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# Implementation of intelligent systems, enabling integration of SMEs to high-value supply chain networks

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ABSTRACT

In the face of increasing competition from low-cost economies, European manufacturing companies are focusing on optimisation of operational activities to remain competitive. Previous work has identified how companies can optimise implementation of specialist technology to improve production capability; however increasing demands in service requirements such as customisability and flexibility are often negating the localised gains in capability.

Supply chain management has become an increasingly important aspect of operations improvement to ensure support throughout the product realisation process. The key to creating a supply chain capable of this rapid response and high level of adaptability is integration of intelligent systems and management capabilities.

A site-visit-based survey and characterisation of small and medium enterprises (SMEs), comprising actual or potential supply chain components, reveals that even those with well developed capabilities and attitudes to adopting production technologies are largely not proactive with technology adoption targeting these needs.

A review of requirements for SMEs to achieve such competitive supply chain capabilities reveals a hierarchy of technical expertise to be developed. This is presented as an implementation strategy for staged introduction of these tools and techniques with a view to establishing high-value supply chains capable of withstanding business pressures from developing economies.



## 1. Introduction

In the face of increasing competition from low-cost economies, European manufacturing companies are focusing on optimisation of operational activities. In addition there are operations that are targeted as value adding opportunities such as service, customisability and flexibility, all of which require either significant resource allocation to be held in reserve at the company, or a supply chain capable of rapid response and high levels of adaptability to these increasing customer demands. Hence supply chain optimisation has become an increasingly important aspect of operations management, but there is also an increasingly prevalent attitude of passing the customer issues directly down the supply chain, causing instability and ineffectiveness in meeting customer demands.

This work builds upon previous investigation into advanced manufacturing technology (AMT) adoption in small and medium enterprises (SMEs) described by Thomas et al. (2008) and part of the 'Superman' (ERDF funded project, 1999–2002) research findings. Contact was maintained with many of the original companies through both Superman2, and Manufacturing Advisory Service (MAS), consultancy based projects. This promoted deeper understanding of the company's business strategy and current capabilities, to the benefit of this work.

Academic work in similar themes such as Voss (1986), Wacker (1989) and Zairi (1991) explore a range of individual case studies and subsequent diffusion toward an AMT implementation strategy, however these works are dedicated to achieving finite outputs in manufacturing capability. The value of this work lies in its comparison of these capabilities with a tandem development of technologies to improve supply chain management, which is previously unexplored. Following initial studies in AMT utilisation in the 1980s, and subsequent strategies for implementation and optimisation in the 1990s, this work advances local understanding in SMEs of intelligent systems (IS) tools developed in the 2000s and proposes how this can be further disseminated by use of a staged progression toward wider integration to intelligent supply chain systems.

Section 2 describes the aim to investigate what supporting technologies were being employed by SMEs to maintain

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individual gains in production capability, and tackle the customer service demands mentioned above, through supply chain management techniques focusing on intelligent tools and systems including

- planning/scheduling,
- communication,
- process optimisation and
- relationship management and negotiation.

Through the survey and results described in Sections 3 and 4 of this paper, it was found that there were distinct categories of SME, characterised by company strategy and level of use of intelligent tools and systems. These companies also typically displayed similar capabilities in the themes listed above.

Hence it was possible to accumulate some appropriate generic rules, and an implementation plan of required improvements and investments which would be required for companies to elevate themselves to a status of competence allowing integration to the high-value supply chains to which they aspire. This is described in Section 5, along with many examples of barriers and complexities in practical implementation, and how other developing academic work is starting to mature and tackle these issues.

### 1.1. SME definition

Taken together, the UK's 3.7 million small and medium enterprises (SMEs) account for approximately 40% of the UK's GDP (Wheatley, 2008), but are individually experiencing difficult economic pressures as the global marketplace becomes more open. However, if they could work towards become a well integrated extended enterprise network then they have a massive potential which would threaten the security of larger single entities. This work aims to contribute to a collective understanding in the sample of 150 companies surveyed. The sample is based in Wales (UK), each company employees between 10 and 200 people and turnover is between 0.5 and 20 million pounds sterling. This is a significant spread but is representative of the SME population which could benefit from this work and collaborate directly for mutual benefit.

### 1.2. SCM introduction

In its most basic form, the supply chain is an extended network of suppliers, factories, warehouses, distribution centres, and retailers through which raw materials are acquired, transformed, and delivered to customers. Traditionally the focal point is an Original Equipment Manufacturer (OEM), however in a competitive global market, the OEM is frequently being eroded in terms of its production capability. Subsequent outsourcing is leading to more and more complex industrial organisations, in forms of extended, or even more extremely virtual enterprise. As this occurs, Ounnar et al. (2007) explain that network complexity is subsequently greatly increased due to the fact that numerous decision centres are required to interact. The contribution and participation of each of the partners are thus fundamental to ensure the supply chain achieves its production potential, which often proves to be a weakness for SMEs (Arend and Wisner, 2005).

To minimise this effect, reducing geographical distance between the partners can become a theme for supply chain development (Thomas and Barton, 2007), but the development of a Local Area Supply Chain Network (LASCaN) is only as good as the skills, organisational limitations, resource constraints and technological capabilities of the companies within that network which, again, traditionally isolates SMEs as the weak point in the supply chain (Neupert et al., 2006). Recent studies have pointed to the lack of capability amongst local suppliers and hence many OEMs are forced to move towards Global Supplier Networks (GASCaN) to meet demand, reduced component and/or tooling costs, improved product quality and greater product flexibility. However, these advantages can be sometimes negated through logistical issues which make the total acquisition costs (TAC) of a product far greater than first imagined (Grossman and Jones, 2002).

> Competition in the future will not be between individual organizations but between competing supply chains (Christopher, 1992).

Hence the challenge becomes one of reducing complexity, increasing flexibility and improving speed of response to unique order specifications without incurring poor quality or high costs. A balance is subsequently required between the leanness of the system components and the agility of the overall network.

To achieve this, all supply chain components must employ intelligent tools and techniques to develop intelligent systems capable of adjusting to these changing difficult demands.

### 1.3. Intelligent systems introduction

Intelligent systems (IS) can be defined as systems which process input signals to actuate an output action, the form of which will depend on rules based on previous experiences where the system learned which actions best let it reach its objectives. Hence the degree of intelligence in a system relates to the system's level of performance in reaching its own objectives.

A procedural characterisation of an intelligent system is given by Antsaklis (1994); "intelligence is the property of the system that emerges when the procedures of focusing attention, combinatorial search, and generalization are applied to the input information in order to produce the output".

Key issues of the domain highlighted by Lemmon (1994), cited from Meystel and Messina (2000) include

- "A desirable property of intelligent systems is that they are 'adaptive'…
- Intelligence is an internal property of the system, not a behavior…
- A pragmatic reason for focusing on 'intelligent' control systems is that they endow the controlled system with enhanced autonomy…"

Artificially intelligent systems (AIS) incorporate additional functionality, often through intermediary agents, to simulate, decide and control the output signal or action. An AIS must be interoperable with other components, such as common sense knowledge-bases, in order to create larger, broader and more capable A.I. systems.

The paper goes on to demonstrate how these themes actually appear in SMEs management strategy as follows; Section 2 presents the aim of the study, Section 3 illustrates the methodology of the survey, Section 4 outlines the survey results and ensuing discussion, Section 5 presents a framework of integration to a supply chain and finally Section 6 summarises the conclusions drawn.

## 2. The need for a supply chain development roadmap

There are many benefits of utilising AIS; reducing variability, lead-time and manual intervention; and increasing reliability,