Management of Technology at Central Coalfields Ltd.

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Abstract: *With rising complexity and factors of globalization, technology has gained overriding importance in the fast changing, competitive environment. In the contemporary business environment, latest technology is imperative for maintaining quality standards. Technology and its effective management are essential for the overall success of any organization. Successful conceptualization and implementation of technology requires coordination of a wide array of activities, information and expertise. This study explores influences that perceptions of new technology implementation and planning processes, and dimensions of organizational climate, have on perceptions of new technology deployment effectiveness. It also examines the extent to which dimensions of organizational climate moderate the relationships between new technology implementation, planning, and new technology deployment effectiveness. Data for this study was collected from 65 employees from the various departments of Central Coalfields Ltd, Central Mine Planning Design Institute Ltd and Project Sites that had installed new technology. The results of the study indicate that these factors do indeed influence new technology deployment effectiveness.*

Keywords – *Mining, Technology, Management, Organization, Culture*

Introduction

The rapid speed of technological development and its effect on organizational strategy, structure, and processes have created a critical need for a systematic approach to managing technology (Burgelman, 1995). Technology Management "...links engineering, science, and management disciplines to address the planning, development, and implementations of technological capabilities to shape and accomplish the strategic and operational objectives of an organization". Technology management has its roots in Strategic Management, Engineering Management, Innovation Management and R & D Management (Narayanan, 2001).

The management of technology change has to be broad rather than narrow and must be based on empirical evidence (Clarke et al. 1990). Such evidence from developing countries has not been adequately documented. The technology cannot by itself bring about change; it has to be supported by appropriate organizational changes, as well as changes in human skills and training. It also brings innovation in a variety of fields affecting human needs such as health, environment, comfort, entertainment, communication, food, etc (Haddad, 2002). There is no denying that the wrong choice of technology for a product or process can have serious implications for the health of the organization. Therefore, assessment and evaluation with respect to cost effectiveness, availability of raw material and skill needs to be established. The technology change may indeed be micro as well as macro and can have inter-sectoral implications.

Technology management, within the last two decades, has emerged as a viable framework within corporate strategy making and is considered to be a viable independent subdiscipline of organizational management. Its interdisciplinary framework focuses upon understanding the peculiar integration between information history and radically new modes of production that is rarely understood within the industrial technology (Cooper, 1995). The emphases placed upon these broader

aspects of technology management are understandable given the implications that technology has for improving an organization's competitive position. However, specific organizational processes, such as the way in which organizations go about planning and implementing technology, are equally salient to the management of technology (Payne, 1978). The influence that these processes have on technology management has, for the most part, been ignored within the empirical literature.

What does exist within the literature is a set of theoretical statements regarding the importance of implementation and planning processes. However, there is a critical need to empirically investigate the impact that these processes have on technology outcomes. Technology is believed to be more effective when it is integrated systematically within an organization's strategy process (Preece, 1995). The micro processes of planning and implementation relate to an organization's strategic behavior towards technology management. Conducting empirical research on how these factors influence technology deployment will provide deeper insights into the processes needed for developing an effective technology management program.

Factors Examined Within Study

Planning and Implementation Factors

The ways in which internal planning and implementation processes are understood could greatly influence new technology. Analyses of how these processes are managed could be seen as an indicator of the extent to which organizations strategically approach the deployment of new technology. Technology implementation and planning refers to the extent in which the organization has strategically designed the deployment of its new technology(s) prior to its implementation.The processes incorporated within this design have been cited as influences on the overall effectiveness of technology deployment and utilization. The implementation factors examined within this study consist of perceptions relevant to the structure of the implementation process, and the extent to which pre-assessment of things such as training needs, required organizational changes, and the capabilities of the new technology were conducted prior to the deployment of new technology.

The planning factors included within this study relate to things such as the extent to which the organization devoted time to technology planning, the level of clarity within the planning process, and the extent to which a strategic plan was utilized. Although the implementation and planning factors incorporated within this study do not exhaust all of the possible factors related to technology deployment, they do include a representative cadre organization that (a) is experienced by its members, (b) influences their behavior, and (c) can be described in terms of a particular set of characteristics or attributes of the organization.

This definition conceptualizes climate as a construct that is linked to perceived qualities of the organization such as leadership, organization design, decision making processes, organizational policies, and procedures. Perceptions of these organizational traits can influence individual behavior in relation to organizational effectiveness. More specifically, organizational climate would appear to influence an organization's planning and implementation processes of new technology. For example, an organization that is characterized by its members as being rigid and unwilling to change would probably approach new technology planning and implementation differently than an organization described as open and that does not resist change. There may also be parallel differences in the effectiveness in which new technology is deployed. Secondly, the perceived climate of the organization may mediate the relationship between technology and planning processes and perceived technology deployment efficacy.

There is a lexicon of studies and writings that point to the usefulness of the climate variable in conducting organizational

analyses. It has been linked to motivation and job satisfaction; it has also been shown to mediate the relationship between job satisfaction and performance. While recent attention has focused on examining the influence that climate has on innovation and organizational learning, very little empirical attention has been directed towards describing its role in technology management issues.

This study examined four dimensions of culture extrapolated from the Business Organization Climate Index (BOCI). They are (a) Questioning authority (b) Administrative efficiency (c) Open-mindedness (d) Innovation. These four factors were chosen from 17 factors within BOCI, because they appeared to be the most relevant towards the subject of new technology implementation and planning.

Research Questions

This study explores the following research questions:

- What is the nature and strength of the relationship between technology assessment, technology planning factors and perceived technology effectiveness outcomes?
- What is the impact of organizational climate on technology assessment, technology planning, and perceived technology effectiveness outcomes?
- In what ways do organizational climates moderate the relationships between technology assessment, technology planning, and perceived technology effectiveness?

Methodology

Sample

Data for this study was collected from 65 employees from the various departments in Central Coalfields Ltd, CPMDIL, Project Sites and selecting and implementing new technologies within their work units. Chart 1 presents an overview of the sampling size of different strata.

Chart I. Targeted Sample Size of Different Strata:

Strata	Dept/Div/Function	Respondents (Nos)		
		CCL	CMPDIL	PROJECT SITES
1.	Materials / Purchase	10	--	--
2.	Production / Manufacturing	3	--	12
3.	Projects / Planning / R & D	8	7	--
4.	Quality Assurance/ Maint.	10	--	--
5.	Marketing / Sales	15	--	--
	Total	46	7	12

Total 65 respondents

Source: Data generated by author

Measurement

They recently installed new numerically controlled machinery. Each respondent completed a questionnaire and was informed to respond to technology implementation, planning, and outcome items as these were pertaining to the most recent new technology within their departments.

Central Coalfields Ltd: Newly Installed Technology

- Installation and commissioning of mobile input coal crushing and conveying in Piparwar OCP (6.5 MTY).
- Installation and commissioning of 10 cu.mtrs. and 25 cu.mtrs. shovels and 85T dumpers in different OC mines.
- Introduction of intermediate technology using SDL/LHD to improve production, productivity and economies of UG mines.
- Installation of Rapid Loading System in Dhori Colliery.
- CCl is exploring the possibility of setting up pit head Power Plant near North Karanpura coalfield in joint venture with private party.
- It has built up mechanical handling / crushing capacity to maximize dispatches of crushed/sized coal to its customers.
- For improving coal quality, measures like picking of shale/stone, selective mining, advance stripping of overburden, and better fragmentation of coal in course of lasting are being taken.

- Massive expansions in coal production over the years have been predominantly met by large-scale expansion of surface mining.
- Introduction of scientific methods in underground and open cast mines for large capacity mining through collaboration with foreign countries.
- Arrangements are made for purchase of spares/sub-assemblies from the OSM vendors (original spare manufacturer) of OEM. Therefore, emphasis will be on maximum purchase from OSM instead of OEM.
- Online interlinking of central and regional stores through installation of digital mart system.
- Timely survey of obsolete materials and equipments.
- Monitoring of the time lag between demand and supply of the bought out items depending upon the criticality of the supplies from the user's point of view.
- Developing items/products through small-scale units.

Present research is survey based. Instruments for the same, which were used to collect data, are through 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 a way to cover all aspects under study. Interview method was used to collect information from the respondents and to get their perception about the effective management of technology in the following open cast mines situated in the state of Jharkhand. Instrument development is covered by 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 in this field. In the pre-pilot study, these items were 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 seniormost experts, information (data) provided by them elicited valuable feedback about this topic.

Chart -II – Mining Site wise production

Sl No	Site	2007-08 (Mt)		2008-09(Mt)		2009-10(Mt)		2010-1(Mt)		2011-12(Mt)		2012-13(Mt)	
		Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual
1	Piparwar	10.0	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	0.85	1.20	1.00	1.25	1.10	1.1	1.101	1.25	1.13	1.00	0.76
5	Jharkhand	1.0	0.81	0.85	0.92	0.85	0.60	0.95	0.606	0.85	0.71	0.49	0.47
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 generated by author

Implementation factors

Eight items pertaining to technology implementation were included within the questionnaire. Each item utilized a five-scale point and three-anchor response format in which respondents were instructed to rate the extent to which each item was utilized during the most recent technology implementation within their department.

Items 1 through 6 were combined to form one implementation scale. Scores ranged from 9 to 41 with a median of 27. Alpha reliability for this scale is .87. Items 7and 8, (top management involvement, and the use of cross functional teams) were used as separate one item scales. A factor analysis revealed that they are separate factors from the ones created implementation scale. Higher scores on each of the scales indicate a higher orientation towards new technology assessment.

Chart – III- Implementation Factors

1. The extent to which training needs related to the new technology were assessed.
2. Assessment of the new technology's impact on existing personnel functions.
3. Assessment of the organizational changes needed to fully support the new technology.
4. Assessment of the capabilities of the new technology.
5. Assessment of the financial feasibility of the new technology.
6. Assessment of how the new technology would affect job responsibilities.

7.The extent to which there was top management involvement during the implementation process.
8. The use of cross-functional planning and implementation teams.

Planning

A technology planning scale was developed by combining each of the first five items listed below. A five scale point and five anchor response format were utilized for each item in which respondents were asked to describe the extent to which the item was used during the technology planning process. Scores for this scale ranged from 8 to 25 with a median of 17. The alpha reliability for this five-item scale is .86. Item 6, strategic plan for the new technology, was used as a separate one-item scale. Factor analysis revealed that it is a separate factor from the created planning scale. Higher scores on each of the scales indicate a higher orientation towards new technology planning.

Chart – IV - Planning Factors

1. The extent that management had a clear understanding of the objectives of the new technology.
2. The amount of time devoted to planning for the new technology.
3. The extent to which there was a clear plan for implementing the new technology.
4.The extent to which there was appropriate planning for costs associated with upgrades for the new technology.
5.The extent to which workers were informed of the new technology before it was implemented.
6.The use of a strategic plan for the new technology.

Organizational Climate

This variable was measured by utilizing four dimensions of the Business Organization Climate Index, which contains 17 climate dimensions. Participants were asked to describe the extent to which each of the climate items was indicative of their work department. A four response scale and four anchor format was utilized with responses ranging from "definitely true" to “definitely false". A score of 4 was attached to a definitely true response and 1 to a definitely false response. Each dimension consists of eight items. The four dimensions along with their alpha reliabilities are as follow:

Questioning Authority: alpha = 0.77
Administrative Efficiency: alpha = 0.81
Open-mindedness: alpha = 0.89
Innovation: alpha = 0.82

Higher scores on each of the dimensions indicate a higher orientation towards that aspect of organizational climate. A copy of the items contained within each of these climate dimensions is provided within Appendix A.

Technology Outcomes

Eight items were used to measure perceptions of new technology outcomes. These items were used to create three separate technology outcome variables: Perceptions of unanticipated new technology outcomes (3 items), perceptions of improved performance and morale (4 items), and overall perception of whether the new technology accomplished its intended objectives (1 item). The scale and response format for the first and third outcome variables are the same as that for the planning factors. The items along with the alpha reliabilities for the unanticipated technology outcome and accomplishment of intended objectives variables are as follows:

Unanticipated Technology Outcomes Scale

1. The new technology had an unanticipated impact on employee job responsibilities.
2. The new technology had an unanticipated impact on employee work stress.
3. The new technology had an unanticipated impact on work processes.

Performance and Morale Scale

The performance and morale variable used an eight point scale response structure ranging from 0 to 2 with four anchors. Scores for this scale ranged from 0 to 27 with a median of 14. The alpha reliability for this scale is .88. The performance and morale scale consisted of the extent that the following things occurred, as a result of the most recent new technology:

•Improved productivity
•Improved product or service quality
•Enhanced the competitiveness of the organization
•Improved employee morale.

Results

Research Question One: "What is the nature and strength of the relationship between technology assessment, technology planning factors and perceived technology effectiveness outcomes?"

The new technology assessment and planning factors are significantly correlated with each of the technology outcome variables. The negative correlations between these factors and unanticipated outcomes indicate that increases in planning and assessment activities decrease the instances of unintentional outcomes that could negatively affect the effectiveness of the new technology. The positive correlations between the implementation and planning factors and the productivity and overall perception variables, show that engaging in technology planning and assessment processes improves perceptions of its effectiveness.

The study also reveals statistically significant correlations between top management involvement during the implementation and planning processes and the unanticipated outcomes and productivity criterion factors. This factor, however, is not correlated with employees' overall perceptions of the new technology accomplishing what it was intended to accomplish.

The cross-functional teams during the planning and implementation processes significantly correlated only with the productivity outcome variable.

Research Question Two: What is the impact of organizational climate on technology assessment, technology planning, and perceived technology effectiveness outcomes?

Relatively few statistically significant correlations between the organizational climate dimensions and the assessment and planning factors are found within this study. However, the data does indicate that each dimension has a different influence on these factors. The questioning authority and administrative efficiency dimensions reveal two relatively strong and statistically significant correlations. The questioning authority dimension is positively related with the amount of top management involvement. This finding seems to imply that top management involvement with the implementation and planning influences technology deployment. A related finding is that all but one (open-mindedness) of the organizational climate dimensions correlate with the strategic plan variable. It reveals statistically significant correlations between the innovation climate dimension and the technology assessment, the use of cross functional teams, and strategic plan factors. In short, based on having the greatest number of statistically significant correlations, one can partially assume that an innovative climate is the most significant factor of the organizational climate dimensions examined within this study. In comparison, a climate of open-mindedness appears to be the least significant.

Research Question Three: In what ways does organizational climate moderate the relationships between technology assessment, technology planning, and perceived technology effectiveness?
The results are presented in Chart III. They indicate that none of the organizational climate factors moderate the relationships between the technology implementation and planning factors and the technology outcome variables.

Conclusion

The results of this exploratory study provide confirmation to the somewhat ubiquitous conceptual proposition that the structure of the implementation process and the nature of the planning process influence the effectiveness of new technology deployment. The study utilized perceptions of employees to measure aspects of the new technology implementation and planning processes, as well as technology outcomes. Future research on this topic should attempt to utilize more exact measurements of these variables. Secondly, although

statistically significant correlations were revealed within this study, the generalizability of these results is constrained by the various departments in CCL and small sample size in CMPDI and Project Sites. Nevertheless, the results of this study have accomplished what an exploratory investigation purports to do; that is to determine the feasibility of conducting future research on a delineated topic. The results of these particular exploratory analyses have indeed suggested that future research on the relationships between technology management factors and technology deployment is warranted. (Appendix B).This exploratory analysis should serve as a heuristic guideline for future research. Furthermore, the results of this study strongly suggest to managers that it is important to devote time and effort for strategic planning of implementation of new technology.

The author recommends the following for future research investigations:

1. Expand the number of dimensions contained within the technology implementation scales.
2. Incorporate the construct of "Organizational Culture" along with the measurement of organizational climate.
3. Expand the number of dimensions within the organizational climate scale.
4. Increase the sampling size of departmental units within the study. Utilize quantitative and qualitative methodological approaches for variable.

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Appendix A

Questioning Authority

1.____ Criticism of policies and practices is encouraged
2.____ When people disagree with a decision, they work to get it changed
3.____ People here are not likely to accept managerial ineptitude without complaint or protest.
4.____ When people dislike a policy they let it be known in no uncertain terms.
5.____ People avoid direct clashes with senior personnel at all costs.
6.____ Many people will not hesitate to give strong support to a project that senior management is opposed to.
7.____ People who get pushed around are expected to fight back.
8.____ People delight in challenging official polices

Open Mindedness

1. ____Errors and failures are talked about freely so that others may learn from them.
2. ____No one needs to be afraid of expressing extreme or unpopular viewpoints here.
3. ____The expression of strong personal belief is pretty rare here.
4. ____One of the values most stressed here is open-mindedness.
5.____ People here tend to be cautious and restrained.
6. ____People here speak out openly.
7.____Criticism is taken as a personal affront in this organization.
8.____People here feel free to express themselves impulsively

Innovation

1.____ Policy changes occur slowly here and only after considerable deliberation
2.____ Quick decisions and actions are not characteristic of this place.
3.____ Thinking of alternative ways in which problems might be solved or things done differently is encouraged here.
4. ____New ideas are always being tried out here.
5. ____The latest scientific discoveries make a few changes in the way this place is run.
6.____Unusual or exciting plans are encouraged here.
7. ____There are conventional ways of doing things here which are rarely changed.
8.____Programmes here are quickly changed to meet new conditions.

Appendix B

Rotated Component Matrix[a]

	Component		
	1	2	3
Financial Feasibility	.975	-.049	.004
Technological Effect on Environmental issue	.955	-.165	.010
Planning for New Technology	.933	.006	-.061
Policy Implication	.929	-.029	-.002
Management of Manpower for Technological Implementation	.916	.052	.122
Land Acquisition issues	.900	.064	.005
Socio-Economic Issue on New Technology	.846	-.117	-.037
Cost and Benefit Analysis (Economic feasibility)	.814	.158	.156
Market Feasibility	.712	.106	-.337
Technological Skills	.034	.986	.027

Real time Training Needs	.051	.889	.105
Technology utilization for enhancement of productivity	-.037	.883	.071
Minimizing Wastage by applying New Technology	.077	.857	.055
Real Time Transfer of Technological Change	-.031	.849	.010
Continuous Monitoring Of Quality	-.173	.814	-.197
Safety Need for Technology	-.013	.736	-.084
Management of HEMM Technology	.086	-.009	.966
Top Level Management	.030	.094	.957
Maintenance of Equipments	-.041	-.016	.935
Adoption of Foreign Technology	-.009	.097	.884
Real Time Technological Advancement	.106	.137	.829
Middle Level Management	-.034	-.061	.814
Supply Chain Issue & Spare Parts management	-.259	.062	.792
Adoption of Indigenous Technology	-.054	-.159	.748
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			

Table No.3 for management of Technology

Parameter / Location		Unit			Total
		7 OC Mines (CCL)	Head Office (CCL)	CMPDI	
Some What Important	Count	51	7	5	63
	Expected Count	36.8	14.9	11.3	63.0
Important	Count	81	36	34	151
	Expected Count	88.2	35.7	27.1	151.0
Highly Important	Count	93	48	30	171
	Expected Count	99.9	40.4	30.6	171.0
Total	Count	225	91	69	385
	Expected Count	225.0	91.0	69.0	385.0

Table No.2: Summary Results of Factor Analysis

Codes	Variables	Factor to which a variable is merged	Factor Loading	Communality
VAR00001	Top Level Management	Factor – 3	.957	.926
VAR00002	Middle Level Management	Factor – 3	.814	.667
VAR00003	Adoption of Indigenous Technology	Factor – 3	.748	.587
VAR00004	Adoption of Foreign Technology	Factor – 3	.884	.783
VAR00005	Market Feasibility	Factor – 1	.712	.632
VAR00006	Financial Feasibility	Factor – 1	.969	.955
VAR00007	Cost and Benefit Analysis (Economic feasibility)	Factor –1	.814	.712
VAR00008	Real Time Technological Advancement	Factor – 3	.829	.717
VAR00009	Continuous Monitoring of Quality	Factor – 2	.814	.731
VAR00015	Technology utilization for enhancement of productivity	Factor – 2	.883	.785
VAR00016	Real time Training Needs	Factor – 2	.889	.804
VAR00017	Management of HEMM Technology	Factor – 3	.966	.941
VAR00018	Management of Manpower for Technological Implementation	Factor – 1	.916	.857
VAR00019	Land Acquisition issues	Factor – 1	.900	.814
VAR00020	Technological Effect on Environmental issue	Factor – 1	.955	.939
VAR00021	Supply Chain Issue & Spare Parts management	Factor – 3	.792	.698
VAR00022	Minimizing Wastage by applying New Technology	Factor – 2	.857	.744
VAR00023	Socio-Economic Issue on New Technology	Factor – 1	.846	.726
VAR00024	Real Time Transfer of Technological Change	Factor – 2	.849	.723
VAR00025	Policy Implication	Factor – 1	.929	.864
VAR00026	Planning for New Technology	Factor – 1	.933	.875
VAR00027	Maintenance of Equipments	Factor – 3	.935	.889
VAR00028	Technological Skills	Factor – 2	.986	.975
VAR00029	Safety Need for Technology	Factor – 2	.736	.549