International Journal of Advanced Information Science and Technology (IJAIST)ISSN: 2319:2682
Vol.5, No.4, April 2016 DOI:10.15693/ijaist.2016.v5.i4.45-63

Technology Management and its Implementations - a study with Central Coalfields Limited in Jharkhand State

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Abstract

With rising complexity and globalization, technology has gained overriding objective in the fast changing competitive environment. In the contemporary business environment latest technology is imperative for maintaining quality standards in order to remain in the business. There are two aspect of technology. The first one is the selection of appropriate and suitable technology and the second is effective management of new technology. Today finding simply new technologies is not 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 in order to capitalize it to its maximum.

At the outset, this paper attempts to focus on coal mining industries which are included in vital sectors of Indian economy. Energy security is the prime concern of Indian economy which is distressing Indian industries a lot. Indian Coal mining industry is still far behind in global standards inspite of implementation and use of best technologies. The problem lies in the implementation and its effective management. The way in which internal planning and implementation processes are managed could greatly influence the outcome of new technology. This study explores the strategies and methods adopted in a coal mining industry for effective management of new technology and its implementation. For this purpose, one of the public sector organizations namely Central Coalfields Limited, located at Ranchi, Jharkhand is being selected. The study pertains to find out the reasons for low productivity of coal at Central Coalfield Limited in great extent.

Key words: *Coal Mining, Opencast, Innovative Technology, Effective management*

Technology Management and its Implementation - a study with Central Coalfields Limited in Jharkhand

1. Introduction

Technology is essentially a starting point for knowledge; required for taking initiative towards effective decision making. It provides new tools to deal with knowledge and a result will have far reaching implication on the future decision-making process. With the rising complexity and globalization, technology has gained overriding objective in the fast changing competitive environment (David and Krit, 2001). In the contemporary business environment needs latest technology is imperative for maintaining quality

standards in order to remain in the business. There are two aspects of technology in business application: first is the selection of appropriate and suitable technology and the second one is the effective management of the same. Appropriate technology is indicating a good match between technology utilized and resources required for its optimal use (Akhilesh, 2013).Technology could be implemented to any level in business application - Low, Medium and high. Today simply taking up of new technologies is not difficult task due to innumerable alternatives available both indigenously as well as internationally. However, second aspect needs to be more focused to understand its affectivity in order to capitalize it to the maximum extent (Monica, 2014).

Technology has become backbone of corporate sustainability after the pro-market reforms due to immense competition (Muthuraman, 2004). Presently,open cast coal mining industries warrants for state of the art technology.Indian open cast coal mining is still far behind in global standards in spite of implementation and use of best technologies as well as central coalfields ltd and their open cast too.The problem lies in the implementation and its effective management. 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 the extent how the organization has strategically designed the deployment of new technology(s) prior to its implementation (Noori, 1990). The processes incorporated within this design influence the overall effectiveness of technology deployment and utilization. Throughout implementation process, effective management means supporting the project team, selecting the right technologyand designing / providing appropriate training. This will ensure that the new technology will complement to existing processes and systems and will allow more productivity throughout (Narayanan, 2001).

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 (Perrino and Tipping, 1989). 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 (Steele, 1989).

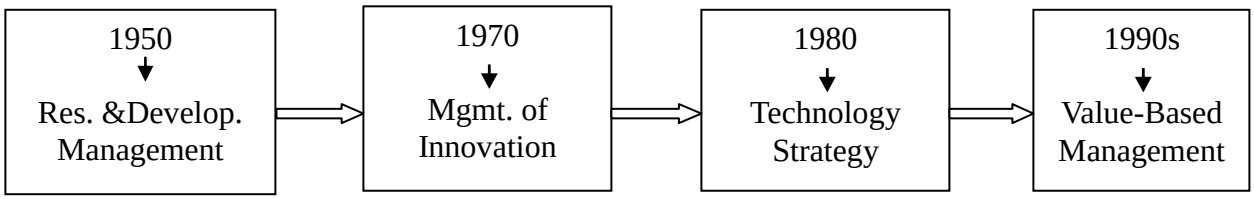
Indian coal industries have witnessed a series of technological changes but it is still struggling in extracting coal suitable for the domestic consumption rather depending on the imported coal (Roy and Singh, 2014). The technology cannot be effective unless it has been supported by appropriate organizational changes as well as

changes in human skills and training. Therefore, assessment and evaluation criteria with respect to its cost effectiveness, availability of raw material and skill availability are needed to be established(Report of Indian Bureau of Mines, 2012). This study explores primarily the strategies and methods adopted in a coal mining industry for effective management of technology and its implementation. For this purpose,we have selected one of the public sector organizationsnamely Central Coalfields limited (CCL) and their open cast mines as well as Central Mine Planning Design Institute Ltd. (CMPDI) located at Jharkhand. Jharkhand is chosen for area of research as because of the existence of best quality coal belts. The study pertains to find out the reasons for low productivity of coal within seven sites of CCL. Taking information by collecting primary data via structured questionnaire, this study attempts to explore overall to various factors required for effective management of technology in Indian opencast coal mining industries.

2.Literature Support

Definition of management of technology may thus be portrayed in a fundamental point that technology is not just a physical thing but also comprises knowledge embedded in hardware and software (MaCarthy, 2003). The acquisition of technological capability is therefore not a one-off process but a cumulative one in which learning is derived from the development and use of technology**.**

The organized efforts in the field of technology management began in the early 1950's when Research and Development as well as modern / innovative management ideas were developed (period characterized by plentiful resources to R&D). During 1960's to 1970's, there was an interesting phenomenon in technology arena to the entire corporate world for understanding innovation and its proper application. However in the twentieth century, graph of this development slows down as a result of the impact of global competition and economic crisis of US markets(Narayanan, 2001). Evaluation phase can be shown by the following figures:



Source: Managing Technology and Innovation, 2001

Management of technology focuses on the principles of strategy and organization involved in technology choices, guided by the purpose of creating value for investors (Khalil, 2000).

Management of technology is an interdisciplinary field that integrates science, engineering and management knowledge and practice (Contractor and Narayanan, 1990). 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 (Bright, 1969). Managing technology implies managing the system that enables the creation, acquisition and exploitation of technology(Khalil and Bayraktar,1990).Technology is the most influential factor in a wealth-creation system; there are factors that contribute to the system like capital information and investment which make a significant contribution to economic growth (Bowonder and Miyake, 2000).

Management of technology is an interdisciplinary field because it involves combining knowledge from science, engineering and business administration fields (Akhilesh, 2013; Klaus, 2013). 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 the organization, while strategic dimension focuses on long term issues(Burgelman et al., 2001). Technology generates wealth when it is commercialized or used to achieve a desired strategic or operational objective for an organization. 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 (Sinha and Roy, 2015). There are three important factors that a successful management of technology has to tackle. First, there is always a time lag between development of a technology and 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.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 (Dodgson et al., 2008). This requires great creativity along with a system designed to exploit. Technology can serve

to expand coal markets as well as improve the costs and performance of coal production. To the extent that new technology can produce cost-effective solutions to certain environmental problems, coal use could increase beyond current projections **(**Daim, et. al. 2014).

3. Technology Management - an overview with Coal Mining Industry

Technological success has changed the life of everyone in the world and it has also changed the way coal mining companies explore and market coal (Mie and Nie, 2008). High-tech and safe exploitation and usage of coal is the demand of the 21st century (Report of Mining of coal, 2005). In order to correspond to these new requirements the effective organizing management of resources must take place. In other words, the technologies have made a coal mining industry a high-technological affair that is equipped with all the necessary machinery for raise the productivity (Khanna, 2013). Nowadays thousands of men and women in the world are working in 2560 mines in 26 countries to supply billions tons of coal. Till 1950, coal mining companies applied old methods of exploration - surface mining techniques. Surface mining techniques are popular and are widely used mining technique throughout the world. This method is useful when coal deposits lie near the surface and can be easily extracted(Debnath, 1991).Coal exploration, extraction and delivery to the market have become secure, effective, clean and not so harmful for environment. Nowadays technologies have become a usual thing in coal mining industry and many coal mining organizations apply all these advance technologies (Dzharlkaganov et al., 2004). Of all the evolutions in coal mining over the last few centuries, none is more significant than the use of modern technology in the mining industry. In the early days, coal was mined by hand, with individuals wielding a pick and shovel. By the Industrial Revolution, coal-cutting machines and steam shovels designed for coal mines were common, making the work more efficient. Throughout 20th century, improvements in equipment design led to dramatic increases in productivity and safety (Chaudhury, 2005; Chikkatur, 2009). Finally, though lot of existing methodologies is there, no one is considered '*best in class technology*' in terms of overall productivity enhancement in Indian scenario(Khanna, 2013;Sinha and Roy, 2015). Still now, research is going on for best adopted technology in the area of coal mining.

4. Research Objective

With all extensive literature survey and preliminary discussion had with shop floor

managers, we fix our specific research objectives in the line of understanding

- The role of effective management of technology in CCL,
- The influencing factors needed for effective management of technology, related to open cast coal mining in Central Coalfields Ltd, Ranchi.

5.Research framework and hypotheses

For our proposed study, we first collect the targeted and actual production details from the head office of CCL. Following table (Table-1)depicts below the actual production of open cast mines are less than the estimated one (except for one instance in the remaining case).

Table 1: Production of Coal in Seven Sites of CCL(in figures of Million Tonnes)

Sl No	Site	2007-2008 (Mt)		2008-2009(Mt)		2009-2010(Mt)		2010-2011(Mt)		2011-12(Mt)		2012-13(Mt)	
		Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual
1	Piparwar	10.00	8.00	10.00	8.50	10.00	9.51	9.75	9.00	10.00	9.90	11.30	11.49
2	Ashoka	6.5	6.30	9.50	7.10	9.00	7.60	8.75	8.030	8.10	7.72	8.00	7.80
3	KDH	4.5	4.01	3.50	3.14	3.70	3.51	3.50	3.451	3.70	3.60	2.00	1.55
4	Rajrappa	3.00	.85	1.20	1.00	1.25	1.10	1.1	1.101	1.25	1.13	1.00	.76
5	Jharkhand	1.0	.81	0.85	.92	0.85	.60	0.95	.606	0.85	.71	.49	.47
6	Urimari	2.0	2.33	2.00	2.44	2.25	1.51	2.50	2.039	2.25	1.95	2.30	2.22
7	Amlo	2.50	1.43	1.20	2.81	2.00	3.12	3.00	2.041	2.70	2.30	1.50	1.15

Source: Data collected from Project and Planning Department, CCL, Ranchi

Actual survey of the site also shows that the actual production was less than the targeted production of these opencast mines. Some factors identified for low productivity of opencast mines is because of lack of innovativeness, improper technology, misuse and non-availability of materials, scarcity of power, shortage of explosives, defective layouts, poor working conditions, etc. Improper planning and lack of management also adds to the productivity problem. The problems related to the productivity of coal mines is due to the internal reasons like technology employed, shortage of skilled manpower,laborunrest and absenteeism, maintenance of equipments, etc. and external reasonslike power and explosive, law and order, wagon availability, land acquisition, environmental issues, etc.

Success of any business lies with effective combination of factors like 5 M`s; material, machine, method, money and market with innovative technology and related technical inputs. An organization having a short time-to-

market and rapid product innovation can be the first in the market thus enjoying a higher market share and sales volume. Amongst the factors mentioned, innovative management matters the most since the creation and adoption of business and technologies needs to be managed in an innovative way for proper and desired results. A wrong choice of management technique for a product or process can have serious implications on the health of any organization. Therefore, assessment and evaluation with respect to its cost effectiveness needs to be established in a real time basis.

Center part of present research revolves around the fact finding procedure of '*Whether effective management of technology are important for enhancing the productivity of coal'*. In this context the researcher feel that the production of coal is far behind and it is not getting the fixed target production because lacking of proper management of technology. Most of the technology adopted so far by CCL is almost imported. The government coal mining industries lacks behind in the effective management of new technology and is not able to justify the return on investment. So considering all arguments lead to hypothesize the following:

H_0= *Technology is the onlypertinent factor for enhancing overall productivity*

H_1= *Technology is not only a panacea for productivity enhancement;effective management of technology is significantly important to make it more productive.*

5.1Trend analysis

Myriad factors contribute to success of any business. Unfortunately, an equal number of factors lead to any company's failure. To become a high-flying company and remain one after that status is achieved, it's essential for business leaders to identify trends and changes in trends. Specifically, in manufacturing industry, analyzing the production data what happened in past can indeed give an inkling of what might happen in the future.Trend Analysis is the process of comparing business data over time to identify any consistent results or trends. Generally, handling with business problems, we can develop a strategy to respond to these trends in line with business goals.

Trend analysis '*proves to be useful in predicting and accessing the character of variable'*, thus paving the way for somewhat accurate predictions about the targets of the company (Mie and Nie, 2008). It offers a measurable and verifiable method for businesses to project future outcomes. It is used generally to forecast market trends, sales growth, inventory levels and interest rates. With accurate future trends prediction, policy makers will implement such policies and may initiate such decisions with the help of which the actual coal

output can easily be compared with that of estimated one. Pertaining to present study, some factors were taken after successful analysis. Table-2 depicts trend analysis to show a significant gap of production mismatched in seven open cast mines.

Table 2:Actual Production vs. Trend Value production

Sites (1-7)	2006-2007 (Mt)		2007-2008 (Mt)		2008-2009 (Mt)		2009-2010 (Mt)		2010-1011 (Mt)		2011-2012 (Mt)		2012-2013 (Mt)	
	A	TV	A	TV	A	TV	A	TV	A	TV	A	TV	A	TV
Piparwar	7.5	7.68	8.00	8.15	8.50	8.61	9.51	9.08	9.00	9.54	9.90	10.0	10.15	10.47
Ashoka	6.10	6.28	6.30	6.59	7.10	6.91	7.60	7.23	8.03	7.54	7.72	7.86	7.80	8.18
KDH	4.00	2.48	4.01	2.76	3.14	3.04	3.51	3.32	3.45	3.60	3.60	3.88	1.55	4.16
Rajrappa	.84	.82	.85	.87	1.00	.92	1.10	.97	1.10	1.02	1.13	1.07	.76	1.12
Jharkhand	.79	.54	.81	.59	.92	.65	.60	.70	.60	.75	.71	.80	.47	.86
Urimari	2.30	1.96	2.33	2.01	2.44	2.06	1.51	2.11	2.03	2.16	1.95	2.21	2.22	2.26
Amlo	1.30	1.96	1.43	1.96	2.81	2.0	3.12	2.02	2.04	2.04	2.30	2.06	1.15	2.08

Pertaining to the above data out of 49 combinations only 25 combinations are there in which the actual production of the coal is less than the projected trend production value where as in rest of the cases, trend value production is more than the actual production. These figures clearly indicate '*some problem in industry with respect to the management and implementation issues'*. This trend value production indicated expected production of coal against the year demarked. Despite actual production is on lower side, this clearly indicates that the installed capacities are not utilized to their optimal capacities. Present work has highlighted this issue from management and capacity utilization point of view and has focused on different aspect responsible to it.

6. Research Methodology

The extensive exploratory research was taken up in order to have a thorough understanding of the problem towards establishing priorities for further research actions. A preliminary survey was conducted by talking with experts and shop floor managers to find out various reasons of low productivity in opencast coal mines in CCL even after adoption of technology. Certain parameters were identified and incorporated in response form of question in the questionnaire to cover content validity. Respondents were selected through sampling in seven opencast mines in CCL. Target sample population was around 400covering top and middle level management professional who are involved in *'implementation process of technology'* in their respective open cast mines. Secondary data has also considered for collecting information to specific queries.

Targeted total sample size was to collect response from 500 respondents from seven sites of open cast mines of CCL, including CCL head office and CMPDI, out of which we received 436 filled questionnaires, and finally 385 questionnaires(complete in all aspects and ready for further analysis) were taken up for analysis. After data collection, statistical techniques are used in order to test and establish reliability of the data gathered. Table 3 and 4 shows the targeted sample size of different strata and open cast mines respectively.

Table 3: Targeted Sample Size of Different Strata

Sl. No.	Strata	Dept. /Div. / Function	Respondents	
			CCL	CMPDIL
1	1	Sourcing/ Materials	25	20
2	2	Production	06	05
3	3	Projects / Planning / R & D	20	29
4	4	Quality Assurance / Maintaince	20	15
5	5	Washery	20	00
		Total	91	69

Table 4: Targeted Sample Size of Different Open Cast Mines

Sl. No.	Opencast Mines	Respondents
1	Piparwar Open Cast mines	30
2	Ashoka Expansion	40
3	KDH	35
4	Urimari	30
5	Rajrappa	35
6	Amlo	30
7	Jharkhand OC	25
Total	---	225

6.1 Factor identification

Some of the important factors related to selection and implementation of new technology are identified after extensive literature survey, talking directly / personally with shop floor managers, and taking expert view of senior level decision making experts within CCL. Table 5 depicts the tabular form of different factors effecting management of technology.

Table 5: Different factors effecting management of technology

Sl. No.	Factors effecting Mgmt. of Technology	Lit. support lead by Authors'/ Practitioners'
1	Planning / Strategy for Technology	Steele,1989; Roy and Singh,2014; Ford,1988
2	Selection of Technology	Khanna, 2013
3	Technological Skills	Floyd, 1997
4	Financial Feasibility	Gaynor, 1991; 1996
5	Cost and Benefit Analysis	Momaya and Ajitabh, 2005
6	Real time Technological Advancement	Henry and Walker,1991
7	Managing HEMM Technology	Perrino and Tipping, 1989
8	Supply chain issues	Gregory,1995
9	Waste reduction by applying new technology	Drejer, 1991; Report of Ministry of coal, 2005
10	Real time transfer of technological change	Khanna, 2013
11	Socio-Economic issue on new Technology	Anders et al., 1997
12	Maintenance of overall Equipments	Sinha and Roy, 2015
13	Continuous Monitoring of Quality	Monica Maria, 2014
14	Proper Utilization of Machines	Report of Indian Bureau of Mines, 2012
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

6.2 Factor Analysis

After factoridentification, we perform factor analysis in SPSS latest version. Table 6 depicts the communalities which show how much of the variance in the variables has been accounted for by the extracted factors (Mie and Nei, 2008).

Table 6: Factor Analysis

Communalities		
Factors	Initial	Extraction
Top Level	*1.000*	*.864*
Middle Level	1.000	.495
Selection of Indigenous Technology	1.000	.489
Selection of Foreign Technology	*1.000*	*.714*
Market Feasibility	1.000	.573
Financial Feasibility	1.000	.580
Cost and Benefit Analysis	1.000	.495
Technological Advancement	*1.000*	*.908*
Continuous Monitoring of Quality	1.000	.559
Capacity Utilization of Machine	*1.000*	*.701*
Real time Training Needs	*1.000*	*.695*
Management Of HEMM	*1.000*	*.785*
Management Of Manpower	*1,000*	*.679*
Land Acquisition	1.000	.541
Technological Effect Environmental	*1.000*	*.934*
Supply Chain Issue	*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
Planning for New Technology	*1.000*	*.923*
Maintenance of Equipments	*1.000*	*.931*
Technological Skills	*1.000*	*.722*
Safety Requirements	1.000	.408
*Extraction Method: Principal Component Analysis.		

Table 7shows 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, first factor accounts for 12.853% of variance, second 9.173% of variance, the third 8.603 and up to ten 4.188%. All the remaining factors are not significant. Rotated component matrix are calculated and shown in Table 8.

Table 7: Total variance explained

Total Variance Explained									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	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						

Table 8: 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 identified and accommodated for the effective management of new technology (Table 9). These interacting factors can be managed properly in order to maintain the equipments reliability, reduction of operational cost and overall profit maximization and production efficiency.

Table No. 9 Importantfactors for effective management of technology

1	Planning for New Technology	7	Real time Training Needs
2	Level of Management	8	Management of HEMM
3	Selection of Technology	9	Management of Manpower
4	Maintenance of Equipments	10	Supply Chain Issue
5	Technological Skills	11	Technological Effect on Environment
6	Proper Utilization of Machine	12	Technological Advancement

6.3 Overall test for hypothesis

Validation for the hypothesis proposed may be done by implementing Chi-square test by checking whether significant or not. Reliability test for the data collected is also done by calculating Cronbech Alpha value. Here, the value is 0.710; a good significant value to proceed for further analysis. The responses given by the selected respondents of CCL, CMPDI and the open cast coal mines of CCL revealed that effective management of technology is highly important to enhance the production of coal extraction. After calculating the Chi-square value comes to be 17.443 at 4 degree of freedom and P-value is calculated to be .002, which is greater than the tabulated value at .05 in 95% confidence level, so it is significant. Null hypothesis is rejected and results show that management of technology may play very effectively to enhance production. Results are shown in the following table.

Table 10 Results of Chi-Square Tests

Chi-Square Tests			
	Value	d.f	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.443	4	.002
Likelihood Ratio	18.627	4	.001
Linear-by-Linear Association	8.886	1	.003
No. of valid Cases	385		
a. 0 cells (0%) have expected count less than 5. The minimum expected count is 11.29			

Technology can only improve the efficiency of the organization but lack of effective managementof technology defeat the entire purpose (Lema, and Price, 1995; Momaya, 2005).Chi-Square test for important factors separately for Open Cast Mines (CCL) and Head office (HO) of CCL and CMPDI are shown in the next table.

Table 11: Chi-Square result for Open Cast Mines (CCL) and Head office (CCL and CMPDI)

Parameters	Open Cast Mines (CCL)			Head Office(CCL and CMPDI)		
	Value	d. f	(P-Value)	Value	d. f	(P-Value)
Planning for Technology	8.240[a]	6	.221	6.133	1	.013
Management level	10.667	6	.099	5.173[a]	1	.023
Selection of technology	12.465[a]	12	.409	.062[a]	2	.969
Maintenance of Equipments	5.154[a]	6	.524	3.137[a]	1	.077
Technological Skills	8.467[a]	6	.206	1.628[a]	1	.202
Proper Utilization of Machine	3.158[a]	6	.789	.003[a]	1	.546
Real time Training Needs	3.693[a]	6	.718	.529[a]	1	.467
Management of HEMM	11.714	12	.469	NA at HO		
Management of Manpower	13.678	12	.322	NA at HO		
Supply Chain Issue	14.978	12	.243	NA at HO		
Tech.effect on Environment	4.451	6	.616	NA at HO		
Technological Advancement	3.443	6	.752	NA at HO		

7. Findings

In this research, an attempt has made to understand and identified various considered factors for effective management of technology. The study utilized perceptions of effective management of new technology, implementation and planning processes as well as technology productivity outcomes in an integrated manner. Present research is based on the following aspects:- Lot much of investment has done on technology aspects in Indian coal sector, still there is a gap between actual production with targeted one. Management is always tried to minimize this gap to enhance overall productivity.

- Identification of determinant factors among all possible may help the decision maker in making right time corrective decisions that ultimately lead to increase productivity and efficiency, and
- Finally, management may review these factors thoroughly as real time basis and also for future investment in technology.

Indian coal mining industry has to take up training programme for each individual worker to help the organizational development.There have been constraints in enhancing coal production due to environmental issues, problems with land acquisition, resettlement and rehabilitation, coal evacuation and the resulting law and order situations arising out of mining in tribal areas. During the course of interaction with the respondents, it was evident that human element in organizations assumes a vital role during the formulation and implementation of effective management.Human Resource is treated as a major part in improvement of production and productivity in CCL. The present situation demands for both technological advancement as well environmental friendly. It has become a major challenge for the coal mining industries to effectively manage both. The loss of productivity occurs because of a mismatch which causes bunching of the hauling units. The improvement of mine productivity, by minimizing both the idle time of equipment and handling cost per cubic meter of material, makes if necessary to analyze complex problems associated with the mining operations.

In spite of the originality of the conceived problem of this research work, possibility of overlapping of certain thoughts and concepts in fragments cannot be ruled out. Limitation of this present study thus can be directed in the line of conducted survey in organizations located in the state of Jharkhand only; findings may not be extended to cover all other organizations in totality. However, the concept, principle, approach, analysis and findings may help to a great extent in the application, analysis and explanation of similar problems in same or different type of organizations.

Findings of the present research in this area can be a useful base for knowledge management studies. The tacit knowledge generated during the course of the research can be formally identified and converted into explicit knowledge through suitable systems in order to ensure effective formulation of effective management of technology and its implementation of coal mining industry.

8. Conclusions

Technology is changing as the state of art status on continual basis. Coal industries have adopted state of the art technology and have turn around to most modern method of mining techniques compared to the traditional one. However,

technology itself may create certain environmental hazards in addition to common environmental problems of coal mining industries. Present situation demands for both technological advancement as well environmental friendly. It has become a major challenge for the coal mining industries to effectively manage both. Apart from implementing technology, environment friendly aspect is also considered as one of the prime cost in the overall cost of the technology. Mining industries have to pay for such cost to mitigate and control the environmental issues considering that the motive of ROI is achieved while purchasing such technologies.

Coal would continue to serve as the primary energy source, as India is endowed with considerable coal reserves but with limited oil and gas resources. The intensity of mining impact largely depends on the method of mining, stage and size of the operation. The negative impact of mining on health, land, water, air, plants and animals and other aspects of society can be reduced by careful planning and implementation of mining. Despite of having modern feet of technology and machines, output of the company is not atparwith the estimated target. Decision making procedure of CCL Management and their employees are not as competitive according to the market and demand due to several barriers.

Future direction of this research may be highlighted and applied toany organizations in order to further establish its authenticity in the area of knowledge management. Similar research can be carried out in other organizations within the country as well as in other countries for the purpose of comparison. Further research can be undertaken to explore and identify specific strategies that can foster and enhance the effectiveness of coal mining industry.

10. References

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