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The Identification of Enterprise System Limitations within Manufacturing Supply Chains

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ABSTRACT

This primary purpose of this paper is to develop improved insights into common enterprise systems limitations, with specific regard to industrial supply chain management co-ordination and control. Enterprise or ERP systems are now routinely used within many SMEs and can be seen to offer many distinct functional advantages, but barriers to holistic business support and market growth still remain. Contemporary academic research and industrial advancement has been placed upon incremental improvements of existing frameworks to deliver novel ERP II or next-generation solutions based upon extended-enterprise or networked supply chain models. However, indications from these efforts reveal that as SMEs shift towards more agile and customer-focused strategies, there has to additionally exist, a reassessment of how internal reference frameworks and process systems are supported and implemented within the new solutions. Results collated from case studies and industrial surveys offer new recommendations and principles for ERP solution designers, researchers and practitioners alike.

Keywords Enterprise Resource Planning, Supply Chain Management, SME

1 INTRODUCTION

Today's competitive environment can be characterized by intensified competition, resulting from market saturation and increasing global demand for customer-orientated production (Davenport, 1998). More recently, it has been increasingly acknowledged that manufacturing enterprises need to move towards networked and globally-focused operations. To meet the requirements of modern markets, new paths must be forged in agile management strategies, organizational methods, manufacturing strategy and information technology (Denton and Hodgson, 1997). Nowadays, a new Internet era has been entered into, with barriers to market entry being removed, allowing SMEs (Small-to-Medium sized Enterprises) to bring new mass customized products to market rapidly and to develop opportunities profitably. Longstanding research into competitive advantage and partnership has additionally investigated the many implications of the various theoretical models of networked trade and global organization (Porter, 1986). More recently, Karlsson (2003) describes how 'extraprises', an emerging production network paradigm or open production system, may take contemporary manufacturing systems a step further and contribute to a richer framework for manufacturing enterprise strategy research. From these concepts, there exists general academic consensus that SMEs are well placed to succeed in such dynamic global environments, evolving from operating as a single enterprise within vertical markets, towards outwardly focused network participants, coordinated and embedded inside much wider global supply chains. What may be furthermore seen though is a shifting academic and industrial bias towards external orientation at the expense of timely attainment of internal operational pre-requisites. These pre-requisites often comprise: defined organizational structures, proven customer demand understanding, product quality, documented practices, accurate production data, established supplier performance, and effective business intelligence.

2 WORLD CLASS MANUFACTURING FOR SMEs

Contemporary SMEs strive to be World Class and regularly achieve new standards for productivity, quality and time-to-market, which have changed the basis for global competition. The term World Class Manufacturing (WCM) was first used by Hayes and Wheelwright (1985) to describe enterprises that achieve competitive advantage through the use of their manufacturing capability as a strategic tool. Developing business excellence and attaining a competitive advantage demands much more than just getting the right product and price. WCM was then popularized by Schonberger (1986) who developed the concept on a set of 16 interacting principles and provided examples of world class manufacturers. Contemporary manufacturing SMEs not only desire to achieve WCM, but also need to deliver marketplace 'agility'. Kidd (1994) proposed that agile manufacturing enterprises are not only capable of responding rapidly to changes in customer demand and are able to take advantage of

windows of opportunities. Mason-Jones et al (2000) further discussed the attribute as successful knowledge exploitation in volatile marketplaces. Whilst these principles can be advocated for any SME, it is proposed by the paper's authors that further investigation and analysis should be undertaken with respect to enterprise growth. Namely, how WCM principles and agile theories can be mapped against established models of global trade development detailed within Figure 1.

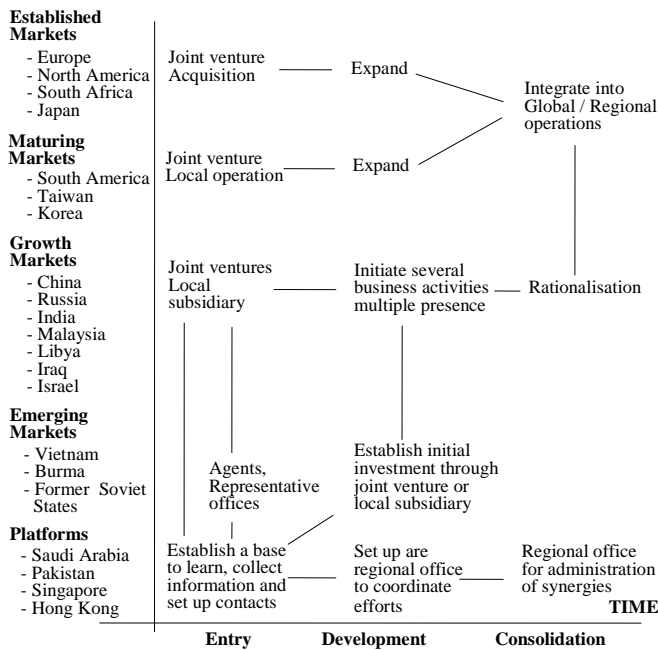


Figure 1: Global Market and Organizational Development

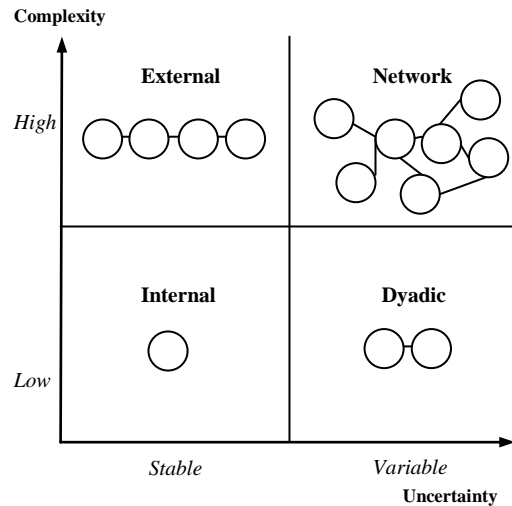


Figure 2: Supply Chain Classifications

Supply Chain Management (SCM) is recognized as a pre-eminent concept by which enterprises can make instant improvements to their business strategies (Fisher et al, 1994). Enhancements to supply chains in terms of improved product quality, faster customer response and greater agility can provide significant marketplace differentiation and increased levels of competitive advantage. Supply chain adoption initiatives strive to match supply and demand thereby driving down costs simultaneously with improving customer satisfaction levels. First step changes to optimizing enterprise logistic processes have relied upon concepts such as Business Process Re-engineering (BPR), Just-In-Time (JIT) and Total Quality Management (TQM) making them faster and more agile. The implementation of SCM techniques externally, as a second step, should lead to enhanced cost saving opportunities as the whole supply chain can be considered and optimized. Whilst, Kehoe and Boughton (2000) acknowledge the research need for more coherent and integrated supply chain classifications based upon complexity and uncertainty, this model provides only a limited, stable and simple view, Figure 2.

ERP systems nowadays form the infrastructure of many SMEs and more recent investigations have been conducted, to develop new holistic models of implementation success (Loh and Koh, 2004). Moreover, contemporary academic thinking has shifted to the extension of ERP or ERP II (Loh et al, 2006) where much closer integration resides between existing enterprise and new supply chain systems. These not only build upon previous internally focused ERP systems, but also recognize outwardly facing SCM imperatives and address changing electronic commerce and Internet-based marketplace trends. Nowadays 'transactional' ERP systems are routinely implemented with additional Complementary IT Systems (CITS), such as Customer Relationship Management (CRM), Advanced Planning and Scheduling (APS), Electronic Commerce, Data Warehousing and Business Intelligence, to provide extra business support in terms of superior customer interaction, supply chain control and effective management reporting (Denton et al, 2007). However, the problems of effective and latent SCM integration, collaboration and performance measurement often remain. It is widely accepted that SMEs can derive step-change improvements from ERP implementations supported by continuous business improvements programmes. What is considered from this research work is that, as ERP systems have further developed towards ERP II, these next-generation enterprise systems concepts should be equally applied internally to SMEs to better support their greater, distributed locations, which similarly require much higher forms of business co-ordination and activity integration.

3 RESEARCH APPROACH

From the literature reviewed, it may be considered that current research tends to consider ERP, or ERP combined with SCM, as a sequential implementation process with both solutions facing diametrically opposite. First develop your internal transaction processing capabilities using ERP and then tackle the outward facing, supply chain planning problems. What can be seen from such implementations is a typically hurried pace to see positive return on software investments at a detriment to longer-term effectiveness of the employed SME development strategies. Far too often, it is seen that unmeasured ERP-type implementations fail to deliver their anticipated business benefits, due to not having appropriate building blocks (e.g. item data, bills of material, routings, resources, lead-time and cost data) in place initially. This poor situation can be further compounded when enterprises try to configure and embed new globally-driven, mass customized processes into functionally structured core ERP systems, for which this has been recognized as a long standing problem with generic, off-the-shelf solutions. Therefore, the primary purpose of this work is to investigate and document aspects of the perception that, in this time of unprecedented global change, 'Current understandings of ERP do not adequately address internal SCM requirements of SMEs who operate global business development strategies'. This research study seeks to be timely in terms of the problems it will address and in the way it will reason on the subject of necessary methodologies and technology that can overcome the key problematic aspects SMEs face. The key questions, which this research paper tries to address comprise:

RQ1: How are SMEs responding to the challenge of internal supply chain management and control?

RQ2: What are current implementation limitations with respect to adoption of ERP solutions?

The methodology of this research work is based on a combination model of descriptive research and experimental research through case studies as described by Yin (1994). From the perception proposed earlier, descriptive research in the form of a literature review, industrial survey, and case studies are to be initially utilized to examine the nature and scope of the problem. This can be seen as a valid approach because a clear statement of 'what is' is an essential prerequisite to understanding 'why it is so' and 'what it might be'. Since the main thrust of this work is related to the implementation of ERP-type systems and only they can be implemented in a real-life experimental context this approach seems clearly justified.

Questionnaire Approach

The aim of the industrial survey was to present work conducted on the applicability and deployment of electronic supply chain tools and techniques within contemporary SMEs to meet global demand. A survey strategy was chosen at this point of the research as it would assist the authors in two main ways, 1) It would aid the authors, as descriptive research, in attaining a good understanding of the current status or 'what is' of current internal supply chain management and control, and 2) It should lend quantitative support to the work's primary perceptions and rationale. Additionally, it was anticipated that this survey and the further case study work would extend the authors' insights into future enterprise strategy development. As such, a questionnaire based on the literature review, was developed comprising three primary areas: the company demographics or configuration; an assessment of enterprise global development position or 'Reach' as classified by Rhinesmith (1991) (National, International, Multinational or Global); and their ERP implementation status, together with identification of internal adoption barriers. From links to the Advanced Engineering and Manufacturing (AEM) Sector within the Yorkshire and Humberside Region of the UK, 280 sample SMEs were selected for survey and contacted.

Case Study Design

Case study investigations were undertaken to build upon the initial survey findings and to offer a more detailed and first-hand understanding of the problematic environment. Yin (1994) proposes that in studies where there exists a lack of defining theory, limited enquiries can be useful to represent unique cases and provide practical examinations of research questions in more natural settings. It was anticipated that by acquiring knowledge from this direct experience, the authors would be better able to develop informed understandings and to answer the posed research questions in a way more closely aligned to actual business needs rather than being based upon theoretical concepts alone. Through AEM Sector contacts, access was facilitated to 10 independent SMEs who were in the process of implementing various types of ERP and pursuing global MTO development strategies. From this SME group, three were chosen for comprehensive study based on access, willingness to

participate, and resource availability. Table 1 summarizes their line of business, strategy, development reach, employee size, structure, environment (complexity/uncertainty), growth and competitive risks. The case study research methodology comprised three phases: 1) Define and Design; 2) Prepare, Collect and Analyze; and, 3) Analyze and Conclude. For all three cases detailed case investigation was carried out to enable a richer level of comprehension of the enterprise processes in which ERP/II was executed and the benefits or barriers associated with its support of global development strategies. On collation of the primary data, formal analysis and documentation was undertaken, with completed reports supplied to the companies for further review and consideration.

Case A	Case B	Case C
Equine transportation manufacture	Healthcare product manufacture and marketing	Chemicals manufacture and distribution
Market leadership focus	Business turnover growth	Increased market share
National	National	Multinational
90 employees	70 employees	240 employees
7 locations	3 locations	8 locations
High	High	High
Uncertain	Uncertain	Uncertain
80%	16%	3%
Return on capital and growth management	Legislative compliance and knowledge exploitation	Contractual risk, capability and delivery performance

Table 1: Case Study Enterprises Overview

4 RESULTS AND FINDINGS

Survey Results

Of the 280 enterprises surveyed, 67 usable responses were received (24%) and comprise selected survey findings. Responding SMEs collectively represented 7 different engineering and manufacturing market segments, with average employee population of 72 employees. Of the survey range, 70% could be classed as primary national in reach, with 18% international, 7.5% multinational and 4.5% truly global. Of the group, a high proportion operated networked structures (79%) with staff located in more than one site and 33% operating in more than one country. The use of company websites was widespread (97%), but only 11 enterprises or 16% of the populations had an integrated e-commerce or payment taking facility built in. The use of Sales Agents (55%) and Regional Sales Offices (42%) demonstrate a potential reluctance of SMEs to invest more in electronic-based sales order management, rather than more traditional face-to-face approaches or contact centres, supported by CRM systems. 17 Enterprises (25%) had distributed manufacturing and warehousing facilities, with a further 4 (6%) having a joint venture agreements. Within the five years prior to the survey 12% of the enterprises had been involved in one or more merger and acquisition activity, with an additional 2 enterprises being able to divest a part of their business successfully. 48% Of the enterprises surveyed did not have an internal IT department and 9% did not have a dedicated IT resource. Rather, in those enterprises, management responsibility for the IT function generally resided with middle management, who had responsibility for both strategy and day-to-day operation. When considered as a whole, on average the 67 responding SMEs deployed 23 PCs each, this figure equating around one for every three employees. All enterprise management engaged in responding SMEs had a high regard for the business benefits and competitive advantage that can accrue from using ERP based solutions. Of the 67 respondent enterprises, 36 respondents had implemented an ERP solution, typically based upon a re-order point stock control or Material Requirements Planning (MRP) planning engine. Of this small group of SMEs, a further 23 enterprises could be seen to have implemented a solution resembling ERP/II, or in this case, ERP combined with 2 or more integrated CITS. In such cases, all ERP/II implementations required additional programming, middleware or the use of other enterprise integration toolsets outside that initially provided by the core advanced business application. System upgrades to the core packages were typically required by responding SMEs every 1 to 2 years. The five main reasons stipulated for implementing ERP/II:

1. To facilitate enterprise business growth.
2. To enhance customer services.
3. To effectively manage complexity and data integration.
4. To achieve a reduction in production costs,
5. To provide effective costing and operation decision-making information.

16 out of 23 respondents admitted that they had undertaken no detailed cost / benefit analysis prior to implementation. 13 Stated that they had not sought any professional advice on the selection of software but relied heavily on the reputation of the vendor and its salesmen's performance. Only 9 employed business process analysis techniques to help them to deduce their system requirements. All respondents agreed that resultant implementation of their systems had delivered business benefit and viewed the adopted use of such systems as a crucial step in maintaining successful operation of the enterprise. Late ERP system implementations were generally blamed on a combination of inadequate management commitment, changing business requirements, lack of production data and problems associated with matching system functionality to current enterprise operation. An issue of total cost was a prime consideration driving this decision. It was felt by the majority (75%) of enterprises, that they probably had an inadequate IT capability to effectively select and implement such systems. 100% of projects exceed their original budgets, 89% ran over time and the acceptable implemented period was identified as between 9 and 12 months. With specific regard to internal supply chain control a range of problem issues were raised, with a selection provided below:

- Costing information cannot be produced per individual manufacturing site with individual overheads rates applied.
- We are limited within the system to one warehouse location and as such we have to use multiple codes, per site for the same production items.
- We do not have system flexibility to schedule manufacturing routing changes easily to balance production between sites for cost improvements.
- It is difficult to include different transportation costs and lead-times for supply to different internal locations.
- We operate differently in each country and one size does not fit all our processes.
- Within our systems it is very difficult to manage inter-location transfers and appropriate stock valuations. We have to consider each internal site as a customer as this leads to a whole host of administrative problems.
- We would like to provide more system access to our remote users, but networking and client license costs are prohibitive.

It is evident from the detailed survey results that: (1) ERP/II-type solutions are now becoming routinely used by a wide range of SMEs operating global; and, (2) SMEs are now deploying highly distributed or networked organization structures, which have unique system and process requirements. The main problems relate to, technical knowledge, the overall cost, expanded time scales and lack of flexibility (as sufficient change capability is not an inherent property of the contemporary packaged software).

Case Study Results

Whilst similarities in their overall business operation could be seen, the three study enterprises exhibited varying classes of ERP/II system adoption, user knowledge and level of implementation resource. All the enterprises selected product specification, customer service, flexibility and quality, not necessarily pure cost, as the key order winning factors. Whilst Enterprises B and C had in employ experienced and dedicated IT professionals, Enterprise A had enlisted the assistance of external consultants and had embarked upon UK Government schemes. Despite the wealth of knowledge contained with these personnel and schemes, all three case study enterprises were found to experience real problems in achieving a high degree of fit between mass customized/global strategies and standard ERP/II-type system functionality. In particular the SMEs further highlighted:

- System support for production data input, capture, integration, scheduling and performance reporting.
- Inter-organization costing and accurate inventory valuation.
- Degree of fit to ETO and global business processes.
- Lack of support for efficient estimation, quotation, configuration and what-if analysis.
- Level and expense of skilled personnel to operate deployed IT solutions effectively.
- Multi-site system operation, networking costs and remote access security.

- Systems integration, performance, data latency and availability (due to record locking associated with batch processing such as finance, MRP, backups).
- Data proliferation and archiving.
- High installation, modification and upgrade costs.

5 CONCLUSIONS AND FURTHER WORK

This work has deliberately covered much ground and its main thrust of developing improved understandings of these evolving areas are largely in their infancy at this stage. From the initial research conducted within this study, it is clear to the author's that much further practical work is required to focus back on the internal working of SMEs with high regard to their rapidly changing organizational structures and ever more complex market dynamics. As enterprise strategies respond to ever more global market opportunities, it is becoming more apparent that those SMEs who hold an improved internal systems foundation and derived business intelligence, will be better placed to achieve success in the contemporary business goals of quality, speed and price. As towards further directions for this area of research the following recommendations are made:

- Conduct wider and deeper primary research into the scope and extent of the perceived industrial problems.
- Further decompose recorded ERP/II limitations and barriers, to develop impact ranking and risk factors.
- Investigate the use of appropriate enterprise engineering concepts to model, classify and construct potential pilot solutions.

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