Aerospace-Academia: ERP-Communication Framework Strategy

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Abstract—**The advancement in management information systems and business intelligence has changed the dynamics of knowledge management. The integration of ERP module for strategic-collaboration among industry-R&D departments with university-wide "Smart-campus" has further reiterated the target focused team environment coupled with value-based corporate-culture. The integration of academia R&D units with industrial-production-units for knowledge-management as well as resource-management is becoming extremely multifaceted. Efforts are now targeted at evolving a "dynamic knowledge management model for higher education and for optimizing the knowledge-diffusion of "University-R&D programs". The philosophy of competitiveness demands that the integrated framework for ERP adoption be planned for complex-structured organizations prior to its deployment. This is meant so as to minimize ERP deployment-span in terms of time and to curtail financial overheads. This paper provides various dimensions of planning communication system-strategy for ERP in complex-structured organization through mapping of activities for Aerospace departments involved in R&D programs vis-à-vis academia-Industry collaborative-joint ventures.**

***Index Terms*— Aerospace industry ERP communication strategy, Aerospace & academia ERP information management strategy, Communication channels for aviation industry, Technology diffusion & knowledge diffusion.**

1. Introduction

To gain access to realms of automation, the pre-eminence of IT based decision support systems (DSS), Enterprise resource planning systems (ERP) needs total alignment with total quality management (TQM) and organizational culture [1,9,16]. The realization of adoption of this very concept is yet another area which academic institutes totally miss out during the campaign of successful deployment and technology diffusion of ERP. Academic institutes are also handicapped to realize the benefits of having corporate wide automated, competitive, informed and supportive (ACIS) leadership and management [7,8,10]. Which reiterates the need of an integrated framework to deploy ERP. A total alignment of all projects deliverables is the key to the success for an industry, which an ERP-suite offers [3,5] to a complex industry like aerospace-industry. However, due to various reasons during the process of ERP implementation intelligentsia and managers are unable to fully diffuse and deploy the knowledge-areas. It is considered to be a challenge for intelligentsia and field managers to jump start the ERP implementation in a hybrid environment vis-à-vis academia-Industry collaborative-joint R&D ventures. [14,15].

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2. Literature Review : ERP-Diffusion

Methodology**:**

In this paper the literature review based analysis would be conducted to extract the communication system framework strategy for ERP module. The best practices of national institute of aeronautics (NASA) [11] would be utilized to build up a model of communication for effective diffusion of knowledge areas in the ERP-module. The methodology for planning and implementation would be proposed in light with technology diffusion theory [1]. The research work is based on the best working practices and methodologies extracted from the previous research-work in other industries. Hence empirical research work is recommended to check the validity of proposed ERP-framework.

Absorption capability of follower country & collaboration programs:

The organizations and countries requiring advanced technologies absorbed technology-sources without considering whether they were even capable of absorbing those. It was observed [2] that absence of this capability made either the whole transfer to be a failure or led the recipient country to a perpetual dependency on the suppliers of technology. A larger degree of independence among collaborating-partners of technology transfer program added to the complexity for technology diffusion [3]. The diffusion of technology involved technical and non technical parameters among the participating organizations and industries [4] this process got more complex while diffusion was taking place from an advanced organization to a developing country organization, where the organizational, informational and even the social environment might not be sufficient to adapt this process. [5]

Competitiveness, Willingness through TQM

Global competitiveness requirements and deregulatory environment has added further dimensions to industries around the world. The will to survive in such environment demands a continuous effort by organizations to acquire advanced technologies in spite of having discontinuities of technology acquisitions in the past [4]. Which emphasize change management strategies. The leadership must strive for willingness of internal customers to adapt to a new technology for the purpose of diffusion in corporate culture; so as to satisfy external customers and to stay in business

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through timely technological advances in terms of ERP suites [6,10] & [15].

Literature Review of non-classical DOI Model for CSFs for deployment of IT techniques

The philosophy of, Non classical model [5] elucidated a number of additional critical success factors (CSFs) which can influence ERP, diffusion of technology (*D.O.T.)*. The research work model argued that; for complex and multi user technology (like IT); communication-channels and social system play a vital role. Whereas, social system is a product of leadership, management, administration, PEST {political, socio-economical, technological influences (opinion leaders & change agents)} [2]. The model of D.O.T., in IT-Industry was used to determine factors or enablers responsible for knowledge-communication to members of social systems in an aerospace-academia-R&D-industry-environment. Researcher provided a conceptual view of the classical & non classical model and market situation relevant to industry. In a high knowledge burden Industry or where there exist high user interdependencies characterize D.O.T., is a functions of variables of classical D.O.T., theory , managerial influences ,critical-mass, absorptive capacity, implementation-characteristics and national-institutions to lower knowledge barriers. The utilization of same model helped in extracting relevant parameters for aircraft manufacturing industry. The parameters which were relevant to aerospace-academia-R&D-industry-environment for diffusion of enterprise resource planning systems were extracted for utilization in this research-study.

Literature Review of Canadian Aviation Cluster

Canadian aviation cluster [6] indicated that supply chain management (SCM) would be a critical success factor for meeting in time production challenges supply of material and finished products from upstream source. These SCM activities could be augmented by ERP system for optimized logistics, inventory management and ware-house management.

Deficiency in existing Literature and methodology of research work to propose a integrated ERP framework

While there has been lot of research in other industries for specific models in specialized fields, limited contribution has been there for making a comprehensive framework for ERP-communication module and its implementation in aviation industry. Primarily the complexity of aircraft manufacturing industry and business challenges demand an exhaustive planning hence present research work shall focus to extract the best working practices, tools and research from other industries. These elements shall then be aligned in major categories to build up an entry level framework for aviation industry.

3. Role of IT & M.I.S.

Organizational and Functional Aspects:

Management information systems (MIS) and information technology can play a pivotal role for communication of technological knowledge and technovations. The MIS departments in any academic institute and aerospace industry typically provide decision support systems (DSS), industry specific CAD /CAM software, material resource planning software (MRP) and ERP systems. "IT", provides technology to support all the functions of MIS including hardware as well as software support. "IT" is a tool which can be utilized in various dimensions by leadership, top management, operations, production, finance and administration. *"IT" can pro*vide a set of integrated system tools (software as well as hardware) for DSS, BI, project management, SCM, MRP, CAD, CAM, financial analysis and HRM analysis. The system can attain the shape of ERP once integrated across the corporate functions through single authoritative database management system. During D.O.T, the security and flow of technovations would be managed through the state of art "IT" coupled with optimized-communication-strategy. Conversely, D.O.T, for organization's functions, processes and operations can also be managed and expedited through use of optimized-communication-strategy.

Information Distribution Network & Security of Information:

In a typical multi-national manufacturing industry, the production and machine departments might be located offshore. "IT" would provide World Wide Web networks to distribute technological and business specific objectives to all stakeholders through optimized-communication-circles [31]. "IT" utilizes satellite networks, earth stations and routing equipments to distribute industry specific information through wide area networks (WAN), metropolitan networks (MAN) and local area networks (LAN). The security of information could be ensured by employing hardware and software firewalls which can have integrated bulk encryption and decryption units. All bulk encryption and decryption units may employs specific algorithms tailored to address the full domain of organizational-specific security-polices. Intrusion-detection-systems could be employed to provide extensive-security for data-warehouse and sensitive manufacturing design and technology knowledge-areas.

Processes & Equipment Automation:

Typically in an Aerospace department are mostly implicated in R&D programs vis-à-vis joint Industry collaborative ventures. "IT" can assist in providing state of the art software as well as hardware. Which can be employed for optimized and accurate calculation of computer aided design (CAD), computer aided manufacturing (CAM), computer simulations, automated wind tunnel testing, performance parameters evaluation, performance parameters analysis, and computer assisted research & development for prototype-product-manufacturing. This is followed by subsequent serial batch production of product after exhaustive interventions by quality control and quality assurance departments.

4. ERP-Communication Medium

A main element in the diffusion of ERP technology is communication channel. The manner in which information is communicated is critical to the success or failure of an ERP-DOT project. As technologies become more complex, communicating those technologies to the marketplace and to the users becomes more demanding.

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Research has shown that NASA employed both informal and formal communications to disseminate its research and technology to the Aviation and space industries [11]. The recommendations relevant to D.O.T, recommended following two channels of communication for D.O.T,:-

(a.) *Informal communication channels*: covering peer to peer, collegial contacts, liaison among academia, industry and government communication.

(b.) *Formal communication channels*: based on publications, periodicals, policies standards operating procedures and seminar-presentation.

As per NASA, [11], in one of the research-study "80% of the respondents used electronic networks in their professional work, but half of the respondents considered the computer networks to be neither important nor unimportant. Respondents used electronic networks more frequently for internal rather than external communication. Libraries played a vital role in providing NASA and DOD technical reports to their intended aerospace users and collaborating partners".

As per NASA [11], the informal system was not as efficient if stakeholders had limited knowledge. On the other hand formal communication was found to be difficult because it employed a one-way, source-to-user transmission and because it relied heavily on information intermediaries and mediators. Hence in this research, it is proposed that during D.O.T, process formal channels may be employed to enhance the rate of knowledge acquisition and subsequent transfer. A generic model of communication may be used to highlights D.O.T, objectives and policies. These policies could be derived through vision and relevant objectives that could be implemented through defined mission & strategy. Communication success factors may depend on the following factors in an "aerospace-academia-R&D-industry-environment":

(a) Clear vision to communicate.

(b) Customer focused attitude as well as Industry specific focus.

(c) Taking action as per defined strategy.

(d) Rapid deployment of communication channels through participative communication.

The resultant output will be observed as in the form of goal oriented behaviour. This communication concept for aircraft manufacturing industry is elucidated in figure 1. The proposed building modules of the D.O.T-communication-model are Vision, Policies, Communication mechanism, Communication channels, Goal oriented behaviour and a feed back mechanism. This model is based on the research model presented by NASA [15], which has been modified in light with diffusion .of innovation theory [1], commensurate to "aerospace-academia-R&D-industry-environment" [3,4,5].

5. CSFs & Policies For ERP Communication

A typical set of "Technology Knowledge policies" and goals for distribution through communication circles to typical set of departments could be following based on earlier research work "Fichman-Model" [5]. There are a number of modifications incorporated in Fichman-Model based on SWOT analysis specific to aerospace-academia-R&D-industry-environment: The CSFs are as follows:

(a) Competitiveness of HRD, Capacity Building & Skill.

(b) Academia & Industry joint collaboration

(c) Economic factors (price)

(d) Supply chain factors augmented by ERP

Goal oriented behaviour-module & mathematical modeling

The rate of absorption and skill enhancement is achieved through activation of goal oriented communication mechanism. The academia and industry conducts joint training session to impart and diffuse knowledge to HR and industry-resource-Pool. A feed back mechanism would be at place to refine and improve the D.O.T, process. The information communication to project elements (staff, managers) would be very vital for the success of Diffusion of technology.

The communication channel in terms of probability Mathematical model can be defined as follows:

Mathematic modeling for Industry Communication channels (C.c)

$$C.c. = n(n-1)/2 \quad (1)$$

Where; in equation 1; "n" stands for number of channels of communication among aerospace, academia and R&D departments for inter or intra departmental communication.

Application and simulation of communication Model:

In a typical Aerospace department involved in R&D programs in a joint venture with Industry, if four (4) departments would be involved in production then as per above formulae the number of channels employed for interdepartmental communication would be Six (6). Consider another scenario, whereby a production planning & production control (PP&PC) department is managing inter-departments manufacturing.

A master-schedule for production would be communicated to 20 departments and also to academia R&D-department for quality control. All departments in such a situation would have to manage concurrent production schedules. Any one product may have to flow through various processes in different departments. All departments may have to keep a close liaison with each other and with academia R&D-department for final verification of finished product. For a controlled and managed activity a feed back from all

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departments would have to be managed by production planning and control department. The necessary changes in master-schedule would be informed to all for implementation and feedback. The goals achievement would be documented for performance review. The unaccomplished or carried-forward manufacturing would be included in subsequent master schedule. As per the algorithm (equation1) for "22" departments (including Academia-R&D and PP&PC) a communication channels employed would comprise of 231 channels of communication. In such a perplexed and multilayered-scenario the requirement of a managed communication module powered by ERP-authoritative-database becomes an absolute inevitability for timely and efficient decision making. A typical set of communication channels is demonstrated in figure-1.

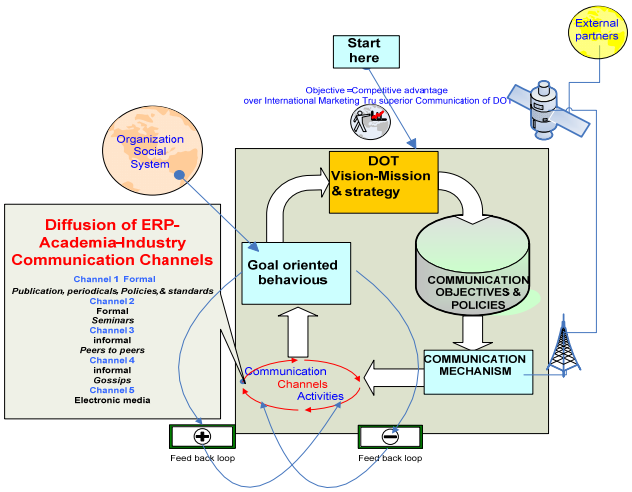

Figure: 1 Aircraft manufacturing industry Communication system Framework

Systems Engineering Approach for ERP implementation & change Management

These ERP implementation projects are highly complex coupled with hundreds of concurrent activities taking place at one given time. During ERP implementation process, one doesn't buy Technology, in fact, performance and knowledge elevation is acquired during unfrozen to refrozen phase. In such a demanding scenario the most preferred practice would demand management of D.O.T., thorough system engineering approach. System approach integrates fundamental parameters of system at organizational level. The system engineering approach circumference all the issues and is expected to provide a holistic picture [8,15].

The details about each parameter for system engineering approach and parameters at figure 1 along with their selection criteria have been worked out with complete diligence, meticulousness and assiduousness, however, these details intentionally not discussed at length and were "kept out "in this diminutive paper.

Role of IT based Communication channels for (DOI) for ERP implementation

The ERP knowledge areas may be planned for diffusion of technology within corporate culture. The ERP technology is diffused to the social system through communication system. The communication system may employ IT techniques including broadband wireless access (IEEE 802.16 standards for Wi-max termed as 4G network), LAN, WAN and MAN to communicate ERP knowledge areas through triple play techniques (TV, internet and Phone). The previous research by NASA had confirmed the use of extensive communication channels including electronic media for D.O.I. The success of ERP would be greatly enhanced through effective utilization of communication strategies utilizing competitive management-institute (CIS-L-GAMA-Consortium of competitive, informed-and supportive (CIS), leadership, (federal) government, academia, management & administration (L-GAMA) the concept is abbreviated as "CIS-L-GAMA"). This strategic-institute attains vigor through the social system. Such comprehensive communication-strategies with feed-back mechanisms are the hallmark of success in terms of continuous improvement to earn goal oriented behavior [1,9,12,13,15]

TQM Approach for ERP implementation

The TQM philosophy calls for continuous improvement, curtailing wastes utilizing six-sigma (Opinion-leaders i.e. black-belts and green belts) and empowerment methodology. Which can ensure timely implementation of ERP. The ultimate management objective could be to earn quality of product. The Technology Management domain may employ tools like Project management, TQM (Six sigma) [8] and SWOT analysis for alignment of all operations at shop floor-level. In a typical aircraft industry management role would be to achieve peak performance for which MIS and latest ERP solutions shall earn peak performance. The deployment of Enterprise resource planning (ERP) solution if coupled with six-sigma concept will earn logarithmic quality improvement to product based production. Eventually, competitiveness shall bring early return on investment (ROI) [13,16].

Leadership, Academia & industrial collaboration for ERP implementation

The past research has confirmed the competitive advantage of operations management through the use of MRP in a manufacturing industry [9]. Additionally the optimum productivity could be earned through consortium of competitive, informed and supportive (CIS) industrial leadership, government, and academia. The power sharing groups at strategic level (Leadership & Government) and at tactical level (management & administration) i.e. CIS-L-GAMA-Consortium need reliable and competitive DSS for monitoring ERP progress. It is proposed that after planning the ERP the BI & MRP module could be implemented in first stage so as to enable CIS-L-GAMA to monitor productivity for rapid ROI. [13,16]. The integration of communication circles with a generic industrial ERP-framework [11,15] is elucidated in figure 2.

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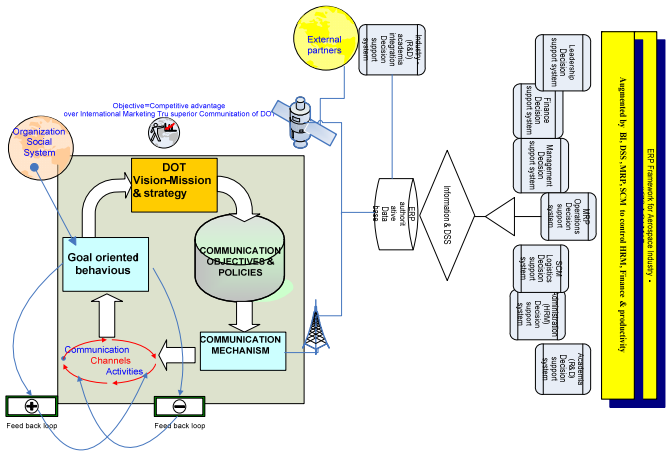

Figure 2: Aerospace-academia-R&D-industry-environment-Communication system integration with ERP-suite.

6. Findings

The research work is an ERP communication framework evolution for D.O.T., processes revealed the following:

(1) Aircraft manufacturing industry encompass highly complex production knowledge synchronized by strict national and international standards.

(2) These technology-knowledge-areas cannot be achieved unless the management systems and production processes are completely conversant with the depth of knowledge required for execution of day to day assignments.

(3) The *ERP* implementation is the key deliberation in any complex manufacturing industry. The ERP diffusion of knowledge adds perplexities due to parameters like organizational size, centralization, formalization and culture competitiveness and willingness.

(4) System Engineering approach of Diffusion of technology in Aerospace-Industry resolves the complex issues leading to uncalled for delays in ERP implementation.

(5) In aviation industry the policies, rules, regulations and technical data are communicated through a state of the art communication network strategy whereby. ERP implementation is influenced by communication mechanism. The NASA research work has reiterated for state of the art communication network strategy for automated management system to earn efficiency by employing ERP systems with integrated business intelligence and communication mechanism.

(6) Communication system for ERP planning and implementation demand goal oriented behaviors by encompassing BI & social system (CIS-L-GAMA). The previous research by NASA had confirmed the use of extensive communication channels including electronic media for Diffusion of innovation (DOI).

7. Conclusion

Technology diffusion and technology transfer are of significant importance in context of developing countries. Technological innovation is like a core competency of a leader country that is perceived as new by follower. During D.O.T., leader country injects superior-technology in the social system and corporate culture of follower-country via a managed-communication-system. At strategic-macro level, the shared vision of leadership provides the synergy which can be considered as the fuel of locomotive during the journey towards D.O.T. At tactical-micro level i.e., at Aviation-Industry level, the support and commitment by the top leadership fosters the D.O.T., process. The collaboration of leadership and academia can provide innovations, to systematize, align and attenuate, "Competitive-D.O.T., Resource-Pool" so as to balance efficiency and effectiveness. The present research has provided an "integrated communication strategy diffusion framework" for an aircraft industry. This research uniquely approaches the D.O.T., from communication standpoint and focuses to evolve a framework which can be employed by any complex structured industry and Academic-institute during information diffusion process so as to earn optimum resource-management as well as diffusion of knowledge-areas.

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