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Strategic Planning towards Effective Management of New Technology in Open Cast Mines

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Abstract: Technology has become backbone of corporate sustainability after the pro-market reforms due to immense competition worldwide in prime sectors. Technology Management is a practice that entails classification, selection, adoption and exploitation of the technologies needed to maintain organization's current and future survival. Manufacturing sector though invested lot in technological part; is still lacking as per their expectation in terms of overall performance. Coal mining sector in India is one of the core sectors which are far behind comparing with global standards inspite of implementation and use of best technologies. Open cast coal mining industries warrants for state of the art technology which have two aspects: first is the selection of appropriate / suitable technology and second is the effective management of them. Present article highlights strategies and methods adopted in a coal mining industry for effective management of new technology and its implementation. It attempts to focus on effective management of new technology by identifying various factors required for the same in opencast coal mining industries. This research also directs to understand and assess the reasons for low productivity and suggest suitable remedial measures towards effective management during implementation of new technology.

Key words: Technology Management, Opencast Coal Mining, Effective management of technology.

I. Introduction

Technology is essentially a starting point for knowledge; is required for taking initiative and decision making. It provides new tools to deal with knowledge and a result will have far reaching implication on future decision-making process. With rising complexity and factor of globalization, technology has gained overriding objective in the fast changing competitive environment. In the contemporary, business environment needs latest technology is imperative for maintaining quality standards. Business house demand two aspect of technology: first one is the selection of appropriate / suitable technology and second one is effective management of the same. Suitable technology is indicative to be a good match between technology utilized and resources required for its optimal use. Simply taking up of new technologies is a difficult task due to innumerable alternatives available both indigenously as well as internationally. However, second aspect needs to be more focused to understand the effective management of technology for capitalizing it to the maximum extent.

Researchers feel that the coal mining industries under government control lacks effective management of new technology and not able to justify the returns on investment. Technology cannot play itself but it can bring a change and has to be supported by appropriate interventions and an advanced human skill. There is no denying of the fact that the wrong choice of technology leads to dismal consequences affecting the overall health of the organization nonetheless the fact also lies in the effective management of technology. Indian coal industries have witnessed a series of technological changes but it is still struggling in extracting coal suitable for the domestic consumption rather depending on imported coal. Therefore, assessment and evaluation criteria with respect to its cost effectiveness, availability of raw material and skill availability are needed to be established.

Indian open cast coal mining is far behind in global standards in spite of implementation and use of best technologies. The way in which internal planning and implementation processes are managed could greatly influence the outcome of new technology. Technology implementation and planning refers to extent how the organization has strategically designed the deployment of new technology(s) prior to its implementation. The processes incorporated within this design influence overall effectiveness of technology deployment and utilization. Throughout the implementation process, effective management means supporting the project team, selecting right technology and designing and providing appropriate training. This will ensure that new technology will complement existing processes and systems and will allow more productivity throughout.

Present study highlights the development of technology in Indian open cast coal mining industries primarily. This study also explores general strategies and methods adopted in a Coal mining industry for effective management of technology and its implementation. For this, we follow survey based methodology followed by analyses. For domain for data collection, we take one of the largest public sector coal units in the state of Jharkhand; namely Central Coalfield Limited under Coal India Limited along with its seven Open cast mines and its designing part (named CMPDI). After pre testing, reliability and validity, data collected are put into

statistical analysis and factors effecting management of technology are finally identified by using Factor Analysis in Statistical Package for Social Science (SPSS) platform.

II. Technology Management - Literature support

Technology comes from two Greek words: *Techne* (skill needed to make something) and *loges* (knowledge of something). Technology is knowledge of how something is made and is essentially a starting point for knowledge (Soloman, 1990). It provides new tools to deal with knowledge and a result will have far reaching implication on the future decision-making process. Other view relating to Technology consists to the branch of knowledge that deals with industrial arts, applied science and engineering related to processes, products, tools and techniques and systems employed in the creation of goods or services (Narayana, 2001).

Rising complexity crisis and globalization factor, technology has gained overriding objective in today's fast changing competitive environment. In the Contemporary, business environment needs latest technology is imperative for maintaining quality standards in order to remain in the business line. Organizational Success largely depends upon the efficient use and application of effective technology. Technology and its effective management are essential for overall success of any organization. Successful conceptualization and implementation of technology require coordination of a wide array of activities, information and expertise (Roy and Singh, 2014). Since business opportunities are time bounded; an organization needs to act quickly for availing the benefits of new and innovative technology in an efficient manner. These challenging developments in the business environment have heightened the need for effective management and control of procedure and technology. Thus, effective and efficient achievement of any goal at corporate or individual level requires a systematic and well planned process of decision-making. Effective management requires the setting of clear objective to perform effectively or efficiently (Bhalla, 1987). One of the major criteria for setting clear objectives is the overall audit of scope. Therefore objective should be such that it provides a clear direction to the people who have to contribute and perform for achievement. It is always desirable to have a participatory approach to set objectives. However management aspiration and expectations should be kept in view while adopting a participatory approach.

Every organization which is working in a highly competitive environment aspires to excel by improving its effectiveness and maintain performance (Chaudhuri and Moulik, 1986). However performance in any organization depends upon dedicated and skillful team of human resources that makes it happen. Productivity refers to accomplishment of objectives through utilization of resources (such as capital, workforce, machinery, infrastructure etc.). It refers to relationship between inputs and outputs or efficiency with which organizational objectives are achieved. Another important factor is team effectiveness which refers to efficient achievement of well-defined set of objective. Successful organizations continuously keep working towards improving their team's effectiveness by becoming responsive to the fast changing internal and external environment (David and Kirit, 2001). This task requires a diversity of skills and talents that is needed to be complemented amongst team members.

Organized efforts in the field of technology management began 1950s' onwards when R&D as well as modern management ideas were developed (this was a period characterized by plentiful resources to R&D). Management of innovation started functioning during 1970's; there was an interest in the entire corporate world to understand innovation and its proper application. During twentieth century, growth of technology shows opposite direction as a result of impact of global competition and economic crisis of United States.

Management of technology focuses on the principles of strategy and organization involved in technology choices, guided by the purpose of creating value for investors (Narayana, 2001). It is an interdisciplinary field that integrates science, engineering and management knowledge and practice. The focus is on technology as the primary factor in wealth creation, wealth creation involves more than just money. It may encompass factors such as enhancement of knowledge, intellect, capital, effective exploitation of resources, preservation of the natural environment and other factors that may contribute to raising the standard of living and quality of life. Managing technology implies managing the system that enables the creation, acquisition and exploitation of technology (Khalil, 2000). Technology is the most influential factor in a wealth-creation system; there are other factors that contribute to the system. Management of technology is an interdisciplinary field because it involves combining knowledge from science, engineering and business administration fields (Khalil, 1992). It impacts different functional entities of the cooperation: research and development, design, production, finance, personnel and information. Its domain involves both the operational and strategic interests of the organizations. The operational aspect deals with day-to-day activities of organization, while strategic dimension focuses on long term issues (Berman, 1992). Technology generates wealth when it is commercialized or used to achieve a desired strategic or operational objective for an organization (Gaynor, 1996). While the underlying premise for the management of technology is the most influential factors that contribute to the system. Management of technology treats technology as the seed of the wealth-creation system and with proper nourishment and good environment seed grows to become a healthy tree (Boskin and Lau, 1992). There are three important factors that a successful management of technology has to tackle. First, there is always a time lag between the development

of a technology and the commercialization of a product or service borne out of that technology. Second, it is very hard to have insight into the future when making evaluations and planning. Third is the readiness and abilities of engineers to draft ideas and concepts and manage development (Natarajan, 1999). It is a potential weak spot in management systems by putting emphasis on the strategic objective of the organization. It guides management in efforts to improve productivity, increase effectiveness and strengthen the competitive position of the enterprise.

Managing technology involves continuous effort in creating technology, developing novel products and services and successfully marketing them (Ford, 1988). This requires great creativity along with a system designed to exploit. The effective management of technology is essential if all the potential benefits for individuals and organizations are to be realized. It has the capability to transform products and processes and can make a huge contribution to organizational performance and even to national well-being. Effective management needs to make complex decisions associated with identification and evaluation of technologies, developing new or improved products and processes and integrating technology with other business processes, and to manage change required by technology implementation (Ulhoi, 1996). Effective management includes the diffusion of innovation; strategic design; power, politics and influence; and the relationship between technology and the individual, organization, and society. Sometimes, adopting technology seems an attractive option for those of us who are faced with an improvement challenge (Floyd, 1997). However Technology is not a panacea for the skills we lack or for every improvement issue we encounter. Instead, it is a tool that complements our abilities, allowing us to do more and to become more productive. Technology is the productive power, which has been both the development and destruction play a critical role in reshaping the world (Daim *et. al.*, 2014). On the other hand we can say that it is one of the prime factors of production therefore the effective management of technology is essential to the optimum utilization of natural resources.

III. Reasons Affecting Production of Coal

Initial talking with the concerned, visits to the production floor and talking with experts, the following reasons were found that affect production of coal within CCL.

- Outdated mining technologies are adding to the problems on the existing technologies. The cost and time run over due to lack of structural, tactical and strategic issues are one of the greater concerns which add to the problem.
- Technology change calls for acquisition, development, utilization and maintenance of adequate human resource.
- Old Heavy earth moving machinery has not been replaced at desire scale, which has caused increase in population of old fleet of HEMM with poor reliability and efficiency.
- Inadequate drilling capacities, backlog in overburden removal, mismatch between excavation and transportation capacities, low availability and under-utilization of HEMM etc.
- Frequent stoppage of coal transportation due to siding and other illegal activities. The issue of obtaining environmental and forest clearances is delaying many mining projects.

For the above problems identified, we talk with concerned persons regarding technology installation. The following technology has been installed within CCL for Open Cast Mines for last couple of years.

Sl. No.	Open Cast Mines	Installed Technology within CCL, Ranchi, Jharkhand
1	Ramgargh (Rajrappa OC)	Installation and commissioning of 10 Cu. Mtrs. and 25 Cu. Mtrs. shovels and 85 T dumpers, Pithead coking coal beneficiation plant.
2	KDH Hesalong OC	Installation and commissioning of 10 Cu. Mtrs. and 25 Cu. Mtrs. shovels and 85 T dumpers.
3	Piperwar OC	Installation and commissioning of mobile Inpit coal crushing and conveying
4	Jharkhand OC	Installation and commissioning of 10 Cu. Mtrs. and 25 Cu. Mtrs. Shovels and 85 T Dumpers
5	Urimari OC	Installation and Commissioning of 10 Cu. Mtrs. and 25 Cu. Mtrs. Shovels and 85 T Dumpers, Rapid Loading System
6	Ashoka Expansions OC	Introduction of Surface Minor in Ashoka expansion.
7	Amlo OC	Installation and Commissioning of 10 Cu. Mtrs. and 25 Cu. Mtrs. Shovels and 85 T Dumpers

IV. Formulation of problem with specific objective

Coal has been recognized as the most important source of energy for electricity generation and industries such as steel, cement, fertilizers and chemicals are major sectors of coal consumption. So in order to satisfy the coal demand, the Indian coal industry needs more investment and private players to raise its production level. The coal washeries have to take bigger role in the industry to produce less moisture and ash-based coal to sustain in strict environment regulations.

The other problem is coal quality and transport. The quality of Indian coal is poor over the past decades. Run-of-mine (ROM) coals typically have the high ash content (ranging from 40% to 50%), high moisture content (4-20%), low sulfur content (0.2-0.7%), and low calorific values (between 10.5 and 20.9 MJ/kg). Low calorific value implies more coal usage to deliver the same amount of electricity. Nearly 65% of non-coking coal in India

are low quality (grade E or below) and amount of ash in coal increases as one moves from core of the coal seam to its floor. In 1997, Ministry of Environment and Forests (MoEF) mandated the use of beneficiated coals with ash content of 34% (or lower) in power plants located beyond 1000 km from their coal source, and plants located in critically polluted, urban ecologically sensitive areas. Another constraint is lack of appropriate contractual agreements between suppliers and consumers. Coal supply is not guaranteed at any particular quality (sizing, ash content, calorific value, etc.) and there is no penalty for non-compliance. Coal producers in India have not taken the responsibility of certifying quality at consumer-end, but rather at the supply end. The coal transporters do not take overall responsibility for either the quality or quantity. In context of present research work and stated facts despite of having ample coal deposit, imported machinery / technology as well as ample demand in market, actual production of coal is less than the targeted one.

Research gaps classify issues and the areas highlighted above in previous section. Basic gaps which have been taken into consideration are listed below:

- There is a noticeable gap between forecasted and actual output of coal in context to CCL.
- There is a significance mismatch from procurement of technology to implementation to its maintenance.
- There is a significant gap in terms of Infrastructure, strategic and operational issues related to management.

The indigenous development of mining technologies will likely require government support of research, development, demonstration, and deployment of the technologies, as development and deployment of these technologies require long time scales and sufficient investment.

V. Research Methodology

Present research is based on survey based and instruments for that that were used to collect data is by Questionnaire designing, Personal interview and information collected during interactions with experts working in leading open cast mines. Questionnaires used for getting information were prepared in such way to cover all aspects under study. Interview method was used to collect information from the respondents to get their perception about the effective management of technology in the following open cast mines situated at the state of Jharkhand. Instrument development is covered into four stages: Item generation, Pre-pilot study, Pilot study and Large-scale Data Analysis.

In the first stage of item generation, items were generated based on literature review, along with discussion and interviews with experts and practitioners working under this field. In the pre-pilot study, these items are reviewed by senior level experts and re-evaluated through structured interviews with some practitioners who were asked to comment on the appropriateness of the research. As the interactions were held with senior most experts, information (data) provided by them elicited valuable feedback about this topic. Based on the feedback collected, redundant items are eliminated and new items are added. For first three stages, basic requirement for a good measurement is *content validity*, a judgment by experts of the extent to which a scale truly measures the concept that it intended to measure study (Flynn *et al.*, 1990). To assess content validity a 'dry run' was performed and subsequently questionnaires were administered to practitioners and experts. Based on their feedback and suggestion(s), final versions of the questionnaires were sent to respondent.

In the context of present economic liberalization, globalization and free market this study assumes greater importance as management of technology will be the hallmark of policy. In CCL it has been studied that the adoptions of state of art technology comprehend the present need; still they are lacking with effective management of the technology installed. Employees are also very reluctant of being at par with the technology installed. Some of the important factors related to selection and implementation of new technology are identified after talking with shop floor managers, senior level decision making experts within CCL.

Sl. No.	Factors effecting mgmt. of Technology	Lit. support lead by Authors'/ Practitioners'
1	Planning for Technology	Steele, 1989; Roy and Singh, 2014
2	Selection of Technology	Allan <i>et al.</i> , 2013
3	Technological Skills	Fredrick, 1987
4	Financial Feasibility	Sun, 1993
5	Cost and Benefit Analysis	Momaya and Ajitabh, 2005
6	Real time Technological Advancement	Moustafa, 1990
7	Managing HEMM Technology	Perrino and Tipping, 1989
8	Supply chain issues	Machado, 1992; Mashelkar, 2001
9	Waste reduction by applying new technology	Joshi, 1991
10	Real time transfer of technological change	Moustafa, 1990;
11	Socio-Economic issue on new Technology	Sharif Nawaz, 1983
12	Maintenance of overall Equipments	Millet and Stephen, 1990
13	Continuous Monitoring of Quality	Monica Maria, 2014
14	Proper Utilization of Machines	Prasad, 1995
15	Real time Training for Technical up-gradation	Lan, P and McCarthy, 2003
16	Safety needs for continuous technology	Gregory, 1995

17	Level of Mgmt. for adoption of new technology	Khalil, 2000
18	Technological barrier due to Land Acquisition	Akhilesh, 2013
19	Technological Effect on Environment	Anders et. al., 1997; Bowonder and Miyake, 2000
20	Proper Management Of Manpower	Bright. 1969
21	Market Feasibility	Burgelmam et. al., 2001; Dodgson et. al., 2008

The above factors identified were based on the production report generated by the CCL on the installed technology considered for the study.

A. Factor Analysis

Communalities which show how much of the variance in the variables has been accounted for by the extracted factors (Flynn, and Sakakibara, 1990). For instance over 93% of the variance in Maintenance of Equipments is accounted for while 67% of the variance in Management of Manpower is accounted for.

Communalities		
Factors	Initial	Extraction
<i>Top Level</i>	1.000	.864
Middle Level	1.000	.495
Selection of Indigenous Technology	1.000	.489
<i>Selection of Foreign Technology</i>	1.000	.714
Market Feasibility	1.000	.573
Financial Feasibility	1.000	.580
Cost and Benefit Analysis	1.000	.495
<i>Technological Advancement</i>	1.000	.908
Continuous Monitoring of Quality	1.000	.559
<i>Capacity Utilization of Machine</i>	1.000	.701
<i>Real time Training Needs</i>	1.000	.695
<i>Management Of HEMM</i>	1.000	.785
<i>Management Of Manpower</i>	1.000	.679
Land Acquisition	1.000	.541
<i>Technological Effect Environmental</i>	1.000	.934
<i>Supply Chain Issue</i>	1.000	.867
Waste Reduction	1.000	.445
Socio-Economic	1.000	.605
Transfer Of Technological Change	1.000	.528
Policy Implication	1.000	.623
<i>Planning for New Technology</i>	1.000	.923
<i>Maintenance of Equipments</i>	1.000	.931
<i>Technological Skills</i>	1.000	.722
Safety Requirements	1.000	.408
*Extraction Method: Principal Component Analysis.		

The next item shows all the factors extractable from the analysis along with their eigen values, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. Notice that the first factor accounts for 12.853% of the variance, the second 9.173% and the third 8.603 and up to ten 4.188%. All the remaining factors are not significant.

Total Variance Explained									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% Variance	of Cumulative %	Total	% Variance	of Cumulative %	Total	% of Variance	Cumulative %
1	3.085	12.853	12.853	3.085	12.853	12.853	2.299	9.578	9.578
2	2.202	9.173	22.026	2.202	9.173	22.026	2.260	9.415	18.994
3	2.065	8.603	30.629	2.065	8.603	30.629	1.918	7.991	26.985
4	1.654	6.892	37.521	1.654	6.892	37.521	1.910	7.957	34.942

5	1.369	5.705	43.226	1.369	5.705	43.226	1.578	6.575	41.517
6	1.240	5.168	48.393	1.240	5.168	48.393	1.434	5.976	47.492
7	1.188	4.950	53.343	1.188	4.950	53.343	1.203	5.013	52.505
8	1.136	4.733	58.076	1.136	4.733	58.076	1.168	4.866	57.371
9	1.121	4.670	62.746	1.121	4.670	62.746	1.161	4.838	62.208
10	1.005	4.188	66.935	1.005	4.188	66.935	1.134	4.726	66.935
11	.977	4.072	71.007						
12	.863	3.596	74.603						
13	.846	3.523	78.127						
14	.807	3.363	81.490						
15	.719	2.995	84.485						
16	.704	2.933	87.418						
17	.686	2.858	90.276						
18	.628	2.617	92.893						
19	.518	2.157	95.050						
20	.473	1.969	97.020						
21	.455	1.894	98.914						
22	.113	.471	99.385						
23	.099	.414	99.799						
24	.048	.201	100.000						

B. Rotated Component Matrix

	1	2	3	4	5	6	7	8	9	10
Planning for New Technology	.956	.009	.083	.032	-.005	.009	.023	-.020	-.002	-.034
Technological Advancement	.948	.011	.076	.010	-.005	-.011	-.007	-.031	-.013	-.036
Supply Chain Issue	-.006	.924	.037	.015	-.011	.048	-.065	-.040	.031	-.040
Top Level	.008	.918	.017	.003	-.077	.066	-.067	-.037	-.010	-.062
Waste Reduction	.062	.574	.053	-.025	.120	.004	.206	.209	.052	.073
Policy Implication	.112	.046	.740	-.015	.154	.076	-.015	.174	.027	.016
Financial Feasibility	-.142	.048	.721	-.033	-.158	.002	.035	-.098	-.022	.018
Market Feasibility	.355	-.027	.643	-.035	.122	.088	-.074	.003	.037	.042
Middle Level	.340	.221	.400	-.021	.207	.085	-1.705	.259	.145	-.179
Technological effect on Environment	.021	-.002	-.040	.963	.054	-.013	-.015	.012	.023	-.026
Maintenance of Equipments	.020	-.007	-.035	.955	.107	-.017	-.014	.016	-.056	-.038
Management Of Manpower	.010	.023	.149	.104	.783	-.081	.075	-.078	.047	-.105
Land Acquisition	-.121	-.014	.039	.166	.588	.172	-.341	.055	-.035	.014
Safety Requirements	.143	-.006	-.149	-.069	.483	.106	.011	.332	.074	.000
Cost and Benefit Analysis	.342	.116	.215	.045	.363	-.061	.192	-.016	-.261	.275
Technological Skills	.056	.158	.061	.040	-.071	.801	-.028	.146	-.059	.131
Real time Training Needs	-.054	-.048	.099	-.082	.181	.754	.087	-.121	-.046	-.218
Socio-Economic	-.023	.062	.030	.003	.118	-.120	-.751	-.076	-.016	.047
Selection of Indigenous Technology	-.047	.318	.025	-.029	.224	-.250	.470	-.031	-.209	-.081
Management Of HEMM	-.075	.065	.105	.045	.038	.011	.049	.869	-.011	.055
Selection of Foreign Technology	.000	.022	.067	-.053	.025	-.169	-.162	.121	.791	-.104
Capacity Utilization of Machine	-.020	.090	4.385	.045	.059	.127	.367	-.279	.698	.286
Continuous Monitoring Of Quality	.053	-.112	.192	-.054	-.031	-.112	.026	.057	.003	.614
Transfer Of Technological Change	.194	-.081	.313	.020	.060	-.106	.167	.010	-.013	-.585

Extraction Method: Principal Component Analysis

Rotation Method : Varimax with Kaiser Normalization

Rotation converged in 12 iterations

After analysis of the various factors only ten factors have accommodated for the effective management of new technology and If these interacting factors can be managed properly it is obvious that equipments reliability will be improved readily, reduction of operational cost and profit maximization will be the end results.

C. Scree Plot

The Scree plot (shown in Appendix-1) is a graph of the eigen values against all the factors (Cattel, 1966). The graph is useful for determining how many factors to retain. The point of interest is where the curve starts to flatten. It can be seen that the curve begins to flatten between factors 10 and 11. Note also that factor 11 has an eigen value of less than 1, so only Ten factors have been retained.

VI. Conclusion and Future direction

Technology has become backbone of corporate sustainability after pro-market reforms due to immense competition. Indian prime industries are facing a lot of competition nowadays due to the problem of globalization. To keep in race, every industry has to be up to date especially in the area of technology involved in it. Mining industries warrants for state of the art technology in real time basis. In our exposition towards management of technology, we will view firms as open systems: sets of interrelated activities that interface with the environment. A firm is viewed as a whole, and any activity that a firm does is meaningful only to the extent that it contributes something to the whole function of the firm. Further, firm interfaces and directed with environment at multiple fronts - customers, competitors, government, markets and so on. To develop ideas about management of technology within an open-systems view, we will employ four basic concepts: firm as a value chain, industries as competitive domains, forms of technological change and ultimately creation of value in the line of competitive advantage.

Technological developments play an important role to influence the mining productivity. The application of motive power and mechanical improvement to the process of production has accelerated the pace of industrialization to an unprecedented degree. The present study highlights the importance of technology and its proper management towards organizational performance. Taking the most viable area in manufacturing like coal, present research analyzed the problem of technological imbalance from management point of view of whether the company has ably harnessed the benefits of technology installed or not. Most of the technology adopted so far by our present domain / area of concern is almost imported with latest technology involvement. Several technological factors including degree of mechanization, technical know-how, product design etc. have a significant implication in overall efficiency. Improvement in any of the technological factors will contribute towards increase in industrial productivity.

Effective management of technology is essential if all the potential benefits for organizations are to be realized. It has the capability to transform products and processes and can make a huge contribution to organizational performance. Effective management needs to make complex decisions associated with identification and evaluation of technologies, developing new or improved products and processes and integrating technology with other business processes to manage change required by technology implementation. In this study, an attempt has been made empirically to identify the factor(s) that influence management of technology. It is expected that the present study will provide a valuable insight into the process of management of technology in a competitive market and help steel companies operating in mature markets to formulate effective strategies towards gaining competitive advantage in coming days of operation. The finding of our present research can further be developed for studying the same effect for medium and small size companies related to other primary domain.

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Appendix-1 Scree Plot

