



# Assessment of e-business adoption in SMEs

## A study of manufacturing industry in the UK North East region

Ramesh Marasini

*Southampton Solent University, Southampton, UK*

Kevin Ions

*B2B Manufacturing Centre, University of Teesside, Middlesbrough, UK, and*

Munir Ahmad

*B2B Manufacturing Centre, SST, University of Teesside, Middlesbrough, UK*

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627

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### Abstract

**Purpose** – Internet technologies are increasingly being adopted by UK businesses to facilitate collaboration, trade, learn, manage company business processes and deliver services. Most manufacturing small to medium enterprises (SMEs), who are low investors in the technology, have not benefited from its application. The purpose of this paper is to identify ways of removing the barriers for SMEs and the change approaches used by SMEs to implement internet and information technologies.

**Design/methodology/approach** – An analysis of 32 companies assisted in the internet technology adoption initiative under government funding was carried out. Tailored ICT solutions were recommended and implemented. Information was collected before the start assistance and at the completion of 10 or 25 days of assistance to the companies. Each company case was analysed to generalise the findings. Two change models: classic three step change model and improvisational model were used to analyse the approaches taken by the SMEs in the adoption of ICTs.

**Findings** – The study suggests that SMEs tend to favour the improvisational model of technology adoption over the classic change model. The reasons might be the alignment of technology, the organisational context and the change model used.

**Practical implications** – This study highlights that incremental change model is favoured by SMEs in adopt in ICT technology as a change process.

**Originality/value** – Any initiative aimed at improving performance of SMEs in ICT adoption will benefit from the lessons learned from this study. Also, SMEs adopting change processes will also find the study valuable.

**Keywords** Internet, Communication technologies, Electronic commerce, Small to medium-sized enterprises, Manufacturing industries, United Kingdom

**Paper type** Research paper



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## 1. Background

Rapidly changing international markets have led to an unparalleled expansion in the number of small to medium enterprises (SMEs) in the UK and consequently they have gained a crucial place in the national economy (Matlay, 1999). In the UK, SMEs now account for over 99 per cent of firms, 58 per cent of total employment and 51 per cent of turnover (Department of Trade and Industry, 2005, p. 1). Yet whilst internet technologies are increasingly being applied by large companies to facilitate collaboration, trade, learn, manage company business processes and deliver services there are significant barriers to e-business adoption by SMEs. The global pace of change is so rapid that employees in many SMEs must continuously learn new skills whilst at work rather than rely on the skills they bring with them (Johnson, 2001). However, many employees in SMEs experience cultural, financial, access and awareness barriers to learning (Lange *et al.*, 2000). SMEs tend to adopt an unplanned, informal, crisis-driven approach to learning, perceiving it purely as a means of solving immediate rather than future problems (Lawless *et al.*, 2000). SMEs also have a lack of awareness of the potential of ICT solutions to help their businesses gain competitive advantage and concerns over the cost of e-business deployment and data security.

There are currently a wide range of initiatives both nationally and regionally to assist SMEs to adopt e-business solutions. One such initiative based in the North East (NE) of England and funded by the European Regional Development Fund (ERDF) and ONE North East, was the business-to-business centre project (B2B-MC). This was a collaborative project between the University of Teesside and Warwick University and was set up to help improve the regional economy by assisting manufacturing SMEs to apply internet technologies. The project assisted 72 SMEs to adopt e-business solutions to enable product and service innovation, learning, improved manufacturing techniques and supply chain collaboration and analysis of 32 companies has been included in this paper, other companies excluded in the analysis due to incompleteness of the data analysed.

This paper discusses the approach taken by the B2B-MC project in supporting the adoption of ICT solutions by SMEs to enable competitive advantage. An analysis of 32 companies assisted in the adoption of internet technologies in UK North-East is presented along with the barriers to technology adoption. Two main change models Lewin's (1951) classic, 3 Step unfreeze, move, refreeze model and Orlikowski and Hofman (1997) improvisational model were used to analyse which one do the SMEs are adopting to implement the change. A detailed technology adoption process used by a SME company specialising in the manufacture of fibre optics and the role of learning in SME technology adoption is presented. The remainder of the paper is organised as follows: Adoption of internet technologies by SMEs-change models and barriers, which includes the review of SME change models and presents the discussion of B2B-MC project methodology and findings after its implementation; role of learning in the adoption of information/internet technologies and finally, conclusions of the study.

## 2. Adoption of internet technologies by SMEs: change models and barriers

Two main models of change: classic and improvisational models were considered in this study to identify which approach is better suited to SMEs in bringing about the successful adoption of e-business solutions. Lewin's (1951) classic, 3 Step unfreeze, move, refreeze model offers one possible model for e-business adoption. This model implies that organisations are stable for long periods of time, but are subject

regularly to adaptations that can be planned and directed by those in charge in order to change it from one (undesirable) state of stability to another (desirable) state. The model offers a rationalistic, staged approach to change, suggesting that the change process is linear and progressive, with a definite starting point and a pre-determined end point (Morrison, 1998). The model advocates both bottom-up and top-down change strategies although Lewin (1951) stresses that bottom up changes that are supported by groups are more important because the major resistances to change arise from norms that are dictated by groups. The model offers a practical guide to managing complex change (Levasseur, 2001) but is over-simplistic, linear and static. The models start-and-stop nature does not encourage on-going modifications in order to cope with the turbulent environment within which many modern SMEs operate. Current theories of organisational development are leading to the realisation that change is a dynamic, complex and multi-directional process rather than a linear one (Senior, 1997). This suggests that due to the ever-accelerating pace of change that the model is becoming increasingly detached from business reality.

Orlikowski and Hofman (1997) offer an alternative, improvisational model that is particularly suited to the implementation of technology solutions into organisations. They claim that although people believe that organisational change must begin with a plan, in practice they tend to react to circumstances as they arise often in an unplanned way, thus demonstrating that how organisational change occurs in practice contrasts with how it is implemented. They claim that, it is this discrepancy that contributes to major problems for modern organisations when they attempt to introduce change. Their improvisational model for change attempts to take advantage of how people implement change in practice.

The model recognises the iterative series of unpredictable changes that evolve from practical experience with new technologies. They suggest that software that supports collaboration through a range of facilities such as discussion forums, desktop conferencing and shared repositories will be most useful in practice by experimenting with it to find out how it can be usefully applied. The model regards change as ongoing, incremental and nonlinear and recognises three types of change – anticipated, emergent and opportunity-based (Orlikowski and Hofman, 1997). Improvisational models of change increase employees' motivation and allow organisations to detect change by exploration and then exploit it (Cunha *et al.*, 1999). The improvisational model is suggestive of a bottom up, incremental approach to change. It seems to offer SMEs a powerful way of managing change, in turbulent environments but it requires organisations to be flexible and accept that managers must relax control. It also requires recognition that improvisation is not an instant solution that can be prescribed but must be "grown" over time. In organisations that try to adopt the improvisational model but do not recognise these factors, there is the risk that improvisation may become more of an espoused theory than adopted practice. This paper demonstrates how UK NE SMEs culture is aligned to the improvisational model of change and how SMEs can use it in practice to adopt technology. This is achieved by analysing the study of 32 SMEs assisted under B2B-MC project. The following subsections present the methodology adopted by B2B-MC and findings.

### 2.1 B2B Manufacturing centre project methodology

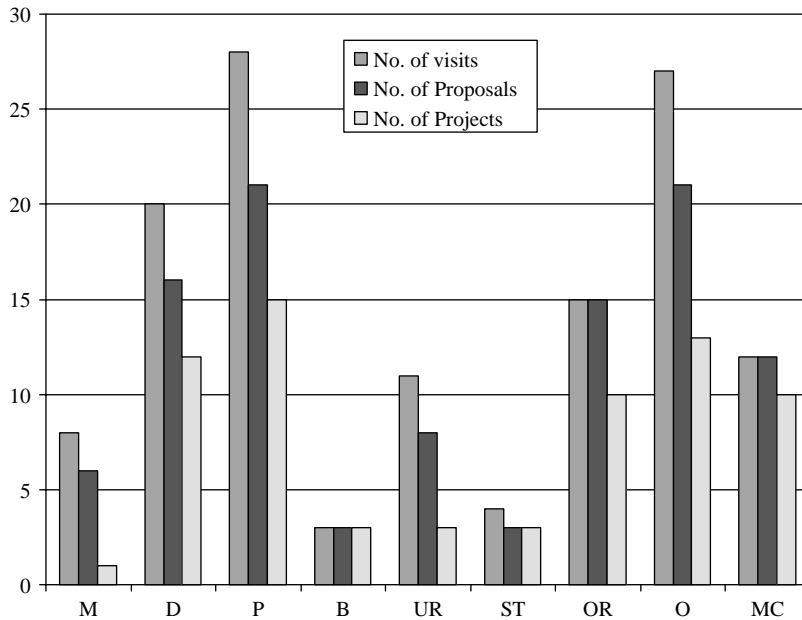
Large companies are reaping the benefits of internet technologies but few manufacturing small to medium enterprises (SMEs), which account for 97.8 per cent

of manufacturing companies in the NE (ONS, 2003) have the skills, facilities and finance to benefit from its application. The NE has a business population of just fewer than 100,000, which accounts for about 10 per cent of all UK businesses (Small Business Service, 2003). In all UK regions, SMEs (0-249 employees) make up over 99 per cent of the business population and the NE has an SME base which accounts for 54 per cent of employment and 45 per cent of turnover (Small Business Service, 2003). ONE North East (2002a, b), a regional development agency, recognises the regions continued dependence upon traditional manufacturing, currently representing almost a fifth of the region's workforce and contributing a greater proportion of regional GDP than any other region bar one. The DTI (2002) predicts that over the next ten years, SMEs will be the main drivers of economic growth, product innovation and job creation. It is essential that barriers to innovation be removed to enable SMEs who are low investors in technology to benefit from technology adoption. The Tees Valley Joint Strategy Unit (2000a) recognises the need for radical action to accelerate the growth of the electronic, knowledge based economy in the NE to ensure the levels of growth required by the region, and that the development of e-commerce is necessary to achieve this.

In collaboration with the University of Teesside and Warwick University and through ONE North East RDA and ERDF funding, the business-to-business manufacturing centre (B2B-MC) project was set up to support SMEs in the NE region of the UK. The project promoted adoption of such technology through targeted support and the development and demonstration of technology demonstrators. The B2B-MC adopted various state-of-the-art techniques to evaluate the IT status of SMEs, identify requirements and solutions, build and facilitate partnerships and design and implement solutions.

*2.1.1 Contact with SMEs.* SMEs profiled by NE Life, the NE regional portal ([www.n-e-life.com](http://www.n-e-life.com)) for finding local businesses and attractions online, were contacted via a variety of means including snail mail, e-mails, e-shots and telephone calls. Figure 1 shows the number of visits, number of proposals written for assistance and number of companies that accepted B2B-MC support. An ongoing on-site visit programme proved successful – 61 per cent of SMEs who were visited accepted the assistance of the B2B-MC. In addition to this, a series of awareness events to showcase the application of internet technology to a particular problem were organised. A mailshot to 1,400 SMEs to one such event, (real-time collaborative product development) succeeded in attracting about 5 per cent of companies mailed. Feedback from SMEs regarding such events was very encouraging and led to a substantial take up of assistance. An analysis of Figure 1 shows personal contacts, demonstrator events, other (vendor or client) referrals, and university promotional events including external seminars generated the most interest amongst SMEs and resulted in the most acceptances of project proposals. Other ways of generating interest proved less successful. The project generally found it difficult to encourage SMEs to take up assistance primarily because of lack of understanding of the type of assistance offered by the project and a lack of awareness of companies about the benefits of technology. In addition to this, SMEs are very time constrained and tend not to use their time thinking about changing their business processes.

Figure 2 shows the size bands and number of visits and proposals written. The highest number of companies which accepted assistance was small companies employing 10-49 people. Although efforts were made to involve large companies to



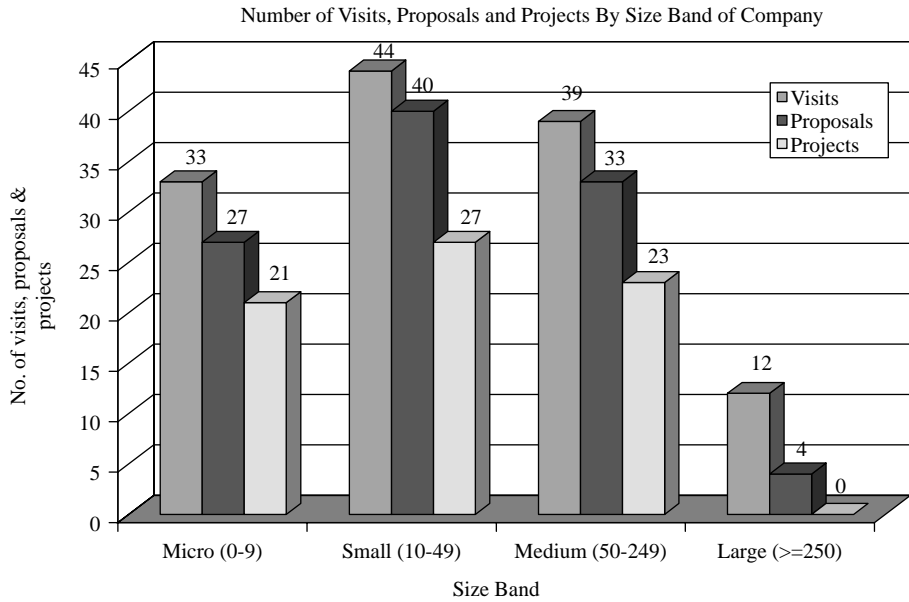
Lead	Code
Northern Manufacturing Show	M
Demonstrator Event Activities	D
Personal Contact	P
Business NE B2B Show	B
Referral from within University (e.g. Project, Centre for Enterprise)	UR
Steering Group	ST
Other referral (e.g. Vendor, Client)	OR
Other (e.g. Uni. Promo. event/publication, ext. seminar)	O
Marketing Campaign	MC

**Figure 1.** Contacts with SME through various modes of marketing

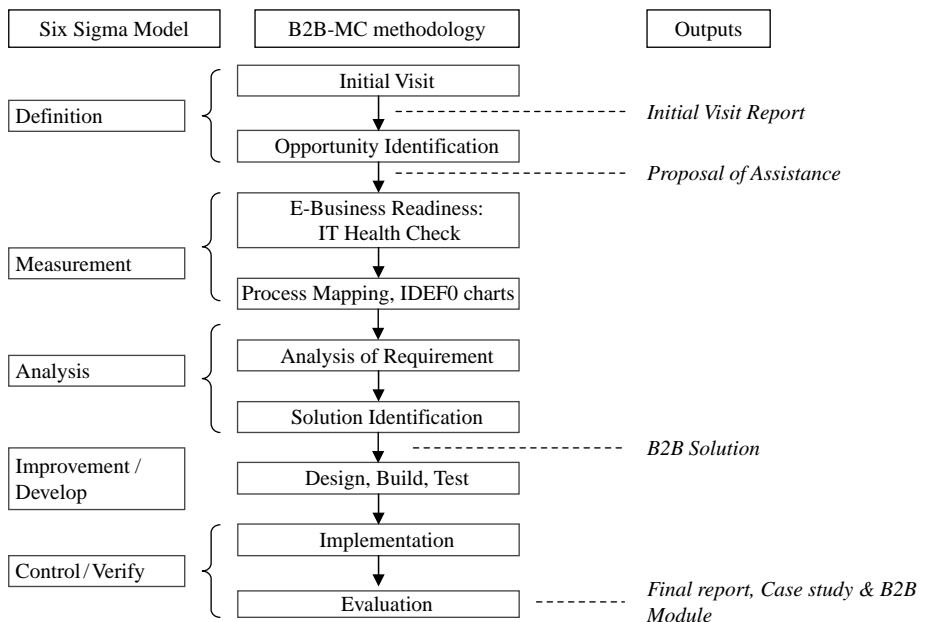
support SMEs through supply chain initiatives these were unsuccessful due to a lack of interest by large companies.

*2.1.2 Engagement with SMEs.* The B2B-MC adapted a model to support SMEs, which is shown in Figure 3. The methodology follows the six-sigma approach that began in the 1980s at Motorola. Two main six sigma models (Six sigma, 2004): define, measure, analyse, improve and control (DMAIC) and design, measure, analyse, develop and verify (DMADV) are utilised. The DMAIC model, which is used for improving existing business processes is practised by the SME and the DMADV, which is used to develop new products, services and processes, is adapted by B2B-MC team. Depending upon the SME requirement, either model was used to support SMEs.

*2.1.2.1 Initial visit.* During an initial visit, project specialists elicited data about company processes and identified areas for improvement. The output of this process



**Figure 2.**  
Size bands of SMEs in contact with B2B-MC



**Figure 3.**  
Methodology used to support SMEs

Source: Business plan, B2B-MC, 2003

was an initial visit report. This process involved a meeting with SME managers to identify possible areas of support beneficial to the company. Based on this report, a proposal was prepared identifying a plan of support and implementation strategies.

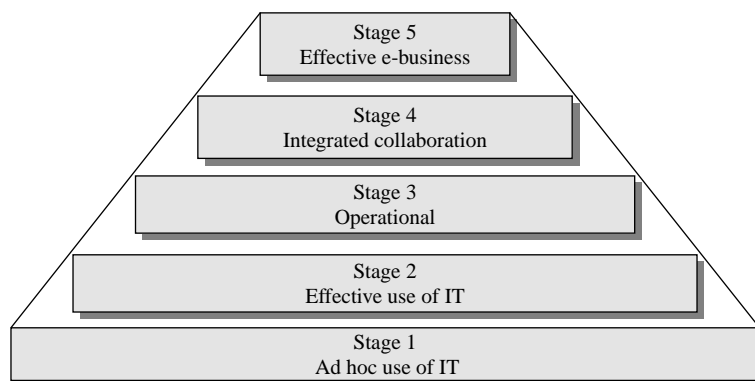
2.1.2.2 Process mapping, IT health check and analysis. This involved, the submission of a proposal of assistance to the SME which if agreed was followed by business process mapping and an IT health check. The objective of the process mapping was to track existing process, bottlenecks and areas where ICT tools could be applied to improve business performance. The IT health check developed by (Jones and Mohon, 2004) as part of a European Social Funded project operated by the University of Teesside, was carried out by completing a standard comprehensive questionnaire. The results obtained from the analysis identified which level of e-business adoption that SMEs were currently at, along with guidelines for improvements to enable progression to the next level of the hierarchy. The results of analysis also assisted the B2B-MC team to select appropriate solutions for the company. Figure 4 shows the five IT capability levels that can be identified by the IT health-check. The model is based on the capability maturity model developed by Carnegie Mellon University.

An analysis of the companies supported by the B2BMC project revealed the various business needs of the SMEs are presented in Table I.

Depending upon each SMEs requirements, business process mapping and analysis were carried out to highlight areas of improvement that would yield significant improvements in business performance. An IDEF0 methodology was used to map the business process requirements. An example is shown later in the paper of the process maps produced for the companies studied.

2.1.2.3 Design, build and test. In agreement with the SME, process improvement programmes through the application of ICT and internet technologies were specified and developed by the B2B-MC or sourced from suppliers. The range of assistance varied from company to company depending on their current level of IT adoption. Assistance ranged from developing business databases or simple websites to the development of complex e-business solutions. Seven technology demonstrators were also developed to demonstrate the benefits of internet technologies to SMEs in the manufacturing sector.

2.1.2.4 Implementation. The off-the-shelf or custom developed solutions were implemented in the companies usually over a period of about six months.



Source: Paulk *et al.* (1995)

Figure 4.  
Capabilities of SMEs

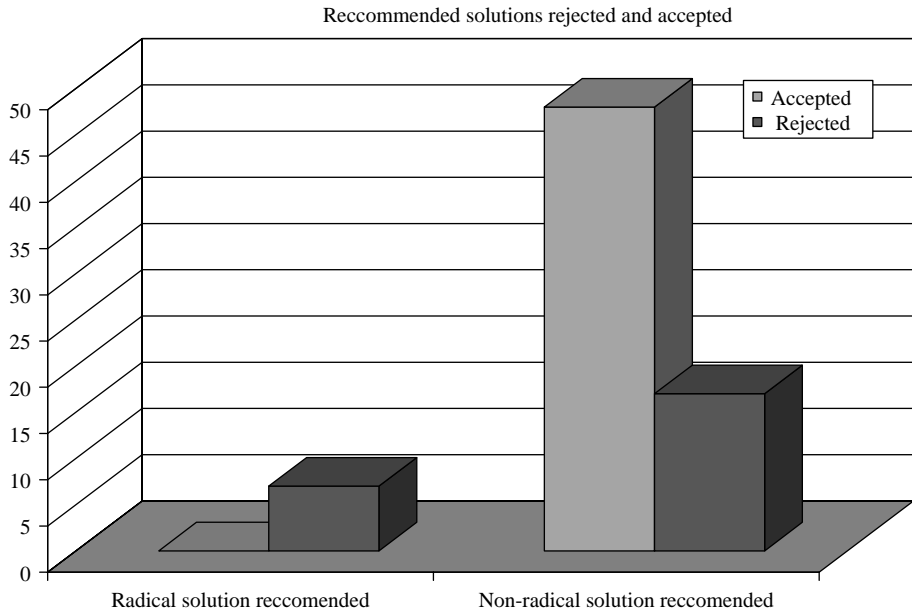


Identified e-business need	Total
Establishing shared project spaces/online collaboration/online conferencing	13
CAD deployment (migrating from 2 to 3D, reviewing and marking up)	9
Developing/enhancing/optimising a company web site	16
Provide external access to company IT systems	2
Procure goods or services online	2
Selling goods or services online	8
Operate within electronic marketplaces	4
Build online partnerships to deliver combined services	3
MRP/ERP deployment	1
Job planning/tracking and scheduling-single and multi enterprise (supply chain)	9

**Table I.**  
Business needs of SMEs

**Notes:** Based on sample of 32 companies. Needs identified through IT HC, questionnaire, semi-structured interview and/or process mapping

Figure 5 shows the number of proposals made recommending incremental changes and radical changes and the number of proposals accepted by the companies in each category. Although implementations were planned, changes were implemented incrementally and recognition was given to the fact that employees in SMEs needed time to explore solutions to find out how they could be usefully applied. Implementations of technology in SMEs therefore, adhered to the improvisational model of change. In some cases implementation of recommended solutions did not occur. This was especially the case where recommendations were made for “radical” solutions such as the introduction of application service provider services to replace existing IT infrastructures.



**Figure 5.**  
Recommendation and acceptance of radical and non-radical changes



2.1.2.5 Evaluation. In the final phase, the IT implementation and its performance were evaluated and further actions suggested if appropriate. The evaluation included an analysis of the number of jobs created and/or safeguarded, increased turnover and the impact on environmental performance in terms of using less paper, less travel, etc. The project recorded as best practice examples or success factors for future use. A final report was also produced highlighting the success and best practice guidelines.

2.2 Findings and lessons learned from the B2B-MC project

This section presents the findings of the NE region based on the analysis of 32 companies who were engaged with B2B-MC project. The information presented is based on data gathered from several key people in each company primarily owner managers, directors, IT managers, production managers, accountants and IT technicians. The number of people involved in the study per company largely depended on company size however the average was three people per company. The analysis is categorised into adoption of ICTs, barriers and opportunities and change models used by the SMEs.

2.2.1 Adoption of ICTs. Figure 6 compares the adoption of various types of ICT adoption by NE manufacturing SMEs who accepted assistance by the B2B-MC with the statistics published by DTI International Benchmarking study (2003) for all UK businesses and all NE businesses. The DTI (2003) suggest that “There is clear evidence of an emerging digital divide between smaller and larger businesses”. However, the cluster of manufacturing SMEs studied, seem to be bucking this trend – at least in terms of internet connectivity and adoption of basic ICTs. For example, internet access is 100 per cent compared to 87 per cent for all NE businesses and 90 per cent for all UK businesses. Additionally, broadband access, having a web site and using external e-mail all compare favourably with national and regional figures. The most probable explanation for this is that it is those companies who responded to the marketing activities of the B2B project that already had a positive attitude to ICT adoption and were keen to move up the adoption ladder.

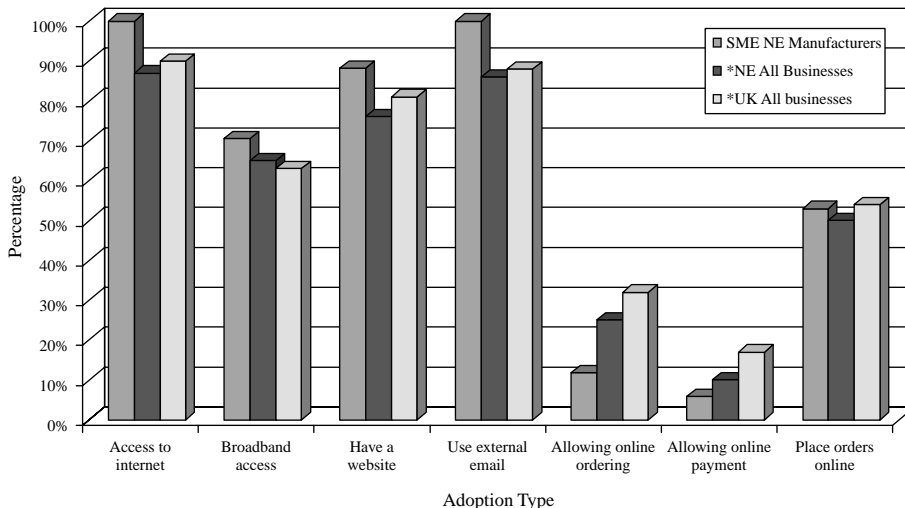
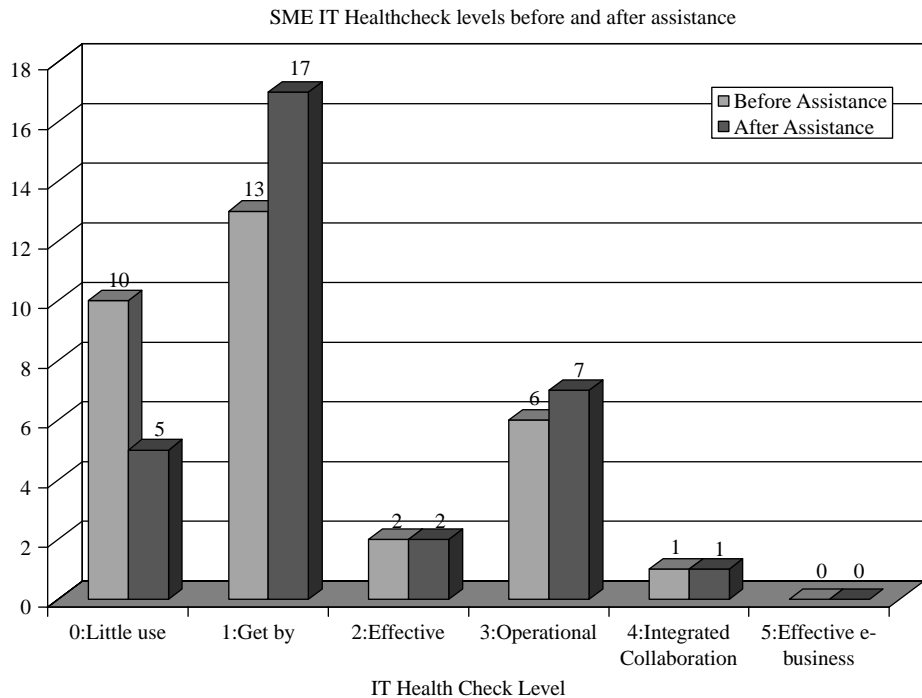


Figure 6. Adoption of ICTs by SMEs in NE

Source: DTI International Benchmarking study 2003

In terms of electronic trading, it is clear that in line with all UK and NE businesses (Figure 6) NE manufacturing SMEs are more likely to place orders online than enable ordering and/or payments for their products or services. The most commonly cited reason SME manufacturers gave for not enabling online ordering was that their products or services were simply not suitable. There are clearly two challenges here; firstly, how to engage the significant number of SMEs who do not respond to ICT adoption initiatives and secondly how to encourage SMEs move up the adoption ladder. Figure 7 demonstrates that the B2B-MC had some success in helping move SMEs up the e-business adoption ladder – especially at the lower levels from 0 to 1.

*2.2.2 Barriers to e-business and internet technologies.* There are several barriers to the adoption of e-business solutions by SMEs and Table II shows the main barriers that were identified in this study. The NE has a relatively-low level of R&D activity, technology transfer and innovation and the overall level of expenditure on R&D is low in the region as a whole (Tees Valley Joint Strategy Unit, 2000b). There is also a lack of awareness of the potential of ICT, the belief that ecommerce is not applicable to SMEs type of products or services and fears over set up costs and security (ONS, 2003). Many SMEs are reluctant to introduce technology, especially internet-based solutions (Tees Valley Joint strategy Unit, 2000c) and consequently the use of the web by SMEs in the region is still relatively undeveloped. It is difficult to convince SMEs to find innovative uses for ICTs for several reasons as highlighted in Table II. The barriers for application of internet technologies (Table II) can be categorised as cultural, financial, technical, access, knowledge sharing and awareness. These categories were identified



**Figure 7.**  
SME IT health check levels before and after B2B-MC assistance

Category	Barriers	Frequency	Rank
<i>Cultural</i>	Fear of IT and resistance to change	12	1
	Trust and quality of support to the companies		
	Commitment of time by SMEs		
<i>Financial</i>	High initial set-up cost	4	3
	Additional cost due to the change		
<i>Technical</i>	Weak skills base	4	3
	Security/privacy issues		
<i>Access</i>	Lack of training opportunities and networking	3	4
<i>Knowledge sharing</i>	Ownership of data, intellectual property	3	4
<i>Awareness</i>	Lack of awareness of potential of ICT	6	2
	Lack of proven best practice examples		

**Table II.**  
Barriers for application of  
internet technologies

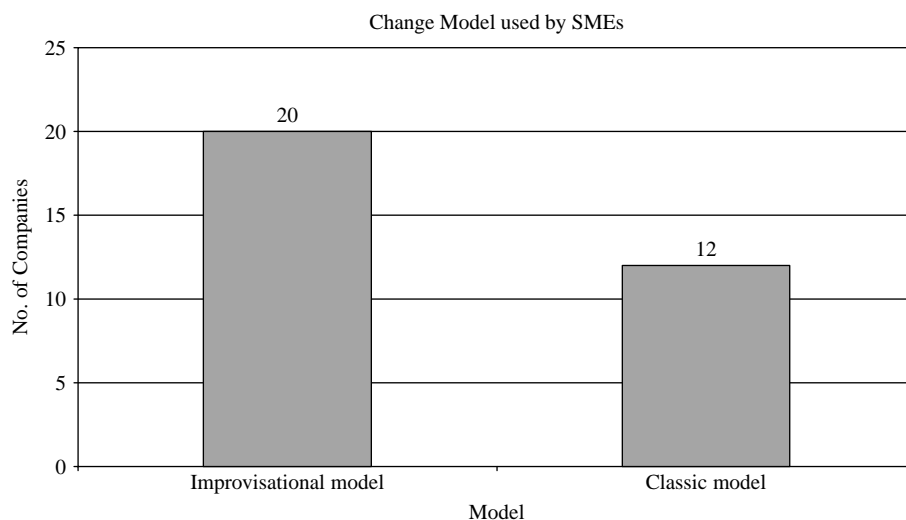
as part of this study and the cultural and awareness categories were ranked as first and second main barriers in the adoption of the internet technologies.

*2.2.3 Approaches to change.* The change model adopted in practice by most SMEs in the adoption of internet technologies was the improvisational model (Figure 8) evidenced by the fact that practical experience with new technologies and experimentation was a major feature of technology adoption in most of the SMEs studied. This is inline with argument made by Orlikowski and Hofman (1997) which highlights that one of the key enabling conditions that allow organisations to effectively adopt an improvisational change model is the alignment of technology, the organisational context (including culture, structure, roles and responsibilities), and the change model used to manage change.

The remainder of the paper describes the role learning in SME technology adoption.

### 3. The role of learning in SME technology adoption

Most research into learning and work features the experience of large organisations (Anderson and Boocock, 2002). There is little evidence regarding how technology



**Figure 8.**  
SME change models

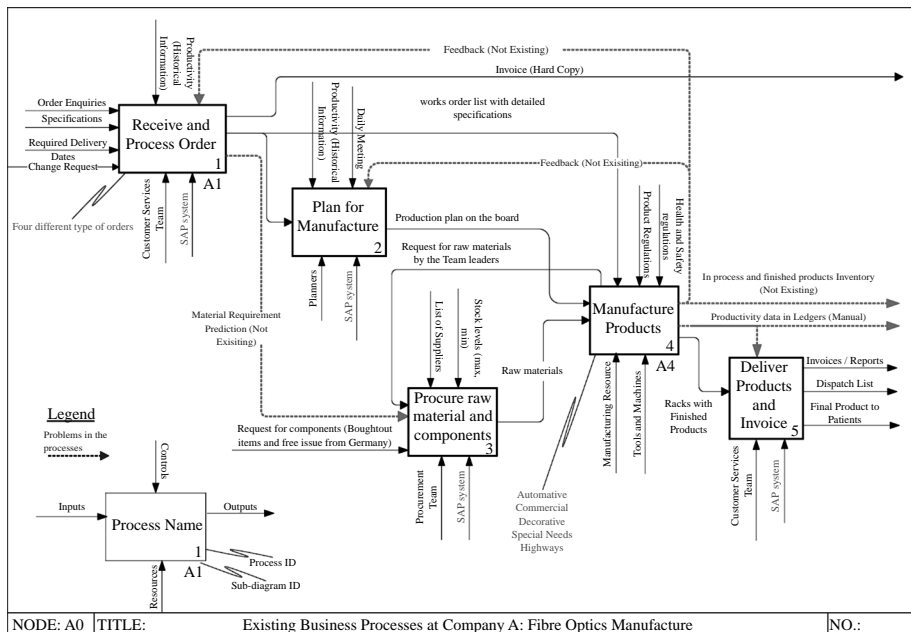
adoption happens in practice in SMEs and more specifically, the role of learning in the adoption process. What is clear is the notion that SMEs are reactive, do not plan or invest in formal training (Holden *et al.*, 2003). This may be because formal training rarely meets the requirements of SMEs and is only considered if it is perceived to meet an important and immediate need (Anderson and Boocock, 2002). SMEs may not be very good at strategic planning or investing in formal training but considerable learning does occur in such organisations. Deakins and Freel (1998) suggest that, it is crucial for SMEs to learn in order to grow, not however, through formal training but from mistakes, experience and their networks. Methods of informal learning are often seen as techniques that a learner can take advantage of right away using work-related resources to provide fast and effective solutions to work related problems (Mosher, 2004).

A qualitative study of one manufacturing company was carried out to determine how SMEs implement ICT solutions in practice (Ions, 2005). The study illustrates the role of learning in SME technology adoption and demonstrates the improvisational nature of the change process in such organisations.

### 3.1 Analysis and findings of the case study

Company A (not named for confidentiality) employs 200 people and is a manufacturer of fibre optic lighting systems and light projectors. The company relies quite heavily on high-volume orders of lighting systems from the automotive industry, but some bespoke, small volume work is also carried out. An outline process map of the business processes of the company has been shown in Figure 9.

The company has a formal hierarchical organisational structure comprising of four directors and 11 managers. The shop floor is split into six teams of production operatives



**Figure 9.** IDEF0 process map of company S: fibre optics manufacture

each led by a team leader. Shop floor labour is very flexible with regular rotation of labour across different product production lines. Information is communicated internally through weekly meetings, e-mail and the company's intranet. Operator training is generally carried out on the job using a "buddy" system.

The company has recently implemented an ERP system to integrate all departments onto a single computer system that can serve all those departments' different needs.

The decision to integrate the various business operations and functions through the implementation of an ERP system was made primarily to enable better planning and reduce inventory whilst improving customer service levels. Although the decision was made by the directors of the company, the decision to implement the system over a six month period was a directive from the managing director. One employee commented that:

There was no discussion about the type of ERP system that would be most appropriate for the company – basically he just went for the market leader at the time. There was also no discussion about timescales to implement the software either which caused considerable resentment.

The decision to implement the system selected was unpopular with employees in the company because of its reputation as a complex, inflexible system more suited to large organisations. One employee who had been involved with a similar implementation in a previous job commented:

I knew that it was a very complex system, and I knew of no company that had implemented it well – we struggled with it. The main problem is that you have to totally change your business processes to fit around the system which radically changes the way most people in the company do things.

Deal and Kennedy (1988, p. 4) define organisational culture as "the way we do things around here". The evidence suggests that the employee had formed the view through his own experiences that ERP implementation requires significant culture change. Such culture changes challenge and redefine people's cultural assumption (Marshall, 1993). Organisational initiatives that require culture change are a risky, complicated drawn out process (Senior, 1997). One interviewee highlighted the main concerns:

There was a very big fear factor because of the implementation of the ERP system. Typically it takes two years to implement whereas our schedule was six months so this put pressure on people who were already resentful that it wasn't a system they were familiar with.

Learning tensions such as fear of change is a barrier to organisational learning and can cause prescriptive organisational initiatives to fail (Sun and Scott, 2003). These tensions can however, be minimised by disabling factors (Sun and Scott, 2003). One disabling factor that might be considered to minimise learning tensions such as fear of change is through effective training. Formal ERP training included timetabled formal on-site classroom sessions and intranet accessible self-study e-learning modules. Classroom training sessions were delivered by external trainers. All of the interviewees commented on the poor quality of formal training. One employee highlighted the main problems:

We often said that the role they [the trainers] played was poor – a standing joke really. It got to the point where there was so much to learn and there was very little logic in what the trainers wanted us to do. During the classroom sessions, we were told by the so-called ERP experts exactly how to do things, but the data and examples they used did not match our

company data. When we asked them how to do the same things they had demonstrated but with our own data they just didn't know. They often just referred us to the simulations on the intranet – easy get out clause!

None of the employees interviewed found the e-learning modules which were essentially simulations of ERP facilities and screens useful. One employee commented that:

The ERP simulation modules were very patchy and sometimes led you down false avenues.

Formal training actually increased employees' fear of change rather than decrease it because it reinforced their fears that the change was both difficult and disruptive. People were unable to do their job effectively – even simple procedures vital to the running of the business could not be achieved. One employee commented:

For the first 8-10 weeks [of the implementation] it hurt the business very badly. For example, we couldn't even get an order onto the system and even when we found out how to do it we couldn't print it out.

A key factor in turning the situation around was the realisation by the team responsible for implementing the ERP system that they would have to take responsibility for their own learning. One employee commented:

We realised that unless we grasped the problem ourselves we were really going to struggle to do our jobs properly.

Survival anxiety is a key enabler of organisational learning (Sun and Scott, 2003). This anxiety led to the formation of a community of practice (CoP) that enabled the team to share ideas, find solutions and identify best practices. One employee describes how this was established:

We set up a sheet of problems we were experiencing and that went round the company by email. We also created a shared team space on the network that was accessible by all who needed to know how to use the system. Any solutions or best practice anyone found was written up into instructions and saved to a folder on the shared space so others could pick them up – that was very useful. We ended up resolving 80 per cent of the problems ourselves using this method.

Collaborative software was used to create and manage the shared project folder. The development of learning materials was aided by the use of a software tool that enabled the team to create their own e-learning lessons consisting primarily of demonstrations of various ERP system functions. One employee commented:

When somebody knew how to use a particular ERP system facility they would use the [authoring] software to record their actions. They could then add text boxes and instructions fairly quickly, store the instructions in the shared team space and post a notice on the system message board to let others know.

Senge *et al.* (1994) suggest that managers must embrace teaching and act as stewards of learning to encourage organisational learning. The employees involved in the implementation included four managers and one director all of who engaged to some degree in teaching and learning in relation to the implementation.

Collaborative software also enabled a message board and task list devoted to the ERP implementation to be established and managed. Orlikowski and Hofman (1997) suggest that collaborative software allows organisations to exploit emerging practices

because they encourage experimentation and improvisation. The evidence presented seems to support this view.

ICT also facilitated access to distant knowledge that was essential to the success of the implementation. The purchasing manager explains how this was achieved:

A desktop conferencing system was set up on my PC so I could communicate with an ERP guru I knew in Germany. The software allowed us to share screens and pass control of the software between us. I would talk him through a problem and then he could demonstrate what to do – how to fill a form in or create a report. I would then practice while he watched and commented if I did anything wrong. Once I knew how to do something I would write up the instructions and save them to the team space for others to use.

This example demonstrates the failure of formal training to address cultural change in company A. Organisational learning must promote enquiry and dialogue (Senge *et al.*, 1994). The training in this case promoted neither because it focused on standardised information that did not allow the team to systemise concepts into their own frames of reference.

Employees responded to the failure of formal training by forming a CoP to share ideas, find solutions and identify best practice. This supports McElroy's (1999) view that CoPs often form to solve problems. ICT played a key role in facilitating communication, problem solving and knowledge capture. E-mail and message boards enabled problems and solutions to be shared, authoring software enabled the creation of tailored e-learning materials and collaborative software enabled the capture and management of tailored solutions. Knowledge transfer from an external ERP expert to a CoP member was enabled through individual practical e-learning workshop sessions facilitated through a desk top conferencing system.

The success of the implementation was largely due to CoP directed, informal e-learning that enabled knowledge creation, capture and transfer. The critical success factor in organisational learning was the synergy that developed between knowledge management techniques and the CoP. This supports Comas and Sieber's (2001) view that a combination of "traditional" knowledge management and CoPs encourages organisational learning. It also supports Martin and Matley's (2003) view that one of the main factors associated with successful ICT adoption in SMEs is effective knowledge management and organisational learning. The study also provides evidence of the incremental nature of change and the importance of exploration and experimentation in successful technology adoption. This study therefore, provides some evidence that improvisational models of change are aligned to SMEs culture and therefore offer an appropriate way of managing technological change in such organisations.

#### 4. Conclusions

This paper has presented a change model that manufacturing SMEs use to adopt e-business technology. A methodology applied by the B2B-MC to support manufacturing SMEs in the NE region of UK was also presented and challenges and barriers to engaging and supporting SMEs identified.

The main challenge for initiatives that aim to assist manufacturing SMEs are to develop strategies to reach the significant number of SMEs that do not usually respond to ICT adoption initiatives. Other challenges include the selection of a mix of marketing strategies such as use of awareness events, workshops, seminars, flyers and use of best



practice examples to increase the awareness of available internet technologies amongst SMEs. This study has highlighted that development of low-cost reliable solutions tailored to the needs of SME that offer demonstrable business benefits should be given a priority.

The study also highlights the fact that SMEs tend to favour the improvisational model of technology adoption over the classic change model. Although the reasons for this were not determined by the study directly, an outline analysis indicates that the reasons might be the alignment of technology, the organisational context and the change model used.

The paper also demonstrates that informal individual and informal group learning plays a vital role in the successful implementation of new technology in SMEs. Such learning through CoPs can be a more effective way of implementing ICT solutions than formal training because it allows employees to systemise concepts into their own frames of reference.

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**Further reading**

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**Corresponding author**

Ramesh Marasini can be contacted at: [ramesh.marasini@solent.ac.uk](mailto:ramesh.marasini@solent.ac.uk)

644

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