Implications for Information Management in a Virtual Organization

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Abstract

There is evidence of a paradigm shift in organizational structures as organizations utilize the internet technology to add a virtual dimension to their activities. Virtuality in the manufacturing domain is referred to as Virtual Enterprises (VE) or Extended Enterprises and within the commercial domain is referred to as the Virtual Organization. The key factor in virtuality is the information flows across enterprises. The quasi-integration of information systems is made possible by the technology but the implications for information management has received scant attention in the literature. This paper explores the concept of virtuality to identify the possible challenges for information management. This exploration identifies a preliminary set of prerequisites associated with information management in the virtual organization. Further research to help meet this challenge is identified.

Introduction

From the existing literature there is evidence of a paradigm shift in organizational structures as the concept of virtuality is explored. Organizations are utilizing the Internet technology to add a virtual dimension to their activities. The virtual dimension enables an organization to establish an extended enterprise (virtual organization) with external parties. Changing organizational structures influence the nature of information systems. The information management provision within a virtual environment has had only a preliminary treatment within the literature and the consensus is that it will be a very difficult task. This paper discusses issues associated with information management in the virtual organization and identifies a number of possible prerequisites.

Defining Virtual Organizations

An Extranet is the most recent application of Internet technology in which the network is a private and secure network which can support multiple and diverse organizations to create an extended organization. Extranets enable organizations to use the Internet or a private network using Internet technology to connect closely with partners, suppliers and major customers. This connection can be for the purposes of sharing information on collaborative projects with partners or gaining direct access to suppliers ordering systems or direct access by customers for service and support [42]. The extranet enables the extended organization to operate in the dynamic and changing environment

of the new millennium [27]. This extended organization is frequently referred to in the literature as a *'virtual organization'* [25].

This concept of virtuality provided the impetus for organizations to start considering the design of new organizational forms [6, 8, 11, 16, 24, 36, 43]. This consideration of new organizational forms has lead organizations to develop alliances with enterprises with which interact within the virtual environment [1, 3, 5-7, 9, 10, 14, 17-19, 25, 31, 47]. These alliances are represented by integrated systems that cut across enterprise boundaries in a seamless manner utilizing Internet technology. Some alliances may be project-based and of a temporal nature. But many alliances will be longer term in nature as enterprises cooperate to gain competitive advantage by delivering keenly priced, integrated products and services.

Virtuality within the Manufacturing Domain

Virtuality in the manufacturing domain is referred to as Virtual Enterprises (VE) or Extended Enterprises. The emphasis in this context is the virtual organization as an 'intelligence manufacturing' entity which permits a global sourcing supply chain for a single product [1, 12, 35, 45]. This global sourcing supply chain is facilitated by a dynamic network of organizations working closely together and the resulting manufacturing environment is highly information–intensive [35]. The Extranet is the enabling technology used for this outsourcing and working with suppliers [11]. Park and Favrel (1997) refer to the VE in the context of a 21st century global manufacturing enterprise strategy [35]. Several authors have further articulated the concept of the VE [45, 47].

Wortmann (2000) created a model called the 'Dynamic Enterprise Modeler', which enables the modeling of several levels of such a virtual enterprise. The first level in this model is the 'Enterprise Structure Diagram', which depicts the various organizations and their interrelationships thus permitting the capture of the supporting procedures by information systems. The second level depicts a hierarchy of 'business control models' (BCM) which define the critical operations and business functions that must be supported by information systems. The critical operations within a BCM are exploded within a 'business function model', which is a decomposition of all the business functions within that particular BCM [45]. Zhano and Li (1999) describe an approach to information modeling for a virtual enterprise manufacturing system. This approach is premised on the inadequacies of conventional data modeling

systems and proposes a new schema for product variant classification [47].

The combined advances in both manufacturing and information communications technologies have been posit as enablers for strategic alternatives by the integration of the manufacturing and business strategies into a total manufacturing information system (TMIS) [23]. The TMIS would help in the creation of a strategic tool by integrating all applications to provide enhanced capabilities that otherwise could not be achieved by separate applications. It is the capability of information and communications technologies to integrated advanced manufacturing technologies that differentiates the TMIS from existing manufacturing systems.

Consideration has been given to the need to define precisely the information access rights and visibility levels for partners within the VE, with the acknowledgement that there was a lack of a common definition of a VE in the literature [1]. Access to information within the VE in the manufacturing domain correlated with the development of a general research base regarding web-based information systems (WBIS) within the commercial domain [13, 14, 34, 42].

Virtuality within the Commercial Domain

Virtuality within the commercial domain is commonly referred to as the Virtual Organization and the emphasis in this context is the virtual organization as a structure for surviving and competing in a dynamic and changing business environment [7, 8, 27, 30]. Dunn and Varano (2000) present a framework within which they discuss WBIS as the consequence of the application of internet technology in developing three types of WBIS; the Internet; the Intranet and the Extranet [14]. In the absence of a research base, Dunn rightly adds a cautionary note that such systems are a relatively new phenomenon with many of the business issues uncertain and confusing. These business issues include the management and control of the user access, maintaining the security of all data and transactions, and having flexible business rules and policies [14, 25].

Six models of virtuality have been proposed in an attempt to classify the various forms that virtual organizations could take, although it is admitted that some of these are, in essence, an electronic re-implementation of traditional forms of doing business [8]. The six models of virtuality are virtual face, co-alliance, star-alliance, value-alliance, market-alliance, and virtual broker. The virtual face model is an existing organization that establishes an Internet presence in which products or services can be marketed and standard transactions performed over the Internet. The co-alliance model is the establishment of partnerships to collectively offer a

product or create a service on the internet. The star-alliance model has a dominant partner who provides a particular competency or expertise over the internet to several partners within a similar domain. The value-alliance model is basically either project-based, such as in a value-chain, or product-based, such as in a supply-chain with the co-ordination, in both instances, facilitated by the extranet. The market-alliance model is the collaboration, to offer a package of services or products, on the internet, by partner organizations whose normal activities are primarily Internet-based. The virtual-broker model is a dynamic network of relationships established to exploit a business opportunity to offer a unique product or service.

These models of virtuality tend to reflect the various perceptions, within the existing literature, of the forms that a virtual organization can take. The practical examples of virtuality that are visible are within existing e-commerce systems. E-commerce systems encompass business-to-customer and business-to-business systems, which have evolved into customer relationship management and supply chain management systems respectively. A customer relationship management system is defined as the integration of the sales, marketing and service strategies and a supply chain management system is defined as a network of relationships that organizations maintain to source, manufacture, and deliver products [20].

Review of the term 'Virtual Organization'

The terms 'extended enterprise', 'virtual enterprise' and 'virtual organization' had been used within the literature to encompass new organizational structures [11, 16, 21, 24, 25, 28, 31, 33, 35]. These new organizational structures being made possible by the application of internet technology [10, 14, 44]. In this paper a virtual organization refers to a number of possible connotations of organizational models.

Key Factor in Virtuality

The flow of information across enterprises is the key factor in virtuality. Information systems were traditionally synonymous with data processing activities of organizations in which the interrelated components would collect, manipulate and disseminate data and information, including a feedback mechanism, to meet particular business objectives [41]. Types of information systems included those at the strategic, management and operations levels and covered functional areas such as sales & marketing, manufacturing, finance, accounting and human resources [22]. Manufacturing information systems have normally been single applications with their foci being the computerization of advanced manufacturing technologies [23]. In the commercial domain information systems were frequently created on the basis of specifications

provided by managers and reflected past or current competitive needs [38]. The lack of responsiveness of such information systems to competitive needs was partially addressed by the introduction of enterprise resource planning systems (ERP). However the underlying strategy of ERP systems was the implementation of a standardized approach to methods and procedures that reaped the benefit of efficiency but at the expense of innovation that is necessary to respond flexibly to changes in the environment [15]. In an era of the virtual organization this traditional approach is under review. The determination of information systems' requirements, in a virtual organization, is deemed an order of magnitude more difficult because of two main constructs : the unique characteristics of a virtual organization including responsiveness, dispersion and empowerment of staff [25]; information systems developers do not always know exactly who the users are going to be and what their information needs might be [40].

Information Management within a Virtual Organization

Changes in information systems and organization structures, in the past, have generally occurred within the relatively stable environment that traditional organizations have normally operated within. Within the virtual organization there are going to be two or more partner organizations. Relationships between these partner organizations may be of a temporal nature [26], the duration of which may be unknown. Within the virtual organization, although relationships are temporal, it would be reasonable to deduct, based on the past, that information systems and organization structures would continue to influence each other and bring about changes in how organizations position themselves. The literature would tend to support this, in part, by portraying the virtual organization as having low levels of bureaucracy and being adaptable and flexible [26, 27].

Models of virtual organizations have been posit [8] to illustrate the organizational structures of such organizations. However the influence of the structure of the virtual organization upon the nature of the information systems provision has received scant attention within the literature except to highlight that it is a task of such magnitude that it may require a multi-disciplinary approach [11, 26].

The virtual organization depends on information to survive [16, 29, 46]. The nature of information in a virtual organization is deemed to differ from that which is provided by existing information systems. Current information systems store a static representation of an organization's information within its software systems and databases or data

warehouses and tend to be inflexible and unresponsive in dynamic business environments [27]. The term 'dynamic business environments' typifies the environments within which virtual organizations exist [36]. To make information available to all parties in a virtual organization is the key challenge [2]. This challenge is to make available single accountable data that is visible and readily available to all in a virtual organization in a timely manner to enable decisions to be made or activities commenced.

Complications from the integration of information systems of strategic partners within the virtual organization may also result in chaos unless great care is taken in the selection of partners [37]. Virtual organizations have been described as operating on the edge of chaos with change even rapid change being about the only constant [4]. Attempts to standardize electronic data interchange vocabularies have only been partially successfully and recent initiatives to standardize the e-business extensible markup language highlight difficulties in reaching agreement on standards for information exchange between organizations [39]. The quasi-integration of information systems is made possible by the technology. However the resulting changes in organizational structures have the potential to be not well understood and to create more change than can be comprehended [32]. The challenge for information management is to respond to these changes.

Challenges for Information Management in the Virtual Organization

Participants within a virtual organization, in common with other enterprises, may need to undertake information systems planning (ISP). However within a virtual organization there are a number of participants and it may therefore be necessary for the ISP to be conducted collectively. Participants could include a dominant organization (or the coordinating party), suppliers, partners, and major customers. The dominant organization would be expected to have a pivotal role in the conduct of the ISP. The determination of information systems (IS) requirements within a virtual organization would necessitate wider participation, than in the traditional organization, because of the cross-organizational dimension. However wider participation may be more time consuming and less responsive which in turn conflicts with a characteristic of virtual organizations, namely responsiveness.

Another possible concern regarding wider participation is that the creativity in determining IS requirements might be constrained by concerns about the practicalities of implementation. The dynamic nature of virtual organizations may result in continual change requests to the IS requirements which may lead to system degradation. To determine IS

requirements of a virtual organization would require knowledge of the inter-organizational processes and attributes associated with these processes. This would suggest the need to establish cross-organizational teams to determine IS requirements. However an external consultant might provide a more objective and independent view of IS needs for a virtual organization, in contrast to staff from each enterprise. An external consultant would only have loyalty to the virtual organization, which could be established as a legal entity. Although an external consultant might be useful in the short term the enterprises would need to overcome any problems they might have, to achieve the long-term benefits of working cooperatively.

A major problem facing management within a virtual organization is the security of data to prevent the leakage of sensitive or confidential data. The forgoing would infer that there also needs to be an awareness of the legal and confidentiality issues that may limit disclosure. Ultimately there is a need for trust amongst enterprises within a virtual organization.

Timely access to information within a virtual organization is essential to achieving the desired synergies. This would suggest that each enterprise within a virtual organization would need to adapt and change to have uniform approaches in the creation, classification and retrieval of all information resources. Perhaps a modular approach would need to be taken in which, a specification is created for each enterprise, within a virtual organization, that gains agreement on what data they must provide and how it should be able to be accessed.

Determining the information requirements for a virtual organization may entail dealing with a large volume of possible needs from all enterprises. Associated with this volume could be an accompanying complexity due to different perceptions of needs and the format in which needs are expressed. The characteristic of volume may be dealt with by the available technology, but the characteristic of complexity might be a much more subtle problem to address. To resolve, or prevent, this complexity might require a cross-organizational IS team and functional management staff from each enterprise, to work collectively to define the information needs. This collective working could be an example of the wider participation mentioned beforehand. In contrast to the traditional organization, this greater participation by functional management staff, may suggest that they have a role in the formulation and facilitation of new strategic IS initiatives, within a virtual organization. This may be a sensible move in that functional managers may have an awareness of internal issues across a virtual organization.

It is probable that enterprises within a virtual organization will try and leverage each other to gain access to pertinent information to gain the maximum benefits possible from the relationship. This leveraging would be dependant on good communications and trust amongst the enterprises involved. It is further suggested that with common objectives and interests enterprises within a virtual organization would contribute to innovative solutions or initiatives. However a possible drawback is that considerable effort might be devoted to exploring these proposed innovative solutions or initiatives. Moreover it would be necessary to ensure that any innovative activities are balanced against the need for adequate management control and available business processes.

Prerequisites for Information Management in a Virtual Organization

Drawing upon the foregoing deliberations it is possible to identify a preliminary set of prerequisites associated with information management in a virtual organization.

- Information systems planning should be conducted collectively across a virtual organization to ensure efficient and effective exchange of information between enterprises.

- Information systems requirements determination should be conducted with wide participation by functional management across a virtual organization to strive for completeness in requirements.

- A cross-organizational team of IS staff and functional management staff should work collectively to prevent or reduce the degree of complexity of requirements in order to strive for conciseness in requirements determination.

- Enterprises should adapt, as far as possible, a uniform approach to data management in the creation, classification and retrieval of information resources across a virtual organization to better facilitate inter-organizational activities.

- Partner organizations need to balance their management and data security controls with the need for flexibility in the exchange of information to facilitate a dynamic, responsive and innovative environment.

- Partner organizations need to balance uniformity and cooperative working in information management with the creative nature of individual parties within a virtual organization.

Discussion

This paper is exploratory in nature as the virtual organization is still a relatively recent phenomenon and many business and organizational issues have yet to be adequately addressed. Some of the issues related to information management are highlighted and possible approaches to remedied or minimize these issues are proposed. The term 'prerequisite' is used deliberately in this paper rather than 'success factor'. The lack of an established research base regarding virtual organizations and in particular information management in a virtual organization results in more assertions than statements of fact. The success, or otherwise, of information management in a virtual organization may be due to a host of factors including similar organizational cultures or high levels of trust amongst the partner organizations. Conversely, a lack of trust or different organizational cultures could lead to failure. To better understand the nature and issues associated with information management in a virtual organization may require a multi-disciplinary approach in the establishment of an adequate research base that would address the many business and organizational issues. Further research that would contribute to this research base may include: development of models to illustrate the different levels of integration and participation within a virtual organization, development of models of organizational and management structures appropriate for a virtual organization, longitudinal studies of organizations participating within a virtual organization to determine the critical organizational practices; investigation into the extent of measurable organizational cultural change resulting from inclusion with a virtual organization.

Summary

This paper presents a contemporary review that illustrated differing forms that virtual organizations could take and highlighted the challenges for information management. A preliminary set of prerequisites is identified for information management in a virtual organization. Future research was identified that would contribute to the establishment of an adequate research base that would provide assistance in helping to meet the challenge for information management in the virtual organization.

References

[1] Afsarmanesh, H., Garita, C., and Hertzberger, L. O., "Virtual Enterprises and Federated Information Sharing," *Database and Expert Systems Applications Proceedings 9th International Conference, DEXA'98*, 1998, pp. 374-383.

[2] Alt, R. and Fleisch, E., Key Success Factors for Transaction-oriented Business Networking Systems, in *Business Networking*, H. Osterle, E. Fleisch, and R. Alt, (eds.), Springer-Verlag, Berlin, 2000, pp. 242-256.

[3] Alt, R., Puschmann, T., and Reichmayr, C., Strategies for Business Networking, in *Business Networking*, H. Osterle, E. Fleisch, and R. Alt, (eds.), Springer, 2000, pp. 95-116.

[4] Black, J. A. and Edwards, S., "Emergence of virtual or network organizations: fad or feature," *Journal of Organizational Change Management* (13:6), 2000, pp. 567-576.

[5] Bouras, et al., "Cooperative information systems over the Internet and the WWW," *EUROMEDIA '99. SCS*, 1999, pp. 232-236.

[6] Bressler, S. and Grantham, S., *Communities of Commerce*. Mcgraw-Hill, 2000, p. 115-116.

[7] Burn, J. and Barnett, M., "Communicating for advantage in the virtual organization," *IEEE Transactions on Professional Communication* (42:4), 1999, pp. 215-22.

[8] Burn, J. M. and Ash, C., "Knowledge management strategies for virtual organisations," *Information Resources Management Journal* (13:1), 2000, pp. 15-23.

[9] Carroll, M. L., *Cyberstrategies*. Van Nostrand Reinhold, New York, 1996, p. 20.

[10] Chan, S. and Davis, T. R. V., "Partnering on extranets for strategic advantage," *Information Systems Management* (17:1), 2000, pp. 58-64.

[11] Davis, M. and O'Sullivan, D., "Systems Design Framework for the Extended Enterprise," *Production Planning & Control* (10:1), 1998, pp. 3-18.

[12] Davis, M. and O'Sullivan, D., "Communications technologies for the extended enterprise," *Production Planning & Control* (9:8), 1999, pp. 742-753.

[13] Dietz, J. L. G. and Schouten, H., "Modeling business processes for Web-based information systems development," *Proceedings of the First

International Conference on Web Information Systems Engineering. IEEE Comput. Soc. (1, 2000, pp. 270-282.

[14] Dunn, J. R. and Varano, M. W., "Leveraging Web-based information systems," *Information Systems Management* (16:4), 1999, pp. 60-69.

[15] Galliers, R. D. and Newell, S., "Back to the Future: From Knowledge Management to Data Management," *Department of Information Systems, London School of Economics and Political Science, Working Paper Series*, 2000.

[16] Gil-Estallo, M. D. A., et al., "The New Organizational Structure and its Virtual Functioning," *International Advances in Economic Research* (6:2), 2000, pp. 241.

[17] Graham, G. and Hardaker, G., "Supply-chain management across the internet," *International Journal of Physical Distribution & Logistics Management* (30:3/4), 2000, pp. 286-295.

[18] Gurd, G., "Information work and coupling in the virtual organization," *4th International Conference on Cognitive and Computer Sciences for Organizations. Communicating Knowledge in Organizations Proceedings Univ. Quebec, Montreal, Canada*, 1993, pp. 431-440.

[19] Hochuli Shmeil, M. A. and Oliveira, E., "The establishment of partnerships to create virtual organizations: a multiagent approach," *Re-Engineering for Sustainable Industrial Production. Proceedings of the OE/IFIP/IEEE International Conference on Integrated and Sustainable Industrial Production*, 1997, pp. 284-294.

[20] Kalakota, R. and Robinson, M., *e-Business Roadmap for Success*. Information Technology, ed. C. Jones. Addison Wesley, Massachusett, 1999, p. 111.

[21] Katzy, B. R. "Design and implementation of virtual organizations," in *Proceedings of the Thirty-First Hawaii International Conference on System Sciences (Cat. No.98TB100216). IEEE Comput. Soc. Part vol.4, 1998, pp.142-51 vol.4. Los Alamitos, CA, USA.*, 1998.

[22] Laudon, C. L. and Laudon, J. P., *Essentials of Management Information Systems*, Fourth ed. Prentice_Hall, 2001, p. 39.

[23] Lee, C. Y., "Total manufacturing information system: a conceptual model of a strategic tool for competitive advantage," *Integrated Manufacturing Systems* (14:2), 2003, pp. 114-122.

[24] Mahesh, S., "Virtual organizations," *1996 IACIS Refereed Proceedings. `Information Systems and Global Communications'. Univ. Wisconsin, Eau Claire, WI, USA*, 1996, pp. 271.

[25] Marshall, P. and McKay, J., *The Challenges of Interorganisational Management: An Emerging Issue in the Virtual Organization*. Internet-based Organisational Memory and Knowledge Management, ed. D. Schwartz, M. G Divitini, and T. Brasethvik. Idea Group Publishing, 2000, p. 201-221.

[26] Marshall, P., et al., "The essence and logic of the virtual organisation," *Proceedings of the Fifth Americas Conference on Information Systems. Assoc. Inf. Syst. Atlanta, GA, USA*, 1999, pp. 594-596.

[27] Mathotra, Y., "Knowledge Management for E-Business Performance: Advancing Information Strategy to "Internet Time"," *Information Strategy: the Executive's Journal* (16:4), 2000, pp. 5-16.

[28] Metselaar, C. and van Dael, R., "Organisations going virtual," *AI & Society* (13:1-2), 1999, pp. 200-9.

[29] Mowshowitz, A., "On the theory of virtual organization," *Systems Research & Behavioral Science* (14:6), 1997, pp. 373-84.

[30] Mowshowitz, A., "Virtual organization," *Communications of the ACM* (40:9), 1997, pp. 30-37.

[31] Mowshowitz, A. and Walsham, G., "Virtual organization: a vision of management in the information age," *Information Society* (10:4), 1994, pp. 267-94.

[32] Mukherji, A., "The evolution of information systems: their impact on organizations and structures," *Management Decision* (40:5), 2002, pp. 497-507.

[33] Pant, S., "Internet Enterprise planning," *IEEE Engineering Management Review*, 1997.

[34] Pant, S., Sim, H. T., and Hsc, C., "A framework for developing Web information systems plans: illustration with Samsung Heavy Industries Co., Ltd.," *Information & Management* (38:6), 2001, pp. 385-408.

[35] Park, K. h. and Favrel, J., "An Inter-organizational information system infrastructure for extended (or virtual) enterprises," *IFAC Intelligent Manufacturing Systems*, 1997, pp. 43-48.

[36]   Park, K. h. and Favrel, J., "Virtual Enterprises - Information System and Networking Solution," *Computers & Industrial Engineering* (37, 1999, pp. 441-444.

[37]   Purnendu, M., Love, P. E. D., and Zahir, I., "Pre-alliance planning: development of an information system infrastructure to support strategic alliance activities.," *Management Decision* (41:2), 2003, pp. 132-140.

[38]   Reddy, S. B. and Reddy, R., "Competitive agility and the challenge of legacy information systems," *Industrial Management & Data Systems* (102:1), 2002, pp. 5-16.

[39]   Rodgers, J. A., Yen, D. C., and Chou, D. C., "Developing e-business: a strategic approach," *Information & Management & Computer Security* (10:4), 2002, pp. 184-192.

[40]   Russo, N. L., Developing Applications for the Web: Exploring Differences Between Traditional and World Wide Web Application Development, in *Managing Web-enabled Technologies in Organisations: A Global Perspective*, M. Khosrowpour, (ed.), Idea Group Publishing, 2000, pp. 23-35.

[41]   Stair, R. M. and Reynolds, G. W., *Principles of Information Systems*, Fourth ed, ed. J. Normandin. Course Technology, 1999, p. 15.

[42]   Treese, W. G. and Stewart, L. C., *Designing Systems for Internet Commerce*. Addison-Wesley, 1998, p. 41.

[43]   Venkatraman, N. and Henderson, J. C., "Real strategies for virtual organizing," *IEEE Engineering Management Review* (27:4), 1999, pp. 26-40.

[44]   Vlosky, R. P., Fontenot, R., and Blalock, L., "Extranets: impacts on business practices and relationships," *The Journal of Business & Industrial Marketing* (15:6), 2000, pp. 438-457.

[45]   Wortmann, J. C., Hegge, H. M. H., and Rolefes, S., "Embedding enterprise software in extended enterprise models," *Computers in Industry* (42:0), 2000, pp. 231-243.

[46]   Yen, D. C. and Yu, C., "Extranet and groupware," *Journal of Computer Information Systems* (40:4), 2000, pp. 32-40.

[47]   Zhano, W. J. and Li, Q., "Information modelling for made-to-order virtual enterprise manufacturing systems," *Computer-Aided Design 31*, 1999, pp. 611-619.