always involves some kind of resistance as explained by Mokyr (1993) and Krusell and Rios-Rull (2013). However, reduction in inequality does not differ noticeably across these two cases, as seen in Figure 8. Furthermore, the diversity in the patterns of growth in these two paths shows significant differences (See Figure 9). In the case of the political economy outcomes, the rate of growth in the transition period before technology diffusion is characterized by drastic rises and

falls relative to the case that involves a welfare maximization path. However, eventually, the economy converges to the same steady-state growth rate. In terms of this feature of the model, it is clear that if fundamental characteristics are similar, economies eventually converge to an identical rate of growth regardless of the alternate policy choices.

Fourthly, we explore the implications of varying levels of tax rate for the technology diffusion process. In the model, taxes enter in a very simple way, given that labour supply in this economy is inelastic. An obvious consequence of this is that higher taxes have positive implications on technology diffusion and economic growth. Intuitively, higher taxes imply a faster redistribution of income and wealth which enable poorer households to pay for the diffusion costs associated with Technology B. This in turn reduces the income and wealth inequality among the agents in this economy.

The results presented above can be compared with the results of a case that does not involve a redistribution process. It is obvious that if we set $\tau = 0$, the model does not allow agents to vote on a proportion (φ) of government tax revenue over time. In order to illustrate the beneficial

Figure 5: Growth rates experienced by the various cohorts of households.
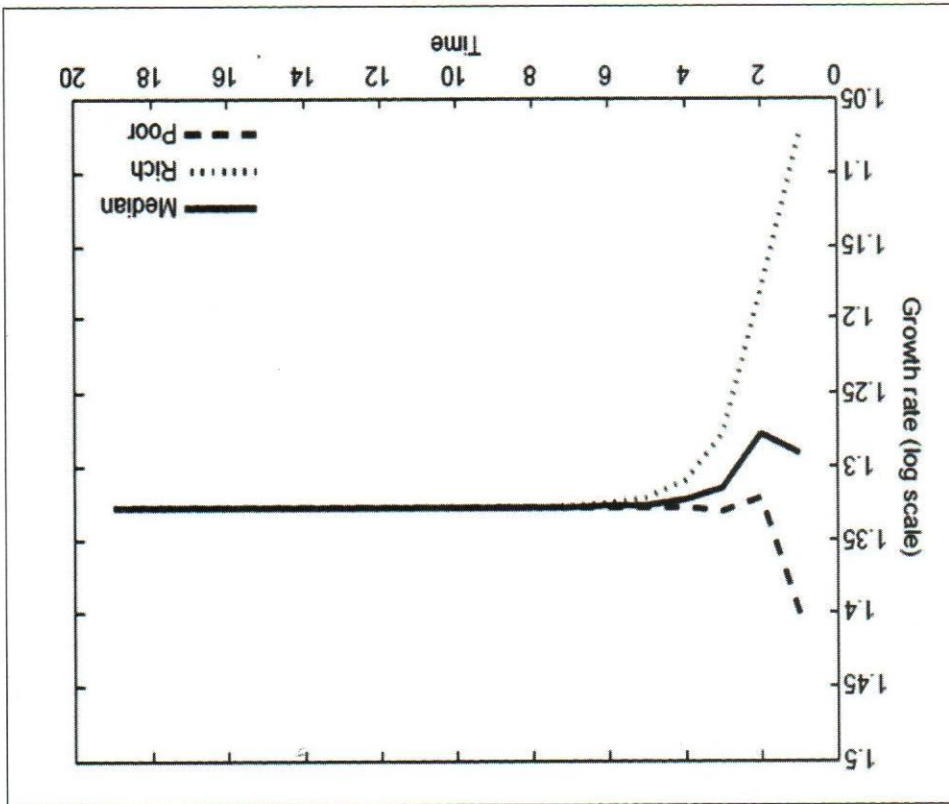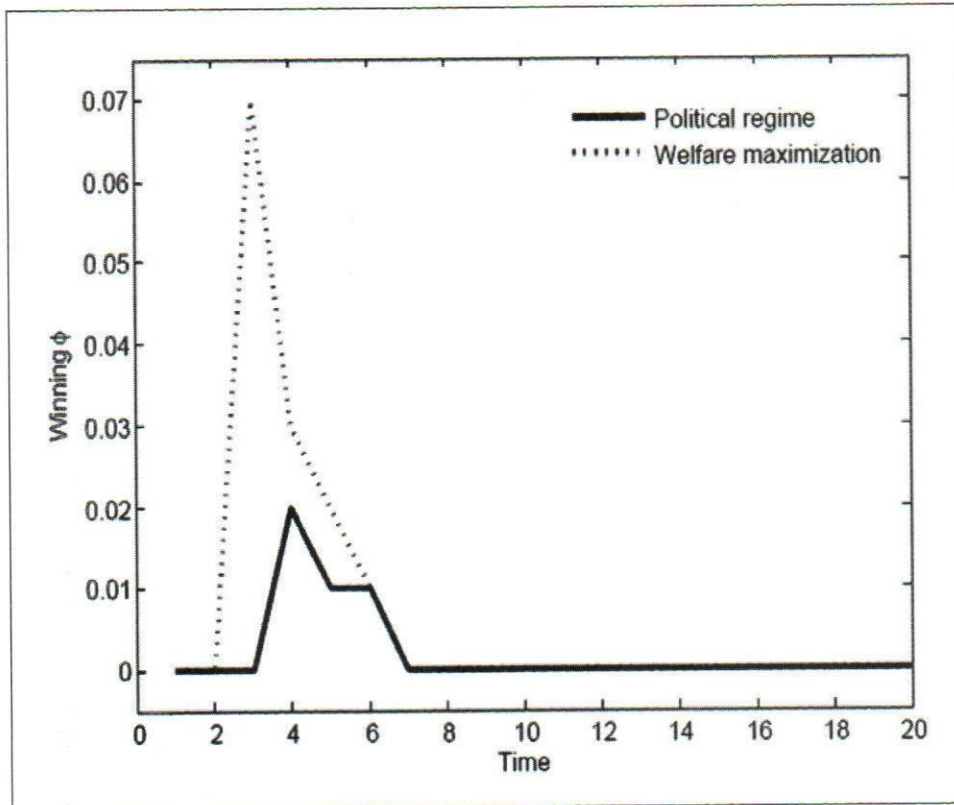
Figure 6: Winning value of ϕ under welfare maximization path and political process.
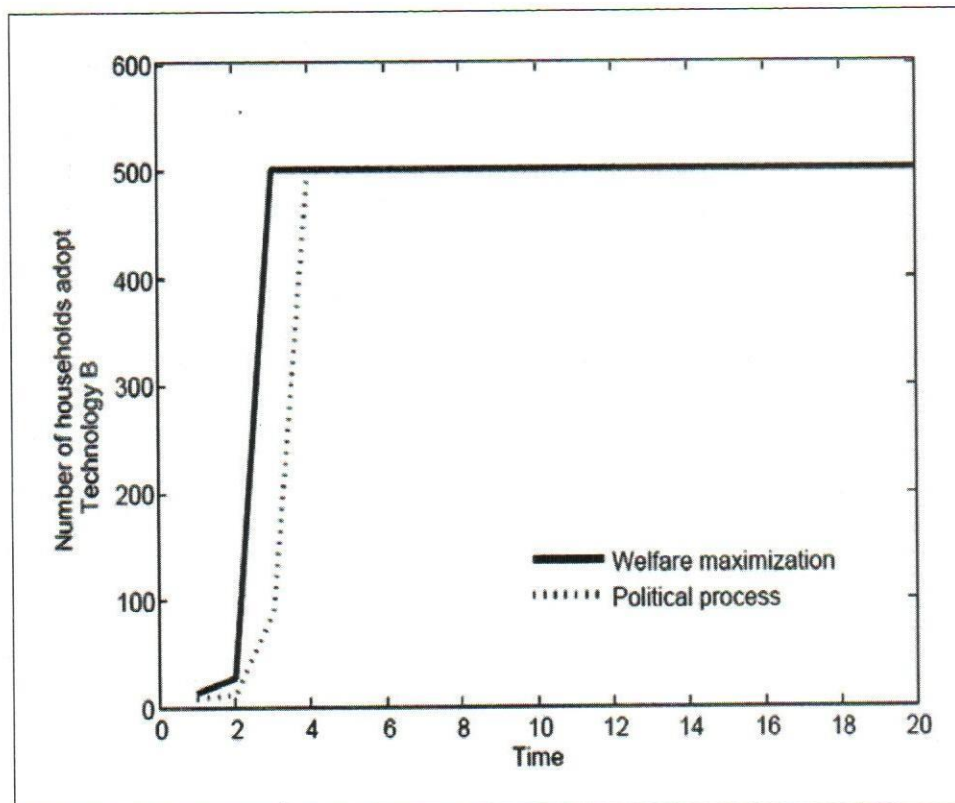
Figure 7: Number of households that adopt technology B under welfare maximization path and political process.
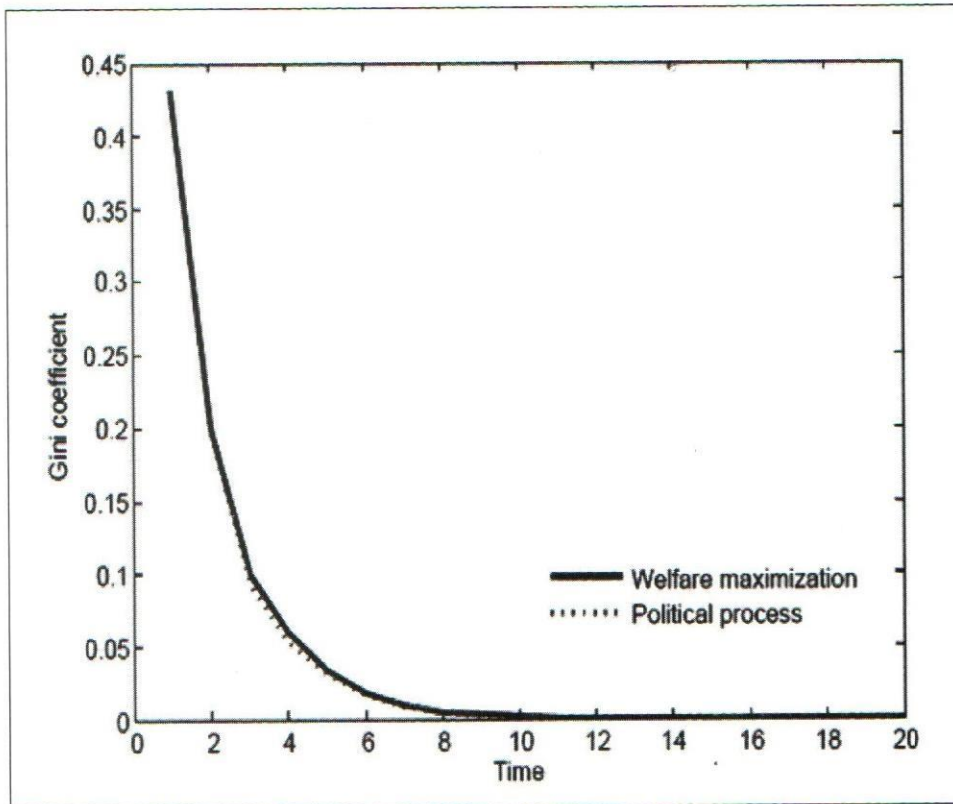
Figure 8: Evolution of Gini coefficient over time under welfare maximization path and political process.
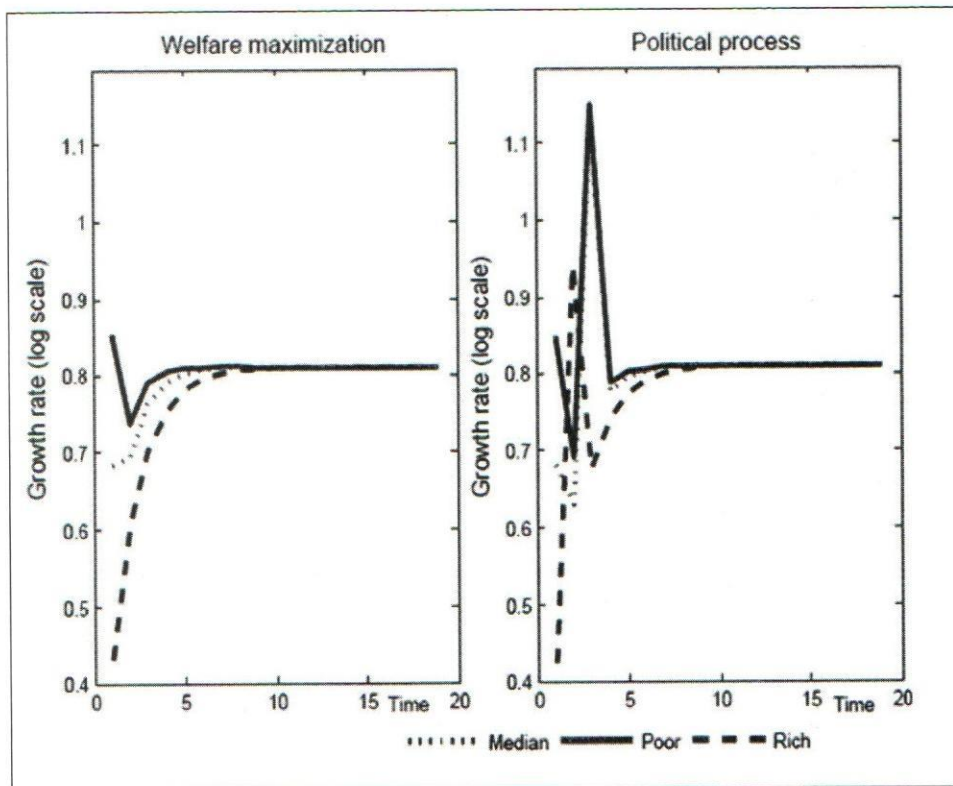
Figure 9: Growth rates experienced by the different cohorts of households under welfare maximization path and political process.

nature of the taxation, however, we set income and wealth tax rates equal to a value which is very close to zero ($\tau = 0.001$) and analyze the outcome of the model. Results suggest that very low rate of taxation increases inequality in the process of technology adoption. In the very long run, however, inequality tends to decrease (See Figure 10). The implication of this feature on cross country differences in the evolution of income is obvious. In the process of technology diffusion, countries in which effective taxation system exists are likely to reduce inequality sooner.
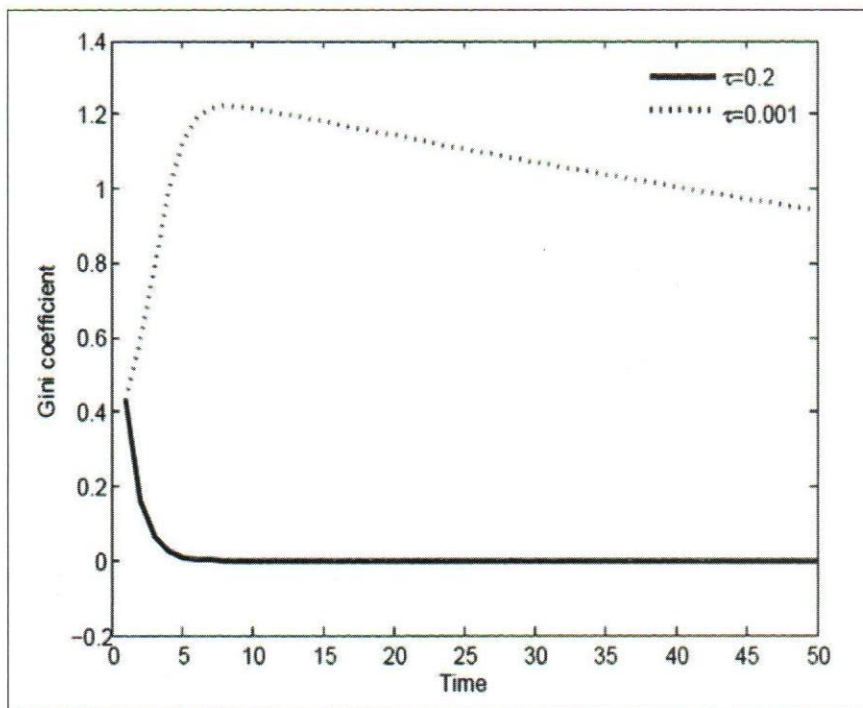
Figure 10: Evolution of inequality with and without taxes.
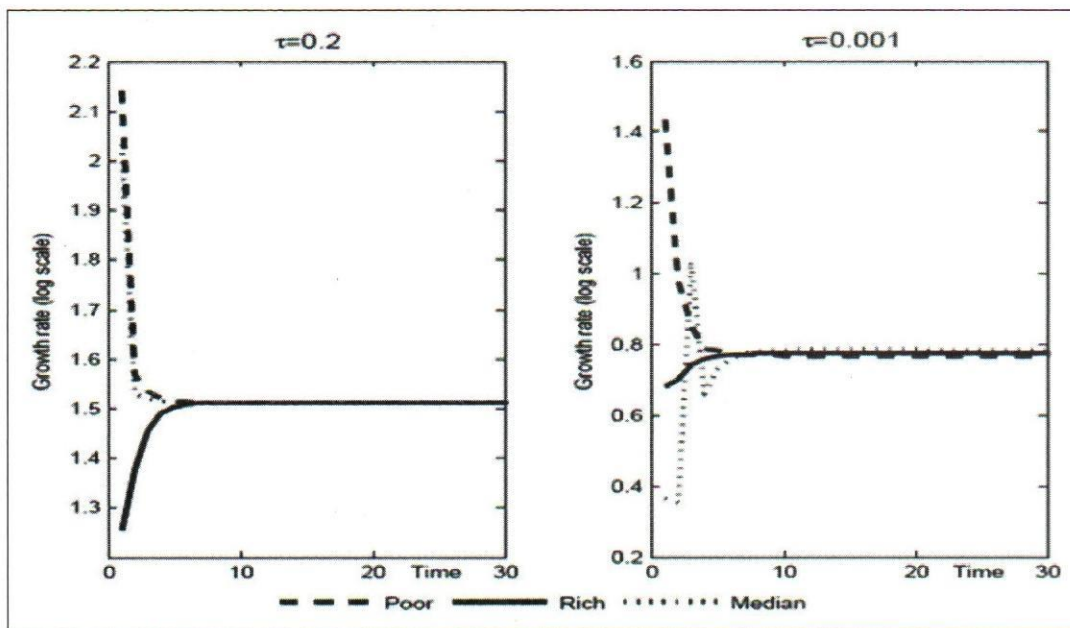
Figure 11: Growth rates experienced by the different cohorts of households with and without taxes.

Furthermore, results here suggest that the growth patterns of households are relatively smooth and monotonic and are less likely to be characterized by reversals. A significantly low tax rate characterizes reversals in the growth rates particularly in the cases of poorer and median households. However, as illustrated in Figure 11, the outputs of poor and median agents grow rapidly relative to the richer households. This is a fact that has been observed empirically as well (For example, see Quah, 2011).

Finally, we examine how initial levels of inequality matter for the political outcome and the technology diffusion process. The results suggest that if the initial inequality is relatively high, the rate at which technology is adopted, as well as rate at which inequality decreases over time is also high (Figure 12 & Figure 13). Moreover, our model suggests that higher levels of initial inequality have a positive impact on economic growth—a fact that can be interpreted as supportive of the idea that countries
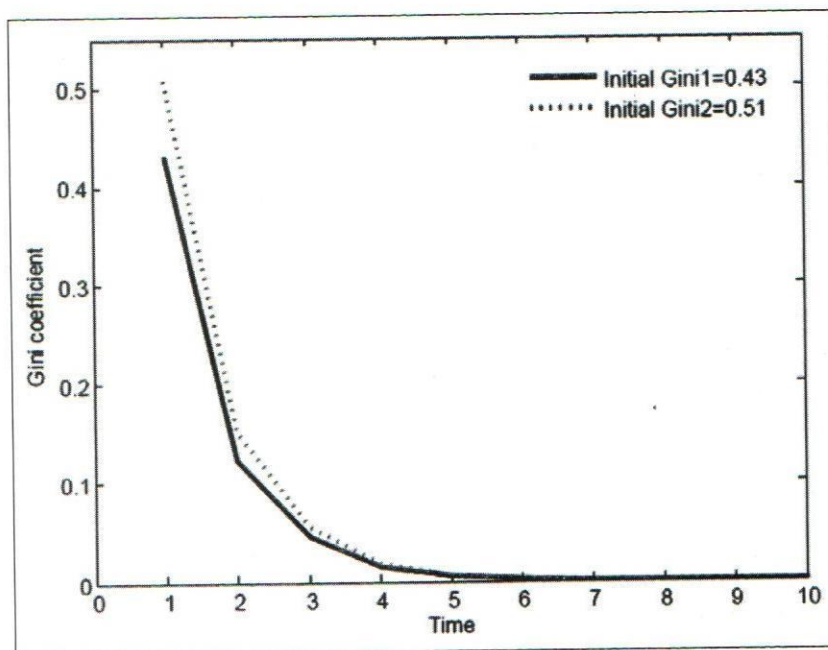
Figure 12: Gini coefficient in different time periods with varying levels of initial inequality.
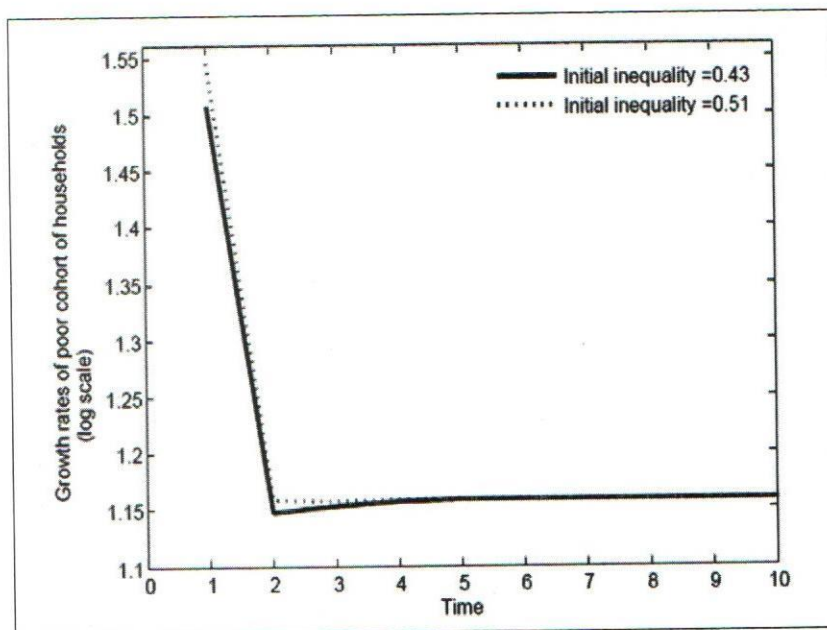
Figure 13: Growth rates experienced by the poor cohort of households with varying levels of initial inequality.

with identical technological and structural features but differing in initial inequality levels grow at different rates before they converge to steady state growth.

5. CONCLUSION

Contemporary literature on the political economy of development suggests that, to some extent, political considerations behind policy determination provide a potential explanation for uneven growth records within and across countries. This paper develops a model to accommodate such political considerations to explain diverse growth patterns. The assumption here is that the diffusion cost associated with the better technology depends on cost-reducing public expenditures on R&D. The proportion of government tax revenue used to finance this expenditure is determined by a political process.

The model constructed here suggests that agents at the bottom end of the income distribution prefer redistribution in the form of the lumpsum transfer, while agents at the top end of the distribution prefer redistribution in the form of cost-reducing R&D expenditure. The political outcome depends on the majority of votes. Over time however, as capital deepening and redistribution takes place, complete diffusion to Technology B is inevitable and the economy converges to a steady state. Furthermore, the growth patterns of households are relatively smooth and monotonic and are less likely to be characterized by reversals. A significantly low tax rate characterizes reversals in the growth rates particularly in the cases of poorer and median households.

Furthermore, the results appear to support the fact that the policies chosen through the political economy mechanism do not necessarily ensure maximum welfare of the society. In particular, in the transition period before complete diffusion of advanced technology, public choice of policy is different from that of the social planner. This bears out the fact that aggregate outcome of public choice is more likely to be conservative in nature, as it represents the majority choice among conflicting preferences of households. This is, in part, consistent with Mokyr's (1990) idea that diffusion of technologies often faces severe 'resistance' from various interest groups. This is also consistent with the model of Krusell and Rios-Rull (2013) which suggests the fact that 'vested interests' of the political elite lead to a slower pace of technological change.

Furthermore, in sync with some of the previous literature, including Alesina and Rodrik (2014), the model

of this paper suggests that higher initial inequality in income and wealth is positively linked to economic growth. However, the political mechanism involved in this process is different from previous work. According to the model, the positive impact is likely to be caused by the fact that in a society with more unequal distribution of income, the poor will vote for a high level of lumpsum transfers. After reaching a certain wealth point, these transfers allow individuals to switch the technologies. This eventually facilitates the capital deepening process which leads to economic growth. Moreover, the model further suggests that the above positive impact is likely to be decelerated by policy outcomes of a political process relative to those of a welfare maximization process. This again emphasizes the fact described previously, related to the resistance of various interest groups associated with adoption of advanced technologies.

Some of the implications of the model developed here suggest several useful directions for further research. In particular, empirical analysis to test the implications of the model is of importance. Furthermore, alternative mechanism of redistribution could introduce different types of trade-offs that have not been explicitly analyzed here. For example, government revenue could be used to finance other public goods such as healthcare, environment etc. Depending on the menu of choices available, one could then have different outcomes for the proportion of revenue allocated to cost-reducing R&D expenditure. This point has been considered for example in Lahiri and Magnani (2008).

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"The regional clustering of Knowledge – intensive entrepreneurship is deeply influenced by the presence of advanced infrastructure and research universities".

– Nicholas Vonortas

A Study of Occupational Stress and Workplace Spirituality in Himachal Pradesh Police

SHYAM KAUSHAL AND STUTI JALAN

Occupational stress has become pervasive in nearly all workplaces. The negative effects of occupational stress have become a serious concern for the management. They constantly endeavour to take initiatives in order to control stress. Policing has been identified to be one of the most stressful occupations. Numerous studies have identified the level and sources of job stress in police which result in lower productivity and efficiency of the individuals. Lately, workplace spirituality has been identified to improve the overall functioning of an organization. The study attempts to examine the relationship and impact of workplace spirituality on occupational stress in H.P. police. The study was conducted on 118 police personnel from Shimla and Solan districts of Himachal Pradesh. The results of the study showed that there exists a negative and significant relationship between occupational stress and workplace spirituality. The study also revealed a significant impact of workplace spirituality on occupational stress. Amongst them, sense of community and alignment of organizational values had the most significant impact on occupational stress. Lack of alignment of organizational values was identified as the major cause which resulted in low workplace spirituality. It is suggested that efforts should be taken to strengthen the alignment between organizational and individual values. Also, the decision makers in the state police should focus on nurturing the spiritual aspect of police personnel at workplace in order to control stress.

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1. Introduction

Occupational stress arises due to mismatch between the potential of an individual and the job demands. The sources of stress vary across individuals depending on various factors such as personality, risk-aversion, family background, value system etc. It negatively affects the individual and hampers their physiological and psychological wellbeing. The presence of stress adversely impacts the functioning of an organization. Hence, it is imperative to handle occupational stress. Stress can be handled by understanding and identifying the needs and aspirations of an individual. Petchsawanga & Duchon (2012) identified that an individual also has spiritual needs apart from physical, mental and emotional needs. It has been asserted that imbibing spirituality at workplace helps to understand the employees at a deeper level. Karakas & Fa (2010) have explained that inculcation of spirituality at workplace has enhanced the wellbeing of the employees and decreased their level of stress and burnout. Employees seek spiritual solutions to overcome stress. Bansal (2015) has identified how spirituality has started to be accepted by the corporates. It was noted that companies like Wal-Mart appoint full time spiritual experts to look after the needs of employees. They are involved in the life of employees at a deeper level. The spiritual experts engage with employees to recover from chronic diseases, nervous breakdowns and suicidal tendencies. Workplace spirituality has occupied a predominant place in both academic and corporate worlds. It has been observed that workplace spirituality aids to improve the overall functioning of an organization. There have been various studies examining the positive impact of workplace spirituality and organizational commitment (Mitroff & Denton, 1990; Marschke et al., 2009; Rego & Cunha, 2008; Milliman et al., 2003). Workplace spirituality improves the association

between the superiors and subordinates, facilitates involvement and a sense of belongingness amongst the employees and it also helps to create a positive work environment (Marques, 2005). Workplace spirituality has been observed to increase job satisfaction amongst the employees (Usman & Danish, 2010; Kumar, 2016; Milliman et al., 2003). Spirituality at work has also been examined to have significant impact on leadership and organizational development (Pawar, 2008). It has been observed that incorporation of workplace spirituality has helped to improve the work performance of its employees (Petchsawanga & Duchon, 2012).

Indian police organization is one of the chief law enforcement agencies. They are responsible to maintain law and order in the state. The list of duties to be carried out by police is exhaustive which puts them in a significant position of responsibility. Police personnel are the most accessible representatives of the government. Apart from maintaining peace and harmony, they are required to carry out additional duties such as VIP visits, court visits, election duty, security arrangements etc. Long and uncertain working hours, exposure to traumatic events, work overload, poor working conditions and lack of facilities are the prominent features of their profession. By the nature of duties to be carried out by police personnel, stress becomes an inherent feature of their work life which affects the physiological and psychological well-being. Their continuous exposure to stress can also jeopardize the safety of general public.

According to Bureau of Police Research & Development (BPR&D) as on Jan 2018, with respect to Himachal Pradesh Police, the actual strength of police personnel was 17,045. The number of vacant positions in the department is 2,459 police officers. Owing to the vacancies, there is a significant amount of gap between the sanctioned strength and actual strength. It is one of the major reasons for workload in the police personnel. An important criterion for effective and efficient police working is the number of policemen available per 100 sq. km. popularly known as Police-Area Ratio. The Police-Area Ratio for Himachal Pradesh is 29.88. This ratio is quite low in comparison to other states of the country. The sanctioned transport facility available per 100 policemen was approximately 8 vehicles at national level. But, the number of vehicles available to Himachal Pradesh police is very low when compared to the other states of the country. According to BPR&D, H.P. police ranks third last amongst all the states of the country in terms of

transport facility available to the police personnel. The lack of adequate vehicles poses a challenge for the police personnel to reach distant places in their respective areas. The lack of resources coupled with exhaustive list of duties puts them into immense amount of stress. Himachal Pradesh also witnessed a substantial rise in the number of cases being registered under the Narcotics Drug and Psychotropic Substances (NDPS) Act. In 2014, the state saw a total of 644 cases being registered, making it the state with the fourth highest rate in the country. In July 2017, an incident of Gudiya gang rape was witnessed by the state. Top officials of the police department were transferred during the incident. The changing scenario of the state owing to modernization, development, evolving tourism and migration of labour from other states have expanded the roles and responsibilities of Himachal Pradesh Police. These dynamic changes in the environment pose a challenging task for the police personnel pushing them into a state of stress.

2. REVIEW OF LITERATURE

Kaushal (1998) undertook a study to examine the impact of gender and hierarchy on job stress in bank employees. The study was conducted on bank employees of State Bank of India, Shimla. It reported that the female employees were more stressed than the male employees and ministerial staff was more stressed than the officers in the bank. Rana & Sood (2008) examined stress and burnout amongst 280 police personnel. The participants were subjected to multidimensional intervention. The experiment revealed that the relaxation training helped in reducing job stress, emotional exhaustion and depersonalization. The authors observed that police working under stress is a threat to the entire society. Bell, Rajendran & Theiler (2012) undertook a study to examine the effects of workplace spirituality on job stress. 139 academic staff members working in various universities of Australia participated in the study. The results of the study revealed that workplace spirituality had a moderate negative correlation with job stress. Chand & Koul (2012) examined the outcome of workplace spirituality, job satisfaction and emotional ownership to cope with work stress. The study was conducted on IT professionals across India. The findings revealed that all the three variables were negatively correlated with stress. Also, workplace spirituality emerged as the strongest construct to cope with job stress. Srinivasan & Illango

(2013) undertook a descriptive study to identify the stress problems faced by police constables in North Chennai. The major reasons identified were unfair behaviour of superiors, getting leaves, undefined working hours and workload. The authors suggested various measures like relief camps, yoga sessions, and relaxation therapies for overcoming occupational stress. Shekhar & Kizhakekkara (2013) identified stress and factors causing stress amongst police trainees in Kerala. The pressure exerted by the instructor was the major cause of stress. Kumar & Kumar (2014) explored workplace spirituality as a moderating variable to probe the relationship between occupational stress and mental health of bank employees. 150 bank executives from New Delhi and Lucknow participated in the study. The finding of the study supported the positive role of workplace spirituality to improve the work environment. Daniel (2014) conducted a study to identify the relationship between workplace spirituality and occupational stress. 304 managers/ supervisors from US and Mexico participated in the study. It was found that meaningful work of workplace spirituality was negatively and significantly correlated with job stress. The results of the study reported that if the individuals engaged themselves in meaningful work, they would encounter lower job stress. Akhondi et al. (2017) examined the relationship of workplace spirituality and occupational stress on a sample of 196 school teachers. The results of the study depicted a negative and significant relationship between workplace spirituality (meaningful work, sense of community) and job stress. Meitasari et al. (2018) undertook a study to examine the influence of workplace spirituality on role stress. The study was conducted on auditors working in public accounting firms in Bali province. The results of the study depict that workplace spirituality had a negative influence on role stress. The authors suggested that initiatives should be taken by the firms to foster a spiritual climate.

From review of literature, it is evident that occupational stress is a pervasive phenomenon. Various authors have also identified the sources of job stress in police personnel. Workplace spirituality has been studied to have a positive impact on various organizational variables such as organizational commitment, job satisfaction, performance etc. Studies have also reported the positive effect of workplace spirituality on occupational stress. Since policing is the backbone of any nation, stress in policing is a serious concern. There is a need to identify the role of workplace spirituality to control occupational stress in police personnel.

3. OBJECTIVES OF THE STUDY

1. To examine the level of stress in H.P. police.

2. To identify the presence of workplace spirituality in H.P. police.

3. To examine the relationship and impact of workplace spirituality on occupational stress in H.P. police.

4. RESEARCH METHODOLOGY

The study is based on primary and secondary data. The present research was conducted on the police personnel from two districts of Himachal Pradesh, namely, Shimla and Solan. The responses were collected with the help of questionnaire.

4.1 Sample

A sample of 118 police personnel working in the above mentioned districts participated in the survey. Sample was selected on random basis but only those willing to participate in the survey were considered, i.e. non-gazetted officers of Grade I & Grade II from Shimla & Solan district. The districts were chosen on the basis of relative population of police personnel in all the districts of the state.

4.2 Research Instrument

Workplace spirituality was measured using the scale developed by Milliman et al. (2003). The scale measures workplace spirituality at three levels, namely individual, group and organizational. It measures the aspect on three dimensions which include meaningful work, sense of community, and alignment with organizational values. *Meaningful work* pertains to work imparting meaning at a deeper level. It assumes that individuals possess inner motivations, desires that push them to be involved in work having a larger meaning and purpose (Ashmos & Duchon, 2000). *Sense of community* covers workplace spirituality at a group level. It is concerned with the interactions at group level and relationship with co-workers (Ashmos & Duchon, 2000). *Alignment with organizational values* views workplace spirituality on an organizational level. It is based on the assumption that an organization has a value system that guides its routine functioning. Alignment focuses on the organizational values to be in conformity with the individual value system of the employees. Also, it ensures that the value of the organization should be such that, it is beneficial for the society at large (Ashmos & Duchon, 2000).

For measuring occupational stress, a self-developed inventory was used. The scale was developed keeping the stressors specific to H.P. police. It consists of 40 items and was framed based on literature review, personal interviews with police personnel and in-depth observations. The dimensions were adapted from the scale developed by Pareek (1983) which includes role isolation, role overload, role ambiguity, role stagnation, inter role distance, role expectation conflict, role erosion, self-role distance, personal inadequacy and resource inadequacy. The items were grouped based on literature review.

4.3 Reliability and Validity

The reliability of both scales was measured using Cronbach alpha. The results of the same have been reported in Table 1. The Cronbach alpha values for both the variables reflect the high reliability of the instrument employed. For determining validity, face validity was determined for the scales used by interaction and discussion with academicians and subject experts.

5. RESULTS & DISCUSSION

Table 2 presents the descriptive statistics of occupational stress across ten dimensions. It can be seen that the mean value of overall occupational stress has been reported at 4 (on a scale of 1–5, 1 being the lowest and 5 being the highest). This indicates that the police personnel of Himachal Pradesh were experiencing high stress. It is evident that the major stressor faced by H.P. police was inter role distance followed by resource inadequacy. Inter role distance measures the stress caused by the conflict between personal and organizational goals. Further, role isolation was found to be causing least stress in comparison to the other dimensions.

Table 1: Reliability Coefficient of Variables

	Occupational Stress	Workplace Spirituality
No. of items	40	21
Cronbach Alpha values	.91	.86

Table 2: Descriptive Statistics of Occupational Stress

Variables	Mean	SD
Inter Role Distance	4.62	0.55
Role Overload	4.44	0.56
Self Role Distance	3.83	0.69
Role Ambiguity	4.08	0.62
Resource Inadequacy	4.47	0.46
Personal Inadequacy	3.98	0.71
Role Stagnation	3.86	0.70
Role Expectation	3.82	0.67
Role Erosion	3.86	0.75
Role Isolation	3.61	0.74
Overall Occupational Stress	**4.00**	**0.47**

Table 3 depicts the descriptive statistics of workplace spirituality across its three dimensions. The results indicate that the overall workplace spirituality in police personnel of Himachal Pradesh was low (i.e. 2.03, on a scale of 1– 5, 1 being the lowest and 5 being the highest). Also, it can be seen that alignment with organizational values followed by sense of community was responsible for low workplace spirituality in them.

Table 3: Descriptive Statistics of Workplace Spirituality

Variables	Mean	SD
Meaningful Work	2.07	0.74
Sense of Community	2.09	0.52
Alignment with organizational values	1.95	0.64
Overall Workplace Spirituality	**2.03**	**0.53**

5.1 Workplace Spirituality and Occupational Stress: Correlation Analysis

Pearson's Correlation was employed to examine if there is any association between occupational stress and workplace spirituality. Table 4 presents the correlation between three dimensions of workplace spirituality and ten dimensions of occupational stress. It was observed that the overall occupational stress was negatively and significantly correlated with two dimensions of workplace spirituality (i.e. sense of community & alignment with organizational values). Also, *meaningful work* of workplace spirituality was found to be negatively correlated with all ten dimensions of occupational stress.. However, the negative relationship was found to be significant with only seven dimensions of occupational stress. All three dimensions of workplace spirituality were found to be negatively and significantly correlated with overall occupational stress. Also, overall occupational stress was found to be negatively and strongly correlated with overall workplace spirituality ($p<0.005$). *Alignment with organizational values* was found to have the most strong negative relationship with occupational stress ($r= -.566$). This implies that there was lack of alignment between individual values and organizational values. An increase in this alignment may result in decreasing the level of occupational stress in H.P. police. *Meaningful work* was found to be most negatively and significantly correlated with *inter role distance* of occupational stress ($r= -. 316$). *Sense of community* was found to be most negatively and significantly correlated with *role ambiguity* of occupational stress ($r= -.514$). Similarly, *alignment of organizational values* was found to be most negatively and strongly correlated with inter role distance ($r= -.526$). Here, it should

be noted that two dimensions of workplace spirituality were negatively and significantly correlated with *inter role distance* of occupational stress. Inter role distance refers to the conflict faced by an individual while performing two different roles, for instance, an officer at work and a father at home. Also, overall occupational stress was found to be negatively and significantly correlated with overall workplace spirituality ($r= -.515$; $p<0.05$). The negative relationship implied that increase in workplace spirituality would help lower occupational stress in H.P. police. Table 5 presents the correlation matrix of the two variables and its dimensions. Further, Figure I depicts a comprehensive picture of the results yielded by the relationship study of workplace spirituality and occupational stress.

5.2 Workplace Spirituality and Occupational Stress: Regression Analysis

Another objective of the study was to identify if workplace spirituality had an impact on occupational stress. Multiple regression analysis were used to probe the individual contribution of different dimensions of workplace spirituality on occupational stress. In this model, different dimensions of workplace spirituality were taken as independent variables and overall occupational stress was taken as the dependent variable. The predictors used for this model are meaningful work, sense of community, alignment of organizational values of workplace spirituality. The below model depicts the adjusted R square to be 0.353. This shows that occupational stress has a variance of 35.3 per cent with workplace spirituality as the predictor. The standardized coefficient (beta) values of dimensions of workplace spirituality have also been reported. The beta values help to identify the amount of contribution of each

Fig I: Correlation between workplace spirituality and occupational stress. ** & * indicate significance at 1% & 5% respectively.

Table 4: Correlation Matrix of Workplace Spirituality and Occupational Stress

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inter Role Distance	1														
Role Overload	.526#	1													
Self-Role Distance	.449#	.407#	1												
Role Ambiguity	.441#	.560#	.513#	1											
Resource Inadequacy	.578#	.571#	.275#	.638#	1										
Personal Inadequacy	.490#	.520#	.547#	.561#	.506#	1									
Role Stagnation	.082	.312#	.318#	.497#	.460#	.371#	1								
Role Expectation	.372#	.595#	.459#	.630#	.457#	.606#	.641#	1							
Role Erosion	.354#	.264#	.410˙	.462#	.399#	.509#	.75#	.501#	1						
Role Isolation	.382#	.371#	.553#	.510#	.364#	.485#	.451#	.561#	.520#	1					
Overall Occupational Stress	.590#	.655#	.721#	.781#	.659#	.786#	.660#	.814#	.713#	.748#	1				
Meaningful Work	-.316#	-.253#	-.185˙	-.167˙	-.267#	-.137	-.007	-.020	-.173	-.218˙	-.220˙	1			
Sense of Community	-.440#	-.380#	-.405#	-.514#	-.385#	-.405˙	-.288#	-.310#	-.268#	-.368#	-.508#	.486#	1		
Alignment with organizational values	-.526#	-.460#	-.370#	-.480#	-.471#	-.502#	-.311#	-.349#	-.451#	-.311#	-.566˙	.531#	.668#		1
Overall Workplace Spirituality	-.512#	-.437#	-.377#	-.456#	-.449#	-.419#	-.236˙	-.271#	-.365#	-.350#	-.515˙	.800#	.829#	.891#	1

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

*. Correlation is significant at the 0.05 level (2-tailed).

dimension of workplace spirituality. It can be clearly seen that *sense of community* and *alignment of organizational values* have a significant impact on occupational stress (p values = .009 & .000 respectively). Since the significance values of both the dimensions are less than .05, the impact can be termed as statistically significant. Alignment of organizational values emerged as the significant contributor in the model. It should also be noted that the beta values are negative, which implies that increase in workplace spirituality would result in lowering occupational stress. However, *meaningful work* was found to have no significant impact on occupational stress. ANOVA values have also been reported which has a significance value of 0.000. Since the significance value is less than 0.05, it indicates that the variance explained by the below model has not occurred due to chance. The significance values also imply that it is a good model depicting the impact of workplace spirituality on occupational stress.

Table 5: Regression Analysis of Workplace Spirituality & Occupational Stress

Dimensions	Standardized Coefficients(Beta)	T	Sig.	Regression Model Summary
(Constant)				R square = 0.353
Meaningful work	.162	.1.80	.073	
Sense of Community	-.272	-2.66	.009	
Alignment with organizational values	-.471	-4.47	.000	ANOVA(F) = 22.23 Significance = 0.000

6. FINDINGS

The present study found that the police personnel of Himachal Pradesh, especially in Shimla & Solan districts, were experiencing high occupational stress. Previous studies in India have shown that police personnel come across high amount of occupational stress (Bushara, 2011). The present study also identified the major stressor as workload and lack of time for the family. Similar results were identified by Srinivasan & Illango (2012), wherein, immense workload was observed as the foremost cause of stress amongst police constables of North Chennai. Further, the study also reported that the existing workplace spirituality was nominal. *Alignment with organizational values* was found to be the major factor that resulted in low workplace spirituality. This indicates that the individual values and organizational values were not in conformity that causes stress and strain. Similarly, the other two dimensions (meaningful work, sense of community) of workplace spirituality were also reported to be low, highlights scope for great attention.

The study aimed to examine the relationship between occupational stress and workplace spirituality. The results of the study revealed that there exists a strong negative relationship between workplace spirituality and occupational stress. All the three dimensions of workplace spirituality were found to be negatively correlated with occupational stress. Similar results have been reported by early researchers (Bell et al. 2012). Their study found out a significant negative correlation between occupational stress and three dimensions of workplace spirituality (meaningful work, sense of community, alignment with organizational values). Meaningful work was found to be significantly and negatively correlated with occupational stress. A study by Daniel (2014) found that meaningful work of workplace spirituality was negatively and significantly correlated with occupational stress. This clearly indicates that the feeling of meaningful work needs to be reinforced to relieve occupational stress. Sense of community was found to have a strong negative association with workplace spirituality. A study by Akhondi et al. (2017) reported that a strong negative correlation was observed between sense of community and job stress.

In the present study, alignment with organizational values, commitment to rule of law, human rights, dignity and respect to citizens were found to be most strongly correlated with occupational stress. This indicates that increase in alignment of organizational and individual values would help lower occupational stress. However, data indicates that the cooperation amongst coworkers in police department is low and conformity issues exist between
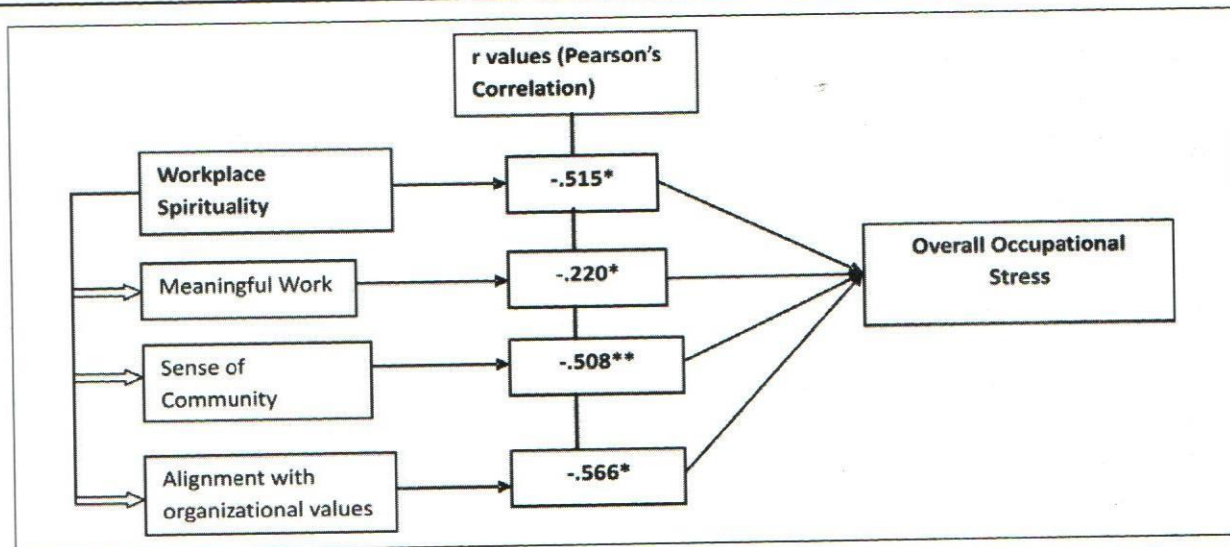
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In the present study, alignment with organizational values, commitment to rule of law, human rights, dignity and respect to citizens were found to be most strongly correlated with occupational stress. This indicates that increase in alignment of organizational and individual values would help lower occupational stress. However, data indicates that the cooperation amongst coworkers in police department is low and conformity issues exist between
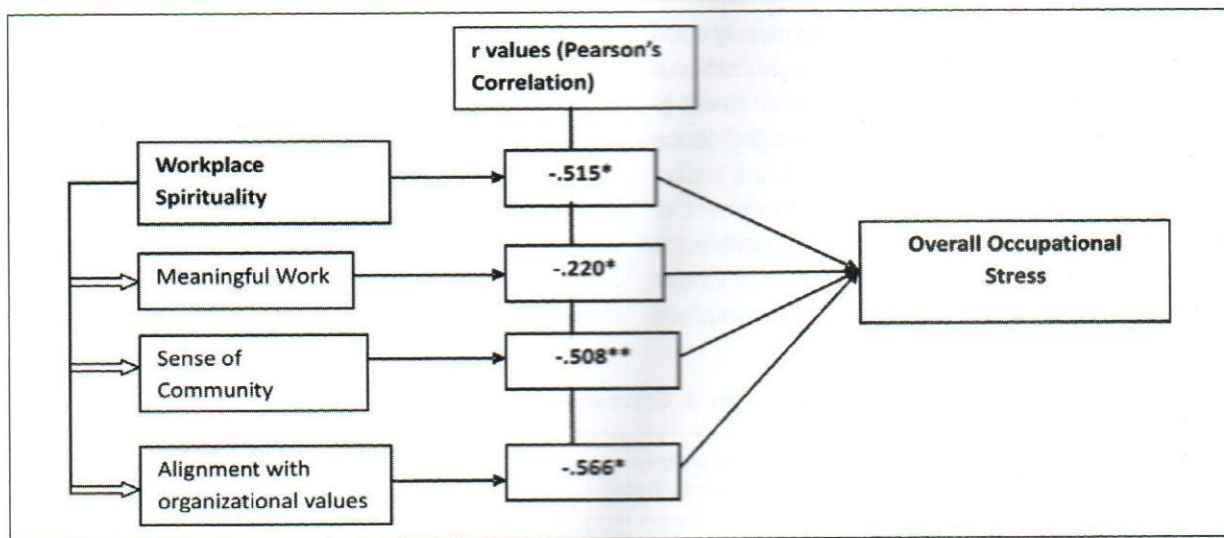
individual and organizational values. While the police personnel identified themselves as spiritually aware, the atmosphere at workplace is notably different as only the dictates of the superior matters, variety of duties and responsibilities need to be performed including sudden occurrences of crimes and happenings that cause uncertainty and stress. Therefore, the study suggests that workplace spirituality can be used as an effective strategy to deal with occupational stress in police personnel.

7. CONCLUSION & IMPLICATIONS

To conclude, the study revealed that the police personnel are facing high occupational stress and the level of workplace spirituality in police personnel was reported to be low. Importantly, occupational stress was reported to have a negative correlation with workplace spirituality. Hence, strengthening workplace spirituality will help in reducing stress. The present study identified that low alignment of organizational values with individual values is the major reason for low workplace spirituality, and it could be a pointer of gap between the personal values and prevalent culture leading to strain. Thus, it is essential that the organization should focus on aligning the organizational values with individual values. Apart from the educational qualifications and physical standards, the individual value system of an employee should also be assessed and suitable spiritual attitude be given more weightage during the hiring process. Subsequently, a sense of community should be promoted by fostering better teamwork and concern in the department. Further, it can be said that nurturing spirituality at workplace will reduce the levels of stress and improve the morale of the law enforcement agency. It is suggested that periodic stress audit and training capsules on stress management, including spirituality exercises, be undertaken. It will have positive effect on other organizational variables such as job satisfaction, organizational commitment etc. on one hand and improve their peace of mind, and more importantly, enhance the image of policing at large. Thus, inculcation of workplace spirituality will create a win-win situation for both the employees and the organization.

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> *"People in a cluster are bound to each other automatically, and can see each other automatically."*
>
> *– J. Michael Straczynski*

Stress at Work Place: A Study with Reference to Police Personnel of Gajapathi District, Odisha

KALYAN CHAKRAVARTHY PARLE

Job stress is a matter of concern in current scenario. Work stress results in disruption of psychological as well as physiological homeostasis of the individual, leading to deviant functioning in the working environment. The present study represents a focused interest in stress research that it seeks to isolate specific self-reported organizational stressors that may negatively impact police performance. Stress scale was used to gather primary data of 303 participants from the universal size of 1010. Student independent sample T-test, Pearson correlation coefficient and descriptive statistics were used in data analysis. The findings showed the stress levels of the respondents have a meaningful impact on job. The descriptive statistics of all the variables are medium, kurtosis is negative, Independent sample T-test indicated that there is no gender difference in opinion. The results indicate that the stress variables are statistical significant with working hour of the respondents as the working hours increased the stress also increases. Implications of the findings are discussed.

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1. Introduction

Work-related stress is the response the people may have when presented with work demands and pressures that are not matched to their knowledge and abilities and which challenge their ability to cope. Stress occurs in a wide range of work circumstances but is often made worse when employees feel that they have little support from supervisors and colleagues, as well as little control over work processes. There is often confusion between pressure or challenge and stress, and sometimes it is used to excuse bad management practice. Stress is simply a reaction to a stimulus that disturbs the physical or mental equilibrium. In other words, it is an omnipresent part of life. A stressful event can trigger the "fight-or-flight" response, causing hormones such as adrenaline and cortisol to surge through the body. A little bit of stress, known as "acute stress," can be exciting—it keeps active and alert. But long-term, or "chronic stress," can have detrimental effects on health.

Job stress is stress related to one's job. Job stress often stems from unexpected responsibilities and pressures that do not align with a person's knowledge, skills, or expectations, inhibiting one's ability to cope. Job stress can increase when workers do not feel supported by supervisors or colleagues, or feel as if they have little control over work processes. Everyone who has ever held a job has, at some point, felt the pressure of work-related stress. Any job can have stressful elements. In the short-term, may experience pressure to meet a deadline or to fulfill a challenging obligation. But when work stress becomes chronic, it can be overwhelming and harmful to both physical and emotional health.

The concept of stress was first introduced in the life sciences by Seyle (1956). Kop and Euwema (2001)

found that organizational factors are the most salient stressors in police organizations. According to Schaufeli and Enzmann (1998) job stressors are divided into two groups: job demands and lack of resources. Whereas Lazarus and Folkman (1984) opined that job stress takes place when job demands exceed the person's adaptive resources.

2. Literature Review

Kauser et. al. (2015) review has made an attempt to study the effect of stress intervention programme on occupational stress among the police personnel in Chennai city. In the present investigation a total sample of 100 police personnel were taken with equal number of them belonging to assess the occupational stress among the police personnel by Rothman (2006). Pienaar and Satish More et. al. (2015) viewed that stress manifests itself in different ways and may limit the performance of police personnel. It manifests as fatigue, chronic headaches, irritability etc. A cross sectional study was conducted to identify various psychometric disorders among police personnel by using stratified random sampling with proportional allocation. LuLu, Li Liu et. al. (2015) stated that Police officers' job satisfaction is an important issue for police force management, but insufficient research exists on the topic, especially in China. This study aimed to examine the associations of job stress and organizational identification with job satisfaction among Chinese police officers, and particularly the mediating role of psychological capital (PsyCap). A cross-sectional study was conducted in Liaoning Province of China during the period of September–October 2014. June-Hee Lee, et. al. (2016) aimed to evaluate the police officer's job characteristics and risk of post-traumatic stress disorder among South Korean Police Officers. The design of the study was Cross-sectional. The sample size was 3817 police officers with a traumatic event over a 1-year period. The main outcome measures were Officers with a response to the Impact of Event Scale (revised Korean version) score of ≥ 26 were classified as high risk, and we evaluated their age, sex, department and rank, as well as the frequency and type of traumatic events that they experienced. The results showed that among the respondents, 41.11% were classified as having a high risk of Post-Traumatic Stress Disorder.

3. The Objective

The present study examines the relationship of demographic features of respondents' age, gender, marital status, monthly pay, working hours, family members and dependents on their job stress.

4. Conceptual model
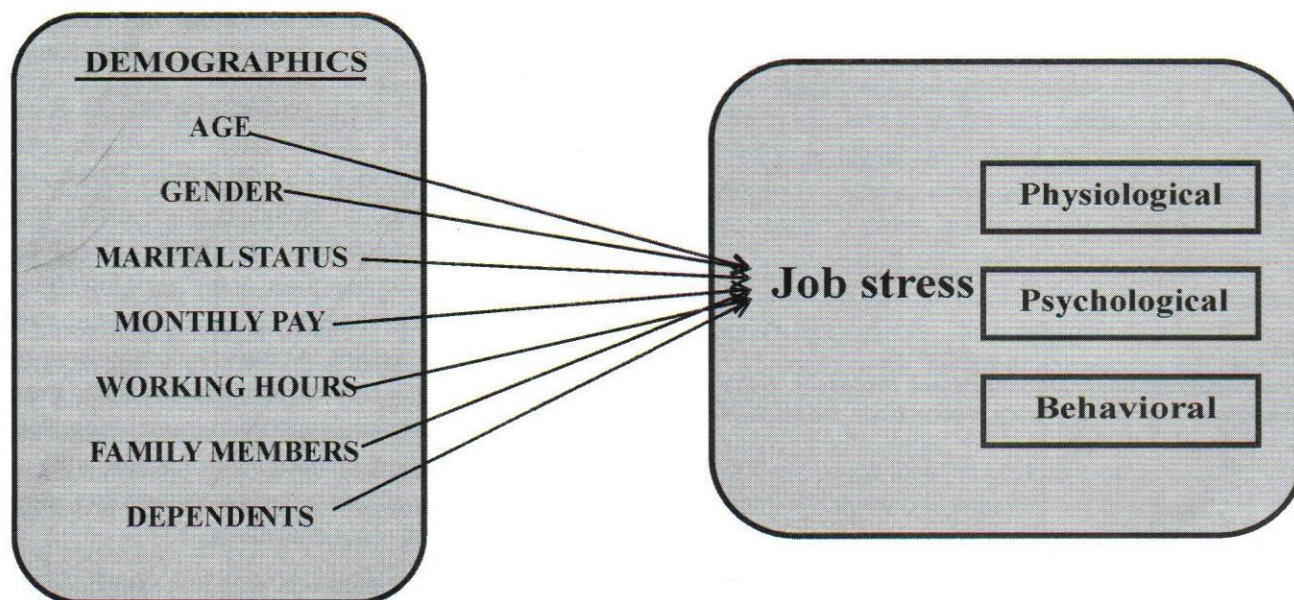
5. Hypothesis

The Selected 7 demographics of Age, Gender, Marital Status, Monthly Pay, Working hours, Family members and Dependents are significantly related to Job Stress.

6. Methodology

Four Battalions of Police Forces has been located in Gajapathi District, Odisha. The strength of these four Battalions are 1010 which constitute the universe of the study. The universe constitutes of 235 Armed Police Reserve (APF), 225 Other Reserve (OR), 180 Odisha Armed Protection Force (OAPF) and 370 third Battalion SS. Out of the Universal size, 848 Men Constables and 162 Women constables are under the Battalions. Primary data to test the above mentioned hypothesis was gathered from a sample of 303 police personnel. The sample consists of 254 Men Police Constables and 49 Women Police Constables.

Total Respondents (n=303)

APF (71)	OR (67)	OAPF (54)	3rdBtlnSS (111)

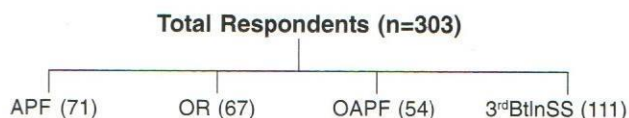The survey data was gathered by using Standard Stress Scale having items of Physiological, Psychological and Behavioral Domains. The Scale was developed on a 5-Point Likert's Summated Rating Scale having 5=Strongly Agree to 1=Strongly Disagree. As presented in Table. 1, the Scale's internal consistency reliability (Cronbach's α = 0.811) and internal coherence (Split-Half Coefficient = 0.823) were found satisfactory.

Scale	Cronbach's α	Split-Half Method
Organizational Justice	0.811	0.823

Student Independent Samples T-test was used to know significant variance in mean perceptions of specific respondent-groups according to their demographics. Pearson's Correlation applied through SPSS 20.0 (Trial Version) to test the hypothesis. Interpretation of the present study outcomes is limited to the extent of respondents' perceptions and interpreted in the light of findings in earlier studies.

7. Analysis & Findings

The table 1. discusses the mean, standard deviation, skewness and kurtosis for Psychological domain variables for total 303 respondents of Gajapathi district. The lowest mean value for Gajapathi is 2.5545 and the highest is 3.0693. The SD is around 1.1 with less deviation among the opinions. The data is positively and negatively skewed with the highest negative skewness -.110. There is negative kurtosis with the highest -1.202. It indicates that the district has the highest average mean value and the average standard deviation is above 1 with medium spread over.

The table 2. discusses the mean, standard deviation, skewness and kurtosis for Psychological domain variables for total 303 respondents of Gajapathi district. The lowest mean value for Gajapathi is 2.5182 and the highest is

Table 1: Descriptive Statistics for Psychological Domain Variables

	N	Mean	SD	Skewness	Kurtosis
Not able to adjust in physical environment	303	2.5545	1.31327	.380	-.972
Feel insecure in the working environment	303	2.5908	1.25447	.345	-.883
Not satisfied with day-to-day work	303	2.6964	1.29193	.173	-1.049
Difficulty with frequent jobs posting & transfer procedures	303	3.0693	1.39244	-.110	-1.202
Carrying lot of responsibilities and duties	303	2.8944	1.20240	.170	-.813
Work for long hours, overtime and even on holidays	303	3.0594	1.24609	-.072	-.926
Experience excessive work pressure	303	2.5578	1.30046	.445	-.877
Performing tasks not related to the job description	303	2.6634	1.21479	.200	-.899

Table 2: Descriptive Statistics for Physiological Domain Variables

	N	Mean	SD	Skewness	Kurtosis
Having sleeping troubles	303	2.5248	1.22551	.296	-.859
Having poor concentration	303	2.5182	1.19276	.304	-.821
Feel out-of-control	303	2.7228	1.27730	.176	-.973
Easily Frustrated	303	2.7030	1.27022	.182	-1.033
Have worried after making a decision whether did the right thing	303	2.6073	1.27672	.326	-.940
Work under a great deal of tension	303	2.7558	1.22058	.224	-.758

2.7558. The SD is around 1.1 with less deviation among the opinions. The data is positively skewed with the highest .326. There is negative kurtosis with the highest -1.033. It indicates that the district has the highest average mean value and the average standard deviation is above 1 with medium spread over.

Table 3: Descriptive Statistics for Behavioral Domain Variables

	N	Mean	SD	Skewness	Kurtosis
Away from family sometimes due to heavy duties	303	3.0924	1.19521	.032	-.928
Not able to attend relatives and family programmes	303	3.0330	1.23641	.159	-.979
Difficulties arising in communicating with multilinguistic public	303	2.7063	1.18609	.214	-.807
Verbal & Physical aggression from the public	303	2.6766	1.19920	.262	-.689
Insufficient facilities to handle the society' aspects	303	2.7921	1.13333	.141	-.542

The above table discusses the mean, standard deviation, skewness and kurtosis for Psychological domain variables for total 303 respondents of Gajapathi district. The lowest mean value for Gajapathi is 2.6766 and the highest is 3.0924. The SD is around 1.1 with less deviation among the opinions. The data is positively skewed with the highest .262. There is negative kurtosis with the highest -979. It indicates that the district has the highest average mean value and the average standard deviation is above 1 with medium spread over.

For 'Not able to adjust in physical environment' for Gajapathi, the significance value is 0.094. The p-value is greater than significant level 1.715, p=0.094 >0.05. The mean difference (t-value) is .23513, indicates that the mean opinion of the district is significantly greater.

For 'Difficulty with frequent jobs posting & transfer procedures' for Gajapathi, the significance value is 0.249. The p-value is greater than significant level 1.195, p=0.029 >0.05). The mean difference (t-value) is .017015, indicates that the mean opinion of the district is significantly greater.

For 'Work for long hours, overtime and even on holidays' for Gajapathi, the significance value is 0.100. The p-value is greater than significant level 1.592, p=0.100>0.05). The mean difference (t-value) is .0.22747, indicates that the mean opinion of the district is significantly greater.

For 'Performing tasks not related to the job description' for Gajapathi, the significance value is 0.350. The p-value is greater than significant level -0.905, p=0.350>0.05). The mean difference (t-value) is .0.12555, indicates that the mean opinion of the district is significantly greater.

For 'Having sleeping troubles' for Gajapathi, the significance value is 0.003. The p-value is greater than significant level 3.071, p=0.003<0.05). The mean

Table 4: Independent T-Test for Psychological Domain Variables in Gajapathi District

	N	Mean	SD	t	df	t-value	P-value Sig. (2-tailed)
Not able to adjust in physical environment	303	2.5545	1.31327	1.678	420	.23513	.094
Feel insecure in the working environment	303	2.5908	1.25447	-.914	420	-.12353	.361
Not satisfied with day-to-day work	303	2.6964	1.29193	.783	420	.10813	.434
Difficulty with frequent jobs posting & transfer procedures	303	3.0693	1.39244	1.154	420	.17015	.249
Carrying lot of responsibilities and duties	303	2.8944	1.20240	3.442	420	.45741	.001
Work for long hours, overtime and even on holidays.	303	3.0594	1.24609	1.648	420	.22747	.100
Experience excessive work pressure	303	2.5578	1.30046	-2.075	420	-.29098	.039
Performing tasks not related to the job description	303	2.6634	1.21479	.935	420	.12555	.350

Table 5: Independent T-Test for Physiological Domain Variables in Gajapathi District

	N	Mean	SD	t	df	t-value	P-value Sig. (2-tailed)
Having sleeping troubles	303	2.5248	1.22551	3.032	420	.39870	.003
Having poor concentration	303	2.5182	1.19276	1.000	420	.13160	.318
Feel out-of-control	303	2.7228	1.27730	1.394	420	.19336	.164
Easily Frustrated	303	2.7030	1.27022	.582	420	.08112	.561
Have worried after making a decision whether did the right thing	303	2.6073	1.27672	2.815	420	.38037	.005
Work under a great deal of tension	303	2.7558	1.22058	-.306	420	-.04254	.760

difference (t-value) is 0.39870, indicates that the mean opinion of the district is significantly greater.

For 'Feel out-of-control' for Gajapathi, the significance value is 0.164. The p-value is greater than significant level 1.386, p=0.164>0.05. The mean difference (t-value) is .19336, indicates that the mean opinion of the district is significantly greater.

For 'Work under a great deal of tension' for Gajapathi, the significance value is 0.760. The p-value is greater than significant level -0.285, p=.760<0.05. The mean difference (t-value) is 0.04254, indicates that the mean opinion of the district is significantly greater.

For 'Away from family sometimes due to heavy duties' for Gajapathi, the significance value is 0.650. The p-value is greater than significant level -0.453, p=0.650>0.05. The mean difference (t-value) is .-0.05885 indicates that the mean opinion of the district is significantly lesser.

For 'Verbal & Physical aggression from the public' for Gajapathi, the significance value is 0.231. The p-value is greater than significant level 0.231, p=0.231>0.05. The mean difference (t-value) is .23513, indicates that the mean opinion of the district is significantly greater.

Table 6: Independent T-Test for Behavioral Domain Variables in Gajapathi District

	N	Mean	SD	t	df	t-value	P-value Sig. (2-tailed)
Away from family sometimes due to heavy duties	303	3.0924	1.19521	-.454	420	-.05885	.650
Not able to attend relatives and family programmes	303	3.0330	1.23641	1.498	420	.20107	.135
Difficulties arising in communicating with multilinguistic public	303	2.7063	1.18609	.717	420	.09283	.474
Verbal & Physical aggression from the public	303	2.6766	1.19920	1.199	420	.15556	.231
Insufficient facilities to handle the society aspects	303	2.7921	1.13333	.085	420	.01057	.932

For 'Insufficient facilities to handle the society aspects' for Gajapathi, the significance value is 0.932. The p-value is greater than significant level 0.084, p=0.932>0.05. The mean difference (t-value) is .23513, indicates that the mean opinion of the district is significantly greater.

For Gajapathi, there is a weak, positive correlation between working hours and Not able to adjust in physical

Table 7: Pearson Correlation Coefficient for Working Hours of the Respondents and occupational Stress Variables

Psychological Domain Variables		Gajapathi
Not able to adjust in physical environment	Pearson Correlation Sig. (2-tailed) N	.138 .017 303
Feel insecure in the working environment	Pearson Correlation Sig. (2-tailed) N	.096 .095 303
Not satisfied with day-to-day work	Pearson Correlation Sig. (2-tailed) N	.344 .000 303
Difficulty with frequent jobs posting & transfer procedures	Pearson Correlation Sig. (2-tailed) N	.341 .000 303
Carrying lot of responsibilities and duties	Pearson Correlation Sig. (2-tailed) N	.256 .000 303
Work for long hours, overtime and even on holidays.	Pearson Correlation Sig. (2-tailed) N	.397 .000 303
Experience excessive work pressure	Pearson Correlation Sig. (2-tailed) N	.019 .747 303
Performing tasks not related to the job description	Pearson Correlation Sig. (2-tailed) N	-0.49 .399 303

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

environment, which is statistically significant at 2-tailed (r = .138**, n = 303, p= .017< 0.05). So, there is a significant correlation between working hours and Psychological domain variables.

For Gajapathi, there is a weak, positive correlation between working hours and feel insecure in the working

environment, which is not statistically significant at 2-tailed (r = .096, n = 303, p= .095> 0.05). So, there is no statistical significant correlation.

For Gajapathi, there is a weak, positive correlation between working hours and Not satisfied with day-to-day

Table 8: Pearson Correlation Coefficient for Working Hours of the Respondents and occupational Stress Variables

Psychological Domain Variables		Gajapathi
Having sleeping troubles	Pearson Correlation Sig. (2-tailed) N	.005 .935 303
Having poor concentration	Pearson Correlation Sig. (2-tailed) N	.381 .000 303
Feel out-of-control	Pearson Correlation Sig. (2-tailed) N	.509 .000 303
Easily Frustrated	Pearson Correlation Sig. (2-tailed) N	.535 .000 303
Have worried after making a decision whether did the right thing	Pearson Correlation Sig. (2-tailed) N	.399 .000 303
Work under a great deal of tension	Pearson Correlation Sig. (2-tailed) N	.299 .000 303

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

work, which is statistically significant at 2-tailed (r = .344**, n = 303, p= .000< 0.05). So, there is a statistical significant correlation.

For Gajapathi-there is a weak, positive correlation between working hours and Experience excessive work pressure, which is not statistically significant at 2-tailed (r = .019, n = 303, p= .747 > 0.05). So, there is a statistical significant correlation.

For Gajapathi, there is a weak, positive correlation between working hours and Having sleeping troubles, which is statistically not significant at 2-tailed (r= .005, n = 303, p= .935> 0.05). So, there is no statistical significant correlation.

For Gajapathi, there is a weak, positive correlation between working hours and Having poor concentration, which is statistically significant at 2-tailed (r= .381**, n = 303, p= .000< 0.05). So, there is a statistical significant correlation.

For Gajapathi, there is a moderate, positive correlation between working hours and Easily Frustrated, which is statistically significant at 2-tailed (r =.535**, n = 303, p= .000< 0.05). So, there is a statistical significant correlation.

For Gajapathi, there is a weak, positive correlation between working hours and Away from family sometimes due to heavy duties which is statistically significant at 2-tailed (r = .310**, n = 303, p= .000< 0.05). Therefore there is a statistical significant correlation.

For Gajapathi, there is a weak, positive correlation between working hours and Difficulties arising in communicating with multilinguistic, which is statistically significant at 2-tailed (r = .415**, n = 303, p= .000< 0.05).Therefore there is a statistical significant correlation.

For Gajapathi, there is a weak, positive correlation between working hours and Insufficient facilities to handle

Table 9: Pearson Correlation Coefficient for Working Hours of the Respondents and occupational Stress Variables

Psychological Domain Variables		Gajapathi
Away from family sometimes due to heavy duties	Pearson Correlation Sig. (2-tailed) N	.310 .000 303
Not able to attend relatives and family programmes	Pearson Correlation Sig. (2-tailed) N	.176 .002 303
Difficulties arising in communicating with multilinguistic public	Pearson Correlation Sig. (2-tailed) N	.415 .000 303
Verbal & Physical aggression from the public	Pearson Correlation Sig. (2-tailed) N	.442 .000 303
Insufficient facilities to handle the society aspects	Pearson Correlation Sig. (2-tailed) N	.331 .000 303

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

the society aspects, which is statistically significant at 2-tailed (r = .331**, n = 303, p= .000< 0.05) and (r = .319**, n = 119, p=.000< 0.05) respectively. Therefore there is a statistical significant correlation.

Discussions

In Gajapathi, 28.7% (neither great nor small extent) of the respondents agree that they are performing tasks not related to the job description respectively. In Gajapathi district, 27.1% of the respondents to a small extent agree that they experience excessive work pressure respectively. In Gajapathi district, 30.0% (neither great nor small extent agree) of the respondents agree that they are working for long hours, overtime and even on holidays respectively. In Gajapathi district, 30.7% (Sometimes feel this way) of the respondents agree that they are having sleeping troubles respectively. In Gajapathi 29.0% (Sometimes feel this way) of the respondents agree that they are having poor concentration respectively. In Gajapathi district, 29.7% (Sometimes feel this way) of the respondents agree that they feel out of control respectively.

In Gajapathi district, 25.4% (Sometimes feel this way) of the respondents agree that they are easily frustrated respectively. In Gajapathi district, 25.1% (Sometimes feel this way) of the respondents agree that they have worried after deciding whether did the right thing respectively. In Gajapathi district, 34.3% (sometimes) of the respondents agree that they face verbal & physical aggression from the public respectively. In Gajapathi district, 35.3% (sometimes) of the respondents agree that they spend so long at work that outside relationships are suffering respectively. In Gajapathi district, 29.4% (sometimes) of the respondents agree that they have difficulties arising in communicating with multi-linguistic public respectively. In Gajapathi district, 38.9% of the respondentssometimes agree that they have insufficient facilities to handle the society aspects respectively. In Gajapathi district, 28.1% of the respondents moderately agree that they are away from family sometimes due to heavy duties respectively. In Gajapathi district, 28.1% of the respondents a little bit agree that they are not able to attend relatives and family programmes respectively.

Conclusion

It is recommended that staff should endeavour to find means of managing psychological attributes such as police self-efficacy, work-motivation, emotional labour, psychological well-being and social networks of their employees. This is based on the fact that management of these attributes will go a long way in enhancing their organizational commitment. This could be done by establishing behavioural clinics in all the police stations throughout the country. This is necessary in order to diagnose and treat the behavioural problems among the police personnel. This implies that the gap between police and attainment of their constitutional objectives could be

Stress at Work Place: A Study with Reference to Police Personnel of Gajapathi District, Odisha

bridged by bringing about improvement in the occupational stress and psychological well-being of police.

The study has been conducted on Job stress in police personnel of Gajapathi district of Odisha. It is concluded that police constables of Gajapathi district are experiencing a moderate level of occupational stress. The study concluded that work environment, work load, bureaucracy, work schedule, interpersonal and social relationships are the causes of Job stress. The study also reveals that women are more prone to Job stress than men as they face some unpredictable problems from the duty, family as well as sometimes heavy pressure from the superiors in Gajapathi district.

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"The Image is more than an idea. It is a vortex or cluster of fused ideas and is endowed with energy."

– Ezra Pound

Feature

Financial Performance Analysis of Tata Consultancy Services Limited (A case study)

MALA RATHI AND KRISHN AWATAR GOYAL

In the last decade, a new revolution has taken place in the field of computer sciences that has been named as Information Technology Revolution. The revolution has had a great impact on the whole world, especially on India, which is now considered as a destination hub for IT services. With the birth of information technology revolution, a need for software development was felt across world. The sudden increase in demand for software services resulted in the birth of some strong Indian companies like TCS, Infosys, Wipro etc. It is an established fact that India has become a super power in the fields of IT & ITES. The IT companies are playing a major role in providing services to the government and for providing employment as well. Foreign exchange reserves have also increased.

Under such a scenario, this paper is an attempt to analyze the financial performance of India's most renowned company in the IT sector—Tata Consultancy Services (TCS). TCS is a world-class company that has marked its presence on the global platform and is recognized as the world's 3rd best IT service provider company. Since its foundation 50 years ago, TCS has received many accolades and has provided seamless opportunities for development in the sector, assisting other sectors, enhancing optimum utilization of resources—physical and human, investors etc. Trend analysis, DuPont analysis and Altman B Model have been used to enumerate the financial performance of the company during the last 5 years. The results indicate a positive trend in its revenue, net profit earnings etc of the company. The company is growing positively with great swiftness.

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1. COMPANY'S PROFILE

TCS is part of the TATA group—one of the world's largest business groups, an IT and engineering services, consulting and business solution providing Indian MNC. Over the last 50 years of its journey, TCS has partnered with the largest businesses of the world. The company is listed on BSE and NSE in India and has been able to secure a place in leading sustainability indices like DOW Jones Sustainability Index, MSCI Global Sustainability Index and FTSE4 Good Emerging Index. Listing on these indices indicates its positive contribution towards corporate social responsibility.

TCS became the first Indian IT company to cross the benchmark market capitalization of US$100 billion. It is to be noted that the market cap of TCS is more than the GDP of many countries. TCS has been ranked among the Top 3 IT services brand at the global level and is marked as the fastest growing brand in IT sector by Brand Finance. TCS ranked 1st across the region in Institutional Investor's 2018 All Asia Executive Team Rankings in IT services and software sector.

TCS employs the maximum number of employees in IT sector not only in India but at the global level too. It has been recognized as the Global Top Employer by the Top Employers Institute for the 4th consecutive year. The company is marked as the Number 1 Top Employer in the regions of North America, Europe, Asia Pacific and the Middle East.

2. BACKGROUND OF TCS

TCS was initially started as a department of Tata Group named Tata Computer Centre. It was formed to offer computer services only to its own group. Soon after in 1968, it was established as TCS, as a division of Tata

Sons Ltd. In 2004, TCS became a publicly listed company. The company has its head office at Mumbai and now has many subsidiary companies worldwide.

3. OBJECTIVE AND SIGNIFICANCE OF THE STUDY

The growth rate of the Indian economy is continuously increasing at a greater pace. This rate is accompanied by the increasing contribution of the service sector, majorly by the IT & ITES sector. This article aims to analyze the financial performance of the selected company. The study will provide multitudinous benefits to the parties interested in the company like management (by undertaking SWOT analysis, it will help frame the policies), creditors (to know the firm's ability to meet its short-term liabilities), investors (for making better investment decisions in terms of expected rate of return), employees and job seekers, banking sector, government and tax authorities, for the researchers etc.

4. PERIOD OF STUDY

The period for the financial performance analysis of the company has been limited for 5 years from 2015–2019. This period has been taken for the latest and recent financial review as the company changed its keeping of financial statements from GAAP to Indian AS after 2015.

5. TOOLS EMPLOYED

The following tools have been used for a better understanding:

1) Trend Analysis

2) DuPont Analysis

3) Altman Z Score Model

6. LITERATURE REVIEW

1) Isberg, S. C. **(1998)** in the article "Financial Analysis with the DuPont Ratio: A Useful Compass", made a study on the Atlantic Aquatic Equipment, Inc. using DuPont analysis comparing with the industry line. He concluded DuPont to be a compass to identify the strengths and weakness of the items from the financial statements. Accordingly, he calculated ROE and analyzed the decomposition of it into profitability, assets turnover and leverage ratio. When compared with the industry line averages it was evident that this company lacked significantly in terms of profitability whereas assets utilization and leverage were in accordance with the industry lines.

2) J. Pavithra et. al (2007) in the paper titled, "A Study on the Analysis of the Financial Performance with Reference to JEPPIAAR Cements Pvt. Ltd." made a conclusion about the financial performance analysis of JEPPIAAR Cements Pvt. Ltd. The period of the study was taken for 5 years from 2009–2013. Comparative financial statements, ratio and trend analysis were employed to study the financial position over the years. It was found that the debtor's turnover ratio is showing an increasing trend which is not considered good for the company and concluded the overall profitability position to be good. The current ratio showed fluctuation, but the creditworthiness of the company was observed to be good.

3) Dr. S. Usha (2010) in the paper titled, " Financial performance analysis of the selected Software Companies in India" collected data of 65 companies for the period 1997–2007. A Stepwise regression model and summary statistics were used to analyze the operational efficiency of the selected companies. They concluded that there is a strong relationship between the operating profit and the independent variables taken collectively. Profitability, efficiency, liquidity, ICR, DER, ROTA, PER, EAT/NET SALES, ROSH, earnings before interest and tax/net sales etc were inconsistently performing. The reason why the inconsistence performance was there could have been because of the financial policies adopted and the size of the companies.

4) Dr. S. Vijaylakshmi et. al (2007), in the article titled, "A Study on Financial Performance Analysis of Bharti Airtel Limited", took a period of 5 years from 2011–2016 for the financial assessment of the company selected. The financial tools employed to measure the financial position was ratio analysis. Under ratio analysis, short-term and long-term ratios were used to see the liquidity, profitability and stability level of the company. It was concluded from the study that the liquidity level of the company kept varying. The profitability of the company was not as good, as the sales was decreasing and income was also not stable. Bharti Airtel needed to improve their debt position too.

7. TREND ANALYSIS:

The analysis and review of financial statements for a number of years is termed as Trend analysis. It is also termed as dynamic or horizontal analysis. It usually applies to two important financial statements namely, Balance Sheet and Statement of Profit and Loss, prepared in the comparative form for two or more years. Comparative figures indicate the trend and direction of the financial position and operating results. It is used for intra-firm comparison where the performance of the company is analyzed for the various accounting periods.

It indicates trend in different financial variables of an enterprise. For example, the revenue from operations increasing over the years shows the positive trend of growth of the enterprise. Study of comparative statements over a period helps to indicate the strengths and weaknesses about the financial position and thus helps forecast and plan for the future.

Generally, for the study of trend for two years, it is calculated on previous year basis. But, when the data includes more years (like 5 years), then the first year is taken as the base year and on that basis, the trend is calculated.

7.1 Trend Analysis: From Table 1, we can analyze the trend of the Income statement of TCS as follows:

- Revenue: An upward trend can be seen in the total revenue earned of the company by 53 per cent in 2019 as compared to 2015.

- A gradual increase in the revenue over the years can be noticed. 9 per cent increase in total revenue of 2017 as compared to revenue of Rs.111730 crores in 2016, revenue growth increased by 4 per cent in 2018 as compared to that of 2017 of Rs.122188 crore and 18 per cent increase in revenue by 2019. Revenue growth has also been positively impacted by the currency fluctuations in the 2019 but negatively impacted in 2018. However, it can be noticed that the revenue growth has been on expected lines and the best in the industry.

- Expenses: Total expenses have increased by 52 per cent in 2019 on a YoY basis i.e. 9 per cent increase in 2017 in comparison to 2016. Increase in the total expenses by 6 per cent in 2018 (taking base as 2017) and 18 per cent increase in 2019 as compared to 2018. However, it can be noticed that expenses are increasing majorly because of the increase in employee cost, operating cost, selling and administrative costs and currency fluctuations.

- Increase in the employees cost is the indication of expansion of business which will give huge returns in future without largely affecting the present returns and without sacrificing the margins.

- The research and development expenses in which the company is increasing its expenditure to develop new products and innovations would largely benefit the company in the coming years.

- Currency movements have also influenced the cost figures.

- EBDIT: An upward trend can be seen in the operating profit of the company on YoY basis except in 2018 where a downward trend is witnessed. This is due to the decline in the other income of the company in the fiscal year by 13.7 per cent in comparison with 2017. The year 2019 can be seen showing an increasing trend by 21.18 per cent which was the best in the industry line. The EBDIT has increased by 21.2 per cent in 2019 as compared to 2015.

- EBIT: YoY earnings before interest and tax are also showing an upward trend. 2018 showed a decline by 1.2 per cent in the trend against motion as depreciation charges increased by 1.4 per cent. 2019 again showed an upward momentum by 22.30 per cent as compared to 2018. Overall, EBIT has increased by 22.3 per cent in 2019 as compared to 2015.

- EBT: Increasing trend can be seen in earnings before tax. Taking the base year as 2015, it increased by 58 per cent. On YoY basis, it can be observed that it increased by 21 per cent in 2016 as compared to 2015, by 8 per cent in 2017 on basis of the previous year 2016. EBT declined by 1.3 per cent in 2018 on YoY basis. Upward trend can be seen in 2019 by 22 per cent as compared to 2015.

- PAT/EAT: An increasing trend can be observed in the years 2016 & 2017 by 21 per cent and 8 per cent respectively. The cumulative effect of other income can be seen as decrease in profits after tax in 2018, as it declined by 1.8 per cent. A positive trend is indicated by 22 per cent from 2015 to 2019.

- The reported revenue has been affected due to the currency fluctuations (by 2.3 per cent) in 2018.

Table 1: Trend Analysis of P&L Statement from 2015 to 2019

Particulars	Note No.	Absolute amounts (Rupees in crores)					Amounts in percentage % showing trend Base year-2015 and(YoY shows the trend on previous year basis in % in yellow shade)				
		2015*	2016	2017	2018	2019	2015	2016	2017	2018	2019
i. Revenue from operations		94648	108646	117966	123104	146463	100	114.7	124.6	130	154.7
ii. Other Income		3720	3084	4221	3642	4311	100	82.9	113.4	97.9	115.8
iii. **Total Revenue**		**98368**	**111730**	**122188**	**126746**	**150774**	**100**	**114**	**124**	**129**	**153**
[i+ ii]		YoY	+13362	+10458	+4558	+24028		+14	+9.3	+3.8	+18.9
Expenses											
(a) Cost of materials consumed		-	-	94	86	40	100		94	86	40
(b) Power and fuel cost		574					100	-	-	-	-
(c) Employee cost		38701	55348	61621	66396	78246	100	143	159.2	171.5	202.1
(d) Other manufacturing expenses		24486	2571	2715	2614	2230	100	10.4	11	10.6	9
(e) Selling and administrating expenses		4842	15589	16392	16808	20387	100	32.2	338	347	421
(f) Miscellaneous expenses		1564	4461	4834	4684	6054	100	285	309	299	387
v. **Total expenses**		**70167**	**77969**	**85656**	**90588**	**106957**	**100**	**110**	**122**	**129**	**152**
		YoY	+7802	+7687	+4932	+16369		+10%	+9.8	+5.7	+18
v. **EBDIT (OPERATING PROFIT)** [3–4]		**28201**	**33761**	**36532**	**36158**	**43817**	**100**	**119**	**129**	**128**	**155**
		YoY	+5560	+2771	(374)	+7659		+19	+8.2	(1.1)	+21.2
vi. Less: Depreciation		1799	1888	1987	2014	2056	100	105	110	111	114
vii. **EBIT**		**26402**	**31873**	**34545**	**34144**	**41761**	**100**	**120.7**	**131**	**129**	**158**
		YoY	+5471	+2672	(401)	+7617		+20.7	+8.3	(1.2)	+22.3
viii. Less: Interest		104	33	32	52	198	100	32	31	50	190
ix. **EBT (Profit before Tax)**		**26298**	**31840**	**34513**	**34092**	**41563**	**100**	**121**	**131**	**127**	**158**
		YoY	+5542	+2673	(421)	+7471		+21	+8.4	(1.2)	+21.9
x. Less: Tax		6238	7502	8156	8212	10001	100	120	131	132	160
xi. **Net profit (Profit after Tax)**		**20060**	**24338**	**26357**	**25880**	**31562**	**100**	**121**	**131**	**129**	**157**
		YoY	+4278	+2019	(477)	5682		+21	+8.3	(1.8)	+21.9

Source: Data collected from TCS financial reports, money control and capital market website, and calculated and compiled as per requirement.

*The company shifted to Indian AS from 2015, from Indian GAAP. 2015 excludes the impact of one-time employee rewards.

Table 2: Trend Analysis of Balance Sheet of TCS from 2015–2019

Balance sheet trend analysis

Sources of Funds	Absolute amount in rupees (in crores)					Amount in % showing Trend base year 2015					YoY trend i.e. Previous year			
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2016	2017	2018	2019
Total Share Capital	195.87	197	197	191	375	100	101	100.5	97.5	191.4	0.57	0.5	-3.1	96.3
Equity Share Capital	195.87	197	197	191	375	100	101	100.5	97.5	191.4	0.57	0.5	-3.1	96.3
Reserves	50,438.8	70,875	86,017	84,937	89,071	100	140.5	171	168	177	40.5	21.3	-1.3	4.80
Networth	50,634.7	71,072	86,214	85,128	89,446	100	140	170	168	177	40	21	-1.2	5.00
Secured Loans	113.69	83	71	54	44	100	72.8	62	47	38.5	-27	-14	-24	-19
Unsecured Loans	186.14	113	200	181	0	100	61	107.5	97	0	-39	77	-9.5	-100
Total Debt	299.83	196	271	235	44	100	65	90	78	15	-35	-38	-13	-81
Minority Interest	1,127.76	355	366	402	453	100	31	32	36	40	-68.5	3.1	9.8	12.7
Total Liabilities	52,062.35	71,623	86,851	85,765	89,943	100	138	167	165	173	38	21	-1.3	5
Application of funds														
Gross Block	18,886	21,111	22,535	24,477	26,401	100	112	119	130	140	12	6.75	8.6	7.8
Less: Accum.Dep.	7,247.8	9,337	10,834	12,504	14,111	100	129	149	173	195	29	16	15.4	12.8
Net Block	11,638.17	11,774	11,701	11,973	12,290	100	101	100.5	103	107	1	-0.6	2.3	2.5
Capital WIP	2,766.3	1,670	1,541	1,278	963	100	60	58	46	35	-40	-7.8	-17	-25.
Investments	1,662	22,822	41,980	36,008	29,330	100	1,373	2526	2167	1765	1273	84	-14	-25
Inventories	16.07	16	21	26	10	100	99.60	131	162	62	-0.4	31.25	23.8	-62
Sundry Debtors	20,437.94	24,073	22,617	24,943	27,346	100	118	111	122	134	18	-6	10.2	9.6
Cash and Bank Balance	18,556.04	6,788	4,149	7,161	12,848	100	37	22	39	69	-63	-39	72.5	79
Total Current Assets	39,010.05	30,877	26,787	32,130	40,204	100	79	69	82	103	-21	-13	20	25
Loans and Advances	18,584	21,953	21,243	24,907	32,156	100	118	114	134	173	18	-3.2	17	29
Total CA, Loans & Advances	57,594.56	52,830	48,030	57,037	72,360	100	92	83	99	126	-8	-9	18.7	27

Current Liabilities	13,645.50	17,318	16,296	20,265	24,761	100	127	119	149	181	27	-6	24.3	22
Provisions	7,953	155	105	266	239	100	2	1.3	3.3	3	-98	-32	153	-10
Total CL & Provisions	21,598.53	17,473	16,401	20,531	25,000	100	81.00	76	95	116	-29	-6	25	22
Net Current Assets	35,996	35,357	31,629	36,506	47,360	100	98.00	88	101	132	-2	-11	15.4	29.7
Total Assets	52,062.35	71,623	86,851	85,765	89,943	100	138	167	165	173	38	21	-1.3	5
Contingent Liabilities	6,148.5	0	8,095.00	4,088.00	4,516	100	0	131.6	66.4	73.4	0	-	-49	10.4
Book Value (Rs)	258.51	360.69	437.54	444.7	238.37	100	139.5	169.2	172	92.2	40	21.3	1.6	-46

Source: Data compiled and calculated from TCS financial reports, money control, capital market and equity master website

7.1.1 Analysis of Balance Sheet:

- An increasing trend can be seen in the equity from the years 2015–2019 by 91.4 per cent and on YoY basis as well. The upward trend is seen in Table 2 and Graphs 1–3.

- In 2018, equity decreased from 197 (2017) to 191, a fall by 3.1 per cent. The reason for this was the buyback of shares by the company which had cost about Rs 6 crores that lead to the equity share to stand at 191 crores.

- In 2019, equity increased by 96 per cent due to the allotment of bonus on equity shares held by the shareholders that stood approximately at 192 crores and extinguishment of buyback shares worth Rs 8 crores lead to the equity stand at 375 crores as against 191 crores in 2018.

- Reserves also show a rising movement by 40.5 per cent in 2016 and by 21.3 per cent in 2017. It declined in 2018 by 1.3 per cent as the reserves were utilized for the buyback of shares and related expenses. The trend to increase continued in 2019 by 4.8 per cent. Overall reserves increased by 77 per cent from 2015 to 2016.

- A downward trend can be seen in the borrowings of the company by 61.5 per cent (secured loans) and by 100 per cent (unsecured loans i.e against banks overdraft) in 2019 as against 2015. This is a positive trend for the company as it demonstrates that the company believes in capital arrangement on internal basis and reducing risk for its shareholders.

Therefore, total debt has decreased by 85 per cent from 2015 to 2019.

- Gross block i.e. total value of the assets to the company (property, plant, equipments including intangible assets) has registered an increasing trend. It increased by 40 per cent from 2015 to 2019. On a YoY basis it increased by 12 per cent in 2016. Thereafter increased by 6.75 per cent and 8.6 per cent in 2017 and 2018 respectively, showing an addition of 7.8 per cent in total worth of assets in 2019.

- Net block i.e. actual value of the total assets has also registered an increase after making for accumulated depreciation. Net block has increased by 7 per cent in 2019 as against 2015. YoY, a positive trend can be witnessed by 1 per cent (2016), 2.3 per cent (2018) and 2.5 per cent (2019). In between, in the year 2017 it decreased by 0.6 per cent.

- A decreasing trend can be witnessed in the capital work in progress (fixed assets under construction) which is again a positive indicator for the company. Net current assets has increased by 32 per cent in 2019 as against the year 2015.
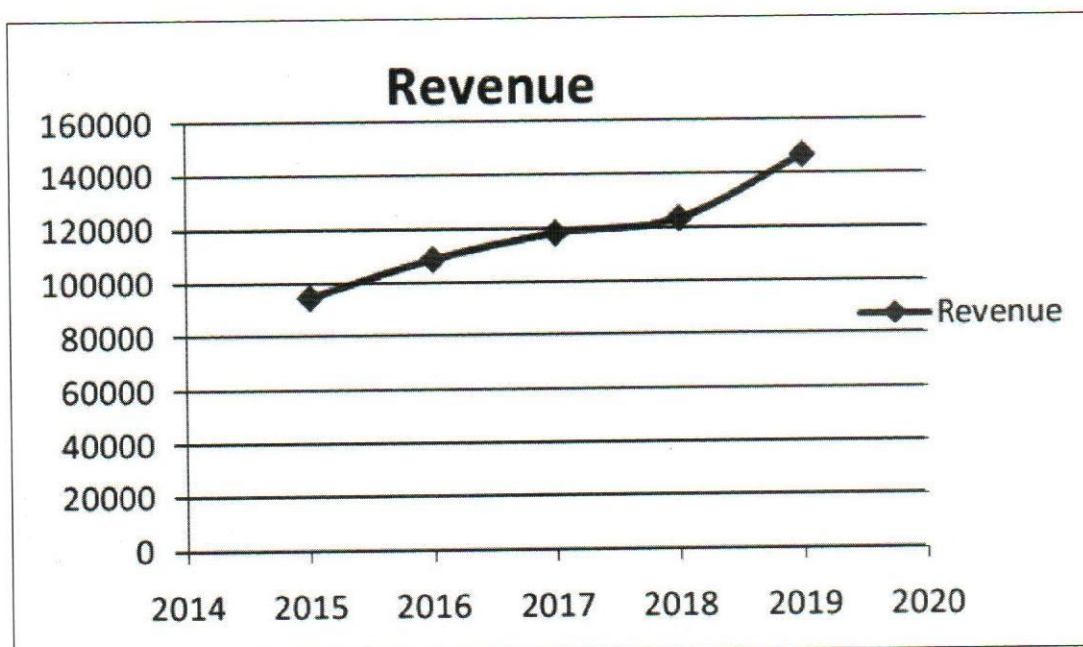
Graph 1. Revenue trend for years 2015–2019

EBITDA
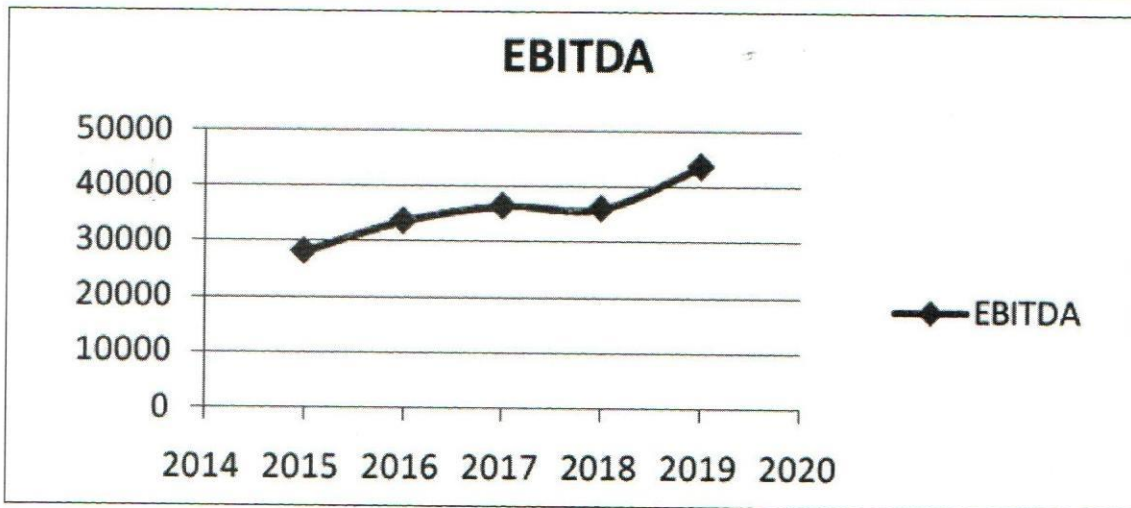
Graph 2. Operating Income trend for years 2015–2019
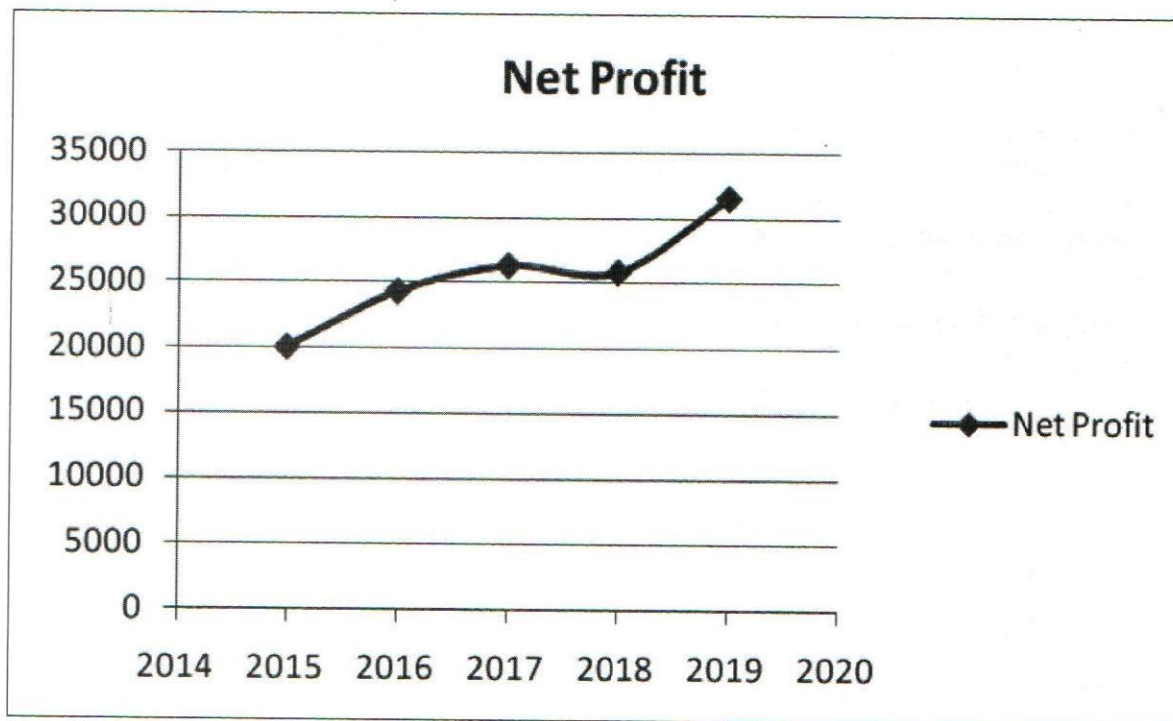
Net Profit

Graph 3. Net Profit trend for years 2015–2019

7.2 Dupont Analysis:

An increase in the ROE is indication of the net income generated over the funds invested by the shareholders, i.e. equity. Higher the ratio, higher is the net income generated by the entity. It has certain limitation such as, it is based on the past financial figures which can be easily manipulated, and it ignores cash flow too. Most importantly, ROE can be increased by playing around with equity. The entity can reduce equity by converting equity

to liabilities through increased debts in order to get better ROE. Investments based on seeing the trend to ROE can mislead the investor.

To overcome this limitation, DuPont analysis was introduced by the DuPont Corporation in the year 1920 (Flowchart 1). DuPont Analysis is the extension of ratio ROE. It breaks down the ROE into three ratios viz. Net Profit Margin, Assets Turnover and Financial Leverage, and analyzes them to see what is the strength of the

entity and where is the scope for improvement. It concludes that a company can earn a high return on equity if it:

Earns a high net profit margin, makes use of its assets effectively to increase the sales, high financial leverage. (DuPont @ 3-point analysis)

When net profit margin is further broken down into EBIT Margin, Interest Impact and Tax impact, it is analyzed at DuPont Analysis @ 5 points.

Computation:

DuPont Analysis = Net Profit Margin * Assets Turnover ratio * Financial Leverage

DuPont ratio is always equal to ROE. It simply tells about which component of ROE is increasing and decreasing. For example, if DuPont analysis shows that the NPM, assets turnover ratio increases while financial leverage decreases, the increase in ROE is beneficial. Instead, if the financial leverage increases and other components decrease, then ROE is not beneficial.

Based on Table 5 we can conclude that:

- From year 2015 to 2016 though ROE decreased, the net profit, operating profit margin increased and financial leverage decreased. Therefore, it is positive though the assets turnover ratio is decreased but other components are showing positive attitude. It
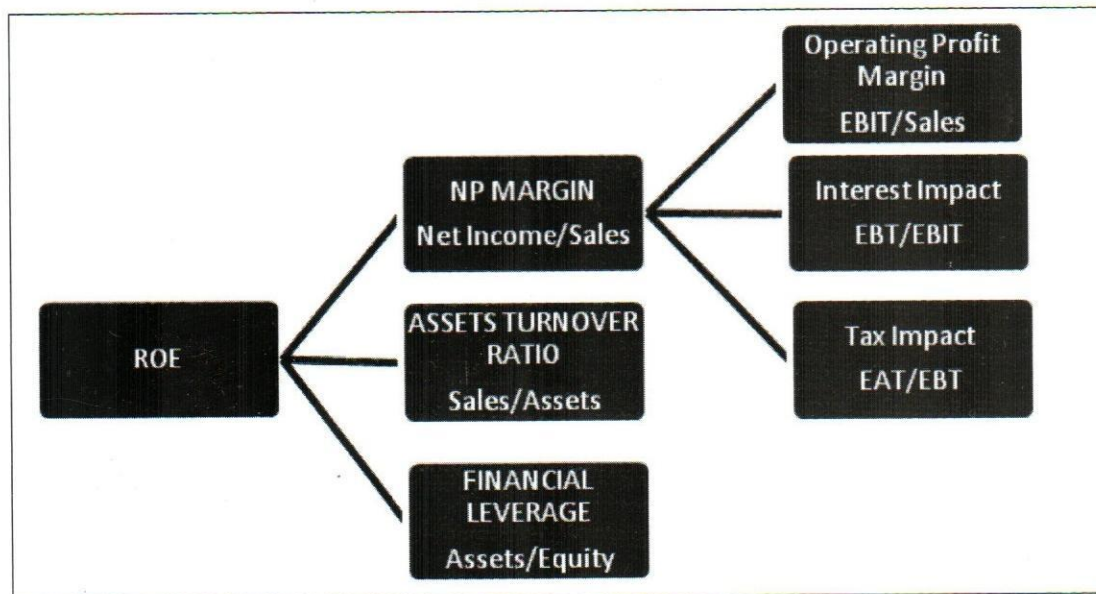
Flowchart 1. Breakdown of ROE

Table 3: Table showing relevant data

Particulars /years	2019	2018	2017	2016	2015
Sales	146463	123104	117966	108646	94648
EBIT	41761	34144	34545	31873	26402
EBT	41563	34092	34513	31840	26298
Net Income	31652	25880	26357	24338	20060
Assets	114943	106296	103252	89096	73661
Equity	89446	85128	86214	71072	50635

Source: TCS annual reports, capital market and money control website

Table 4: Calculated Ratios on basis of Table 3

Ratios	2015	2016	2017	2018	2019
ROE	39.20	34.14	30.49	30.33	35.18
NP Margin	21.19	22.40	22.34	21.02	21.54
Assets Turnover	128.94	121.94	114.25	115.81	127.42
Financial Leverage	145.47	125.3	119.76	124.86	128.5
EBIT/Sales	27.37	29.33	29.28	27.73	28.51
EBT/EBIT (Interest impact)	99.6	99.9	99.9	99.8	99.5
EAT/EBT (Tax impact)	76.2	76.4	76.3	75.9	75.9

Source: TCS annual reports, capital market and money control website

Table 5: DuPont Analysis

Particulars	2015 ⇨ 2016	2016 ⇨ 2017	2017 ⇨ 2018	2018 ⇨ 2019
ROE	↓	↓	↓	↑
NP Margin	↑	↓	↓	↑
Assets Turnover	↓	↓	↑	↑
Financial Leverage	↓	↓	↑	↑
Operating Profit Margin	↑	↓	↓	↑
Interest impact	↑	↑	↓	↓
Tax Impact	↑	↓	↓	No change

Table 6: Average of ratios of TCS and IT Industry

Particular	TCS	Industry Line
Gross Margin	90.09%	66.55%
Operating margin	25.44%	24.67%
EBT margin	28.49%	28.31%
Net Profit margin	21.7%	20.93%

Source: data collected from investing.com and compiled

can be beneficial to invest in equity as against the negative movement of ROE.

- From 2016 to 2017, though financial leverage has decreased, other components such as NPM, Assets Turnover ratio, Operating profit margin and interest impact have also decreased. Hence, it can be concluded that ROE decrease as shown is not beneficial.

- ROE is decreasing which shows that return on funds to the shareholders was decreasing and not beneficial to invest in 2018 particularly. NPM, Operating profit margin was decreasing and financial leverage had increased, though assets were effectively used this year. Tax and interest impact has declined, which is evident, as the NPM has decreased.

- From year 2018 to 2019, ROE has increased due to the increase in positive factors like NPM, Assets turnover ratio, Operating profit margin and decrease in interest impact and no change in tax impact. Though financial leverage has also increased, all other factors are showing positive movement which is beneficial to invest in equity as suggested by ROE movement.

From Table 6, it can be analyzed that the ratio averages of the TCS are higher than the industry line averages.

7.3 Altman B Model (Z score)

Altman Z score is a financial model developed by Prof. Edward I. Altman in 1968 to predict the chances of a public manufacturing company's likelihood to move into bankruptcy. To evaluate the financial health of a company, it makes use of five financial ratios such as profitability, activity, liquidity, leverage and solvency ratios to predict/gauge the company moving towards insolvency. Essentially, the Altman Z score model was formulated for the manufacturing companies and not for private companies or non-manufacturers. Later, many public service companies came up. Therefore, some variations were made to the original model, and in 1983, Altman Z score model A was developed for private companies. Later, Model B was developed for service companies.

Model B makes use of only 4 ratios and does not include Sales/total assets i.e Assets turnover ratio. It is basically the horizontal summation of ratios weighted by coefficients.

Table 7: Calculated Ratios

Ratios \ Years	2015	2016	2017	2018	2019
X1	0.69	0.49	0.36	0.42	0.52
X2	0.96	0.98	0.99	0.99	0.99
X3	0.50	0.44	0.39	0.39	0.46
X4	1.79	14.17	14.46	13.30	30.25

Z score formula for service industry:

$$Z = 6.56^*X_1 + 3.26^*X_2 + 6.72^*X_3 + 1.05^*X_4$$

X_1—Working capital/Total assets

X_2—Retained earnings/Total assets

X_3— EBIT/Total assets

X_4—Market value of equity/Book value of debt

Interpretation:

a) Z>2.6-Safe Zone

b) Z<2.6-Gray Zone

c) Z<1.1-Distress Zone

Table 7 shows the ratios calculated—liquidity, profitability and leverage ratios.

Working capital ÷ Total Assets is a liquidity ratio that evaluates the ability of a company to cover its short-term financial liabilities. It indicates the company's liquidity position and financial strength. Higher ratio indicates good financial strength and liquidity level to meet out the short-term obligations.

Retained earnings ÷ Total Assets indicates the extent to which the company relies on debt and shows assets profitability. Lower ratio means that the company makes use of borrowings instead of using reserves for the purchase of the assets. It indicates the possibility of insolvency if the firm is not able to cover its debt requirements.

EBIT ÷ Total Assets show the efficient use of assets to be able to generate earnings. It also helps to know about which assets are unproductive, and to dispose them off. Higher ratio is considered better as it measures that the assets are effectively utilized.

Market value of equity / book value of debt show the possible decline in the value of the assets before the assets go short of liabilities, making the firm insolvent. Higher ratio is better.

From Table 8, it can be analyzed that the value of Z score is greater than 2.6 in all the years and is showing an overall increasing trend. In the years from 2015–2019 there is no sign of company going into gray zone and/or distress zone.

Table 8: Calculation of Z score

Years	Z Score
2015	$(6.56 \times .69) + (3.26 \times .96) + (6.72 \times .50) + (1.05 \times 1.79) = 11.56$
2016	$(6.56 \times .49) + (3.26 \times .98) + (6.72 \times .44) + (1.05 \times 14.17) = 24.22$
2017	$(6.56 \times .36) + (3.26 \times .99) + (6.72 \times .39) + (1.05 \times 14.46) = 23.38$
2018	$(6.56 \times .42) + (3.26 \times .99) + (6.72 \times .39) + (1.05 \times 13.30) = 22.55$
2019	$(6.56 \times .52) + (3.26 \times .99) + (6.72 \times .46) + (1.05 \times 30.25) = 41.51$

8. FINDINGS AND CONCLUSIONS:

- As per trend analysis: Net sales (revenue) of the company is growing year by year.

- Overall Operating Income, Net Profit is increasing and is best in the industry among peers like Infosys, Wipro etc. In the latest five-year period, while the market for IT-BPM services expanded by a CAGR of 1.3 per cent (IT Services CAGR: 0.6 per cent), TCS had a CAGR of 10.5 per cent in USD terms. Overall profitability position is good.

- The five year averages of gross profit margin, operating margin, EBT margin and net profit margins are higher than the industry average. Therefore, the overall efficiency stands to be good for the company.

- Debts are falling, demonstrating a positive attribute.

- Overall, the total assets and liabilities for FY19 stood at Rs. 89943 crores as against Rs. 85765 crores during FY18, thereby witnessing a growth of 5 per cent.

- ROE to the shareholders is best among the peer companies. ROE is 35.18 (2019) which is very high as against the average of the peers of 1.81 in year 2019.

- DuPont analysis makes it clear that company needs to focus on the effective utilization of the assets. Though trading on equity has helped to increase the earnings per share, which is beneficial, it should be seen that financial leverage (use of equity funds for assets) should be reduced.

- Tax and interest impact is declining and consistent, a good sign for the company.

- Z score is continuously increasing that shows that the company is able to meet its short term liabilities, is using more of reserves to fund assets indicating the reliance on the internal management of assets and the cash flows related to the cost of debt are reduced.

- Assets need to be efficiently utilized to generate earnings before tax and interest impact.

- Market value of equity-market cap is higher, to cover the debts of firm.

The company has gained momentum in a positive direction and it can be estimated that in the coming years the upward trend in the sales, operating income and the net profit of the company will be monitored. The financial health of the company is very sound and it doesn't indicate any sign of bankruptcy.

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"*Moving in space, the atoms originally were individual units, but inevitable they began to collide with each other, and in cases where their shapes were such as to permit them to interlock, they began to form clusters. Water, air, fire, and earth, these are simply different clusters of the changeless atoms.*"

– Democritus

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