Extending the enterprise: An evaluation of ERP and EAI technologies within a Case Study organisation

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Abstract. It is widely understood that both Information Technology (IT) and Information Systems (IS), provide great benefits in improving the visibility of supply and value chains within and across organisational boundaries. Those enterprises which can realise the benefits of extending their core business processes outwards to clients and trading partners, will be able to create unique supply chain-dependent products and solutions. Thus, such business infrastructures have enabled organisations to expand and improve the effectiveness of their enterprise. One method to achieve this, has been to integrate Enterprise Resource Planning (ERP) systems with web-based and other IS systems, using Enterprise Application Integration (EAI) technologies. This paper seeks to investigate those factors which contributed to a case organisation's extended enterprise experiences, by using extant ERP and EAI implementation IS evaluation criteria; and by placing the research results within the context of applicable IS research techniques in the area.

1   Introduction

Much of the benefits attributed towards adopting Information Technology (IT) and Information Systems (IS), centre on the ability to speed up decision-making, improve process productivity and efficiencies and increase the level of control available to management. Similarly, the joint effects of market globalization and competition is urging producers, distributors and vendors to integrate their operations, in order to maintain competitive advantage. Hence, companies that are successful with Supply Chain Management (SCM) must be able to work effectively

with customers and trading partners (Boyson *et al.* [1]), recognising the need to optimise the interface between IT/IS and individuals (Willcocks and Sykes [2]), in order extend the reach of the organization towards becoming a "Digital Enterprise" (Tapscott *et al.* [3]). Thus, this paper seeks to assess and analyse how such technological and organisational factors occur within the context of an extended enterprise context, by using data from a case study organisation. The use of a case study approach provides MIS researchers with access to protocol and coding methods which allow feature-rich behavioural, organisational and process-related data to be harnessed and gathered (Orlikowski and Baroudi [4], Walsham [5] and Yin [6]). By assessing the case organisation's attempts at implementing an extended enterprise approach, the authors thenceforth seek identify key factors for carrying out research in this area of MIS.

2   Research Approach

Given the rationale to investigate both technological and organisational aspects of implementing an extended enterprise, the authors now define the background, data and focal theory relating to the topic.

2.1   Background Theory: the Extended Enterprise

The concept of an extended enterprise is congruent with the idea of a Virtual Organisation. As such, the underlying notion is that of a business entity which exists as a so-called "borderless" form, having access to people, process and technological resources which may or may not be rooted in physical, i.e. geographical space (Goldman *et al.* [7]). Hence an extended enterprise can be said to comprise of three aspects: a set of extended business relationships across and between an organisation's customers and suppliers (Malone *et al.* [8]); a business ecosystem which belies a set of business processes (Tapscott *et al* [3]), which is underpinned by a networked supply chain, which require the integration of inter-organisational systems (IOS). Hence, the authors suggest that the fundamental components of extended enterprises rely heavily upon both Enterprise Resource Planning (ERP) and Enterprise Application Integration (EAI) technologies (Linthicum [9]). Figure 1 shows a model of these facets. This highlights business-to-business / business-consumer (B2B / B2C) architectures, which provide communication and automation of business processes across and between enterprises; Digital Marketplaces (DMP) which are a collection of B2B vertical/horizontal supply chain intermediaries (Strader and Shaw [10]); and ERPII, which is an externalisation of an organisation's SCM, Customer Relationship Management (CRM) and ERP functionalities (Bakht [11]).

2.2   Data Theory
The authors are primarily concerned with analyzing human factors in relation to organizational systems, in terms of an empirical case study approach, where the primary units of analysis will be via narrative discourse and dicsussion.
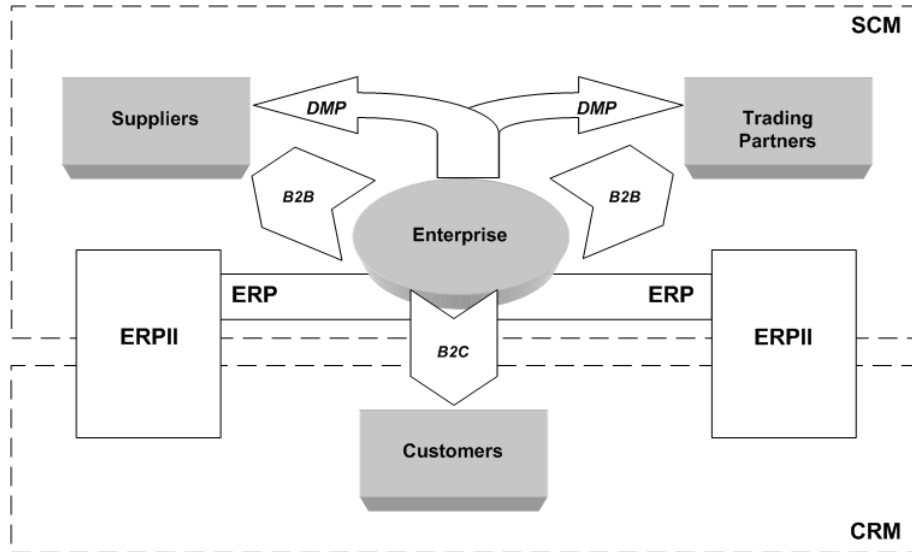
Fig.1 A model of Extended Enterprise components

The authors believe this can be achieved by applying a range of ERP and EAI evaluation criteria: 4 business-based (actor) models from the ERP literature (Akkermans and van Helden [12]; Dalal *et al.* [13]; Lee *et al.* [14]; Swanson [15]); and 7 technology-based (network) models from both the ERP and EAI literature (Al-Mudimighi *et al.* [16]; Brehm *et al.* [17]; Linthicum [9]; Parr and Shanks [18]; Schmidt [19]; Themistocleous *et al.* [20]; Themistocleous [21]). This is in the vein of the taxonomical approach to Information Systems Evaluation as defined by Irani and Love [22] and in the importance that should be given to identifying those emergent aspects of supply chain management as highlighted by Sherif *et al.* [23]. Hence, the research methodologies employed within the extant MIS literature on this subject, tend to focus on and support the integrative nature of the impact of technology upon people and processes. In so doing the authors seek to not only analyse the case company's experiences in the light of evaluative models but thenceforth compare and extract those details from the case company, which can aid the MIS researcher in investigating this field further. This will be achieved by a brief comparison of this data via the lens of organizational, socio-technical and systems theory components.

2.3   Focal Theory

The theoretical stance taken by the authors in this paper, is that of providing a view into the richness of the exogenous / endogenous relationship of humans and the systems they interact with; essentially using a socio-technical lens, in the guise of Actor-Network Theory (Tatnall and Gilding [24]), to relate the many sociological and technical factors within the given extended enterprise context. As such, Orlikowski and Baroudi [4], Lamb and Kling [25], and Nichols [26] all suggest using such multiple modes of analysis within complex IS-based organizational settings. The underlying research method used is that of the case study type (Yin [6])

following an Empirical, Interpretivist philosophy (Klein and Myers, [27]). The data collection procedure followed all the major prescriptions within the literature for doing fieldwork research (Walsham [5]; Yin [6]; Fiedler [28]). This was applied within the context evaluating human, organisational and technology perspectives (Irani and Love [22]). The authors sought to gather primary data (via a semi-structured interview and participant observation protocol) and secondary data (via organisational reports, memos and archived material). One on one interviews and discussions were conducted with senior board members (CEO, COO, CTO and CFO), as well as two managers from the IS department. This involved using the "long interview" technique as prescribed by Tan and Hunter [29], where responses were fed back to the interviewee, allowing for the resolution of research biases from the interviewer. Numerous secondary data sources were also used, such as internal reports, budget data and archived documentation that were later transcribed. The findings were subsequently presented using a narrative mode of analysis, as used extensively within IS research (Orlikowski and Baroudi [4]; Walsham [5]). Hence, given this contextual background, the case detail is now presented.

3   Case Detail

The case company investigated is an internationally renowned Global industrial products company (herein known as Company X), specialising in industrial control, workshop scheduling, safety, control systems and software. Company X boasts a range of global clients and suppliers across manufacturing, pharmaceuticals, process automation, computer software / hardware and systems integration. At the time of conducting the research, Company X had approximately 15 IS product lines feeding into production planning and fulfilment processes, involving a tight integration with core ERP. Senior management realised, that if by integrating information across and within their industrial automation software product line, via a core ERP package, potentially both suppliers as well customers could be able to see across their production cycle more easily. For trading partners of the case organisation (resellers and external strategic alliance partners), sales level information encompassing sales contact, product and support / maintenance information would need to be viewable. Customers of Company X would also be able to access and demand a range of services, products and information such as sales orders, shipping information and on-line help. Thus, management instigated an EAI programme to enhance the integration between the organisation's order entry, planning, production and order tracking and logistics technologies. Under the auspices of the CEO and board, the project would involve the delivery of an internal "B2B portal" concept. This would be carried out using Baan as the core manufacturing process ERP system in order to aggregate planning and fulfilment information for customer orders, in effect embracing both partners and customers. Thus, by integrating both core CRM, ERP and SCM components of their enterprise, both manufacturing and shipping operations would be combined in a single manner (i.e. in an ERPII sense). Although Company X had enthusiastically highlighted and began working on this initiative, it did not fully realise the effort that was involved.

From the outset and as a result of an internal IT audit, the organisation unwittingly faced the prospect of upgrading and maintaining its current SAP R/3 product internally, which was nearing its license re-purchase state, and was a significant cost outlay. Crucially, Company X decided to adopt Baan not only as their own internal core ERP, but also as the basis of their software products also. This was because the module architecture fitted its discrete manfucturing processes better. As such, senior management persisted in making a switch to Baan ERP, given its stated aims at the behest of the managing director. The apparent disregard for the inherent risks associated with moving away from core SAP ERP and the vigorous and aggressive timescales suggested by senior management, did not take into account the change management issues which would be encountered.

For all company admissions about involving stakeholders, partners and even external systems integrators, the reality of executing the project plan meant that Company X effectively ignored such external involvement. Thus, considerable effort had to be expended in order to integrate and consolidate the core business process applications (not least of which, was replacing their existing ERP package, SAP, with Baan). As an ensemble effort, the application development and rollout of the system was scheduled to be delivered within an aggressive timeframe of 12 months. The initial scoping and definition of the integration effort required, took 6 man months alone to complete. Such estimates were driven and mandated by senior management, with a disregard for the active and necessary involvement of technical and operational IT/IS managers within the divisions concerned. The Chief Financial Officer (CFO) also commented that unless costs were also not tightly controlled, such a strategic project could easily come off the rails. As such, the proposed B2B portal concept and EAI implementation was shelved after a period of 6 months as it became clear, that the successful adoption of Baan internally in order to achieve "reference site" status, was not achievable. Also, the heads of Enterprise Management and Automation product lines, were also concerned about the extent of effort required in order to integrate and standardise their product lines with Baan (which had not even been fully implemented as core ERP within the company). Company X therefore was left with the task of continuing with attempting to replace its SAP ERP with Baan ERP – focussing all its efforts on completing an ERP as opposed to ERP-EAI integration programme (ultimately returning back to utilising its core abilities). In summary, their experiences were as follows:

- Lack of understanding of complexity involved in replacing SAP with Baan;
- Change management and re-organisation, not understood by management;
- Difficulty in managing operational amd strategic initiatives at the same time.

4   Case Analysis

In order to understand the case organisation's experiences, the authors now apply evaluation models from the ERP and EAI research literature in order to ask: can we learn anything more by applying the evaluation models?; and can we identify any aspects which can assist in forming a research agenda in the field? The results are shown in Table 1 and are now discussed in further detail.

4.1   Evaluation of the Extended Enterprise implementation

In terms of "old economy" processes, it is immediately clear that models T.g and O.a were not apparent at all, and that the B2B portal platform was only going to be considered for low transactional liquidity. Conversely, it appears that there was greater concentration around models T.a, T.b, T.f, O.b and O.d. This was in terms of technology considerations; whilst in terms of business (and hence actor) components, there was an emphasis on planning and control, internal focus, and limited user involvement. Overall there appears to have been a general concentration around procedural capabilities, and hence existing skills and experience (the below average result of model T.d denotes a lack of deep integration skills). The view of the organisation's ERP implementation lifecycle, was short to medium term, and as defined by model T.e, the implementation path taken was strategic only (not operational or tactical) - the focus being on finding a rapid solution.

There was a general lack of understanding and recognition of an ERP implementation approach (model I.f), given the large number of EAI interconnections required (model T.b). This further highlights the lack of understanding given to the impact of the ERP system (O.b). For all company X's views and ideals on creating a borderless, connected enterprise network with its supplies, partners and customers, the breadth and depth of its business processes was also negated by their implementation approach also. As noted, there was little user involvement and appreciation of a multi-dimensional (or rather, multi-contextual)view of the plan-source-make-move lifecycle envisioned by the firm. Concepts of agility, flexibility and high transaction liquidity although mandated, were not evident in the design and implementation of the B2B portal. Hence as can be seen there was a greater desire to concentrate on those technology aspects of ERP tailorability and enterprise modelling (model T.g and O.a, respectively), but this could not be realised due to a lack of thoroughness in models T.b, I.f and O.b.

It could be said that strategic goals were trying to be achieved at the expense of tactical and operational considerations. In technology terms, there was a preference / desire to address the tailorability of the new ERP (SAP) alongside attempting to be innovative and design the processes around the system (models T.g, O.d and O.a respectively). Also, it can be seen that there was less reliance and importance given to the ERP implementation approach to be used (model I.f), along with the organisational impact of the given system (model O.b) and finally the level of adoption of the resulting implementation (model T.c). Model O.c shows that there was strong communication but weak collaboration, leading to a "spiral" of failure. Therefore, there was little understanding of the impact on the firm's people and how the step-change in technology would affect their processes. In the case of Company X, although factors relating to management control, communication and overall support for the programme were evident, it is important to highlight those CSFs which were not found, such as: interdependent co-operation; management of expectations; existence of a project champion; careful package selection; user training; education on new business processes; business process re-engineering; choice of a technical architecture; change management; and the use of consultants (and other professional services).

Table 1. Analysis of integration approach, using ERP and EAI evaluation models

Type	Description	Result in Company X	Significance	Type	Context
T.a	**EAI Process Steps (Linthicum [9])**	EAI process steps carried out in order: 1, 5, 7, 2, 3, 4, 6, 8, 11, 9, 10, 12	EAI implementation process was out of sequence (as compared to Linthicum)	EAI	TECHNOLOGY
T.b	**EAI Interconnections (Themistocleous et al. [20])**	105 interconnections required across 15 subsystems	High magnitude of interconnections to develop in the time period given		
T.c	**EAI Adoption model (Themistocleous [21])**	Run the business; cut costs; some internal resistance / pressure	Barriers and internal pressures outweighed benefits to be gained (little experience of full scale integration also)		
T.d	**EAI Lifestyle evaluation (Schmidt, [19])**	10 out of a maximum of 25	According to the rating scale, this defines an organisation with solid / mature EAI capability (does not necessarily equate with *ability*)		
T.e	**ERP Implementation Strategy (Al-Mudimigh et al. [16])**	Strategic and Tactical aspects considered only	Little or no consideration of operational effects on business to meet 12 month milestone	ERP	
T.f	**ERP Implementation Approach (Parr and Shanks [18])**	High budget and short timelines; motivated by operational (data visibility) and strategic (responsiveness) factors	Change continuum experienced in the company was more akin to a vicious circle (sic), as opposed to a smooth change		
T.g	**ERP Tailorability (Brehm et al.[18])**	Type 2 company profile: See Figure 7 for detail	Too much customisation required to meet needs		
O.a	**Pre-Modelling of the IS enterprise (Dalal et al.[17])**	No modelling carried out – implementation began almost immediately	Little or no thought given to the design and impact of the technology on the business processes within and across the organisation	Process Design	ORGANISATIONAL
O.b	**Organisational impact of enterprise integration ERP implementations (Lee et al. [14])**	Process Integration with level of High BPR; High resistance to change; Decentralised business processes| short internalisation period	Management interference and reliance upon technology delivering the solution, rather than working with and steering the IS organisation to achieve the goals	Change Management	
O.c	**CSFs for Communication and Collaboration in ERP (Akkermans and van Helden [12])**	Management support, team competence, clear goals & objectives, interdepartmental communication, vendor support, dedicated resources	Strong communication (from management), weak collaboration (from teams)	Collaboration	
O.d	**IS Innovation level (Swanson [15])**	3c (out of a maximum of 5c)	Short / medium term view of Innovation; emphasis given to know-what rather than know-how. Little or no support from other innovation levels also.	Innovation	

4.2   Researching the extended enterprise: a synthesis

Company X attempted to implement a combined approach to extend and integrate a base-level ERP system to encompass CRM and SCM functionalities, but failed. Because it was trying to extend the capabilities of the underlying Baan ERP, by attempting to articulate its business needs, Company X unwittingly confused itself in attempting to carry out an ERPII-type implementation: but using traditional ERP and EAI techniques to do so. The case study analysis has highlighted several necessary precedents for enacting an extending enterprise initiative, in the application of an ERP/EAI evaluative lens. In short, there was a lack of cohesiveness in bringing together resource complementarities (collaborative opportunities and processes); organisational design (decentralisation with re-integration); enterprise IS; relationship management (governance, contracts and incentivisation) and sustained competitive advantage (trating IT as a valued resource). The linkage between these strategic and operational views of the firm is hence critical to extended enterprise success (Constantinides [30]).

The case study methodology highlights not only significant technological failings, but also the inherent human aspects of the programme undertaken. This is similar to that as reported by Kumar and Crook [31] who suggest that empirical analysis of such organisational contexts, allows for the identification of inter-organisational conflicts. In order to address and realise the nature of such a business strategy as the extended enterprise, the authors suggest viewing the continuum of issues as reported in the given case study, in terms of a multidisciplinary approach. The study of extended enterprises themselves should tend towards a multidisciplinary approach to capture facets as sales order fulfilment right through to third and fourth-party logistics (Sherif *et al.* [23], Chiasson and Davidson [32]); even using a technology testbed or enterprise model to elucidate the implementation aspects of such strategies (Lin *et al.* [33]). Although the case study approach taken by the authors within this article has sought to capture a sense of the human impact of such an initiative, the wider implications of management behaviours and actions, needs to be placed within a longitudinal context. This could be achieved by extending the scope of study outwards across all supply chain participants, by investigating asymmetries in the economic utility of SCM information (Wareham [34]). This could be achieved by applying a hybridisation of case study and action research, via a socio-technical lens; a combined approach of Actor-Network Theory with structural agency theory (Structuration) as noted by Rose [35].

5   Conclusions

This paper has outlined and discussed how an industrial automation company, attempted to transform itself into an Extended Enterprise, through the introduction of a combined ERP and EAI approach. The authors applied a number of ERP/EAI evaluation models in order to highlight the approach taken by the organisation, in the context of a socio-technical stance (considering both human and systematic facets). Thus, it was found that an extended enterprise implementation requires a holistic

approach to People, Process and Technology (in terms of supply chain participants; value chain integration; and ERP/EAI implementation). The authors suggest that future research in the area of extended enterprises, should attempt to uncover such facets, via applying a hybrid approach of theories arising from social and management science, and information economics underpinned by an empirical interpretivist epistemology and research methodology, within a longitudinal timeframe. In doing so, helping to provide a deeper insight into the relationships between extended enterprise agents and the context within which they exist.

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