Technology Implementation in Manufacturing SMEs: A Model for Change

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Abstract
In order for UK manufacturing companies to meet the current pressures of a modern manufacturing environment they need to develop leaner, flexible and more responsive manufacturing systems. At the heart of these requirements is the need to introduce advanced manufacturing technologies (AMT) into companies in order to improve their efficiency and responsiveness to customer demands. Whilst technology continues to be developed at unprecedented rates, the number of companies implementing such technologies is low. This in turn threatens their long term economic sustainability.

This paper initially identifies the reasons why SMEs fail to adopt new and advanced technologies. It then goes onto propose a coherent strategy for the effective introduction and application of AMT in SMEs before proposing a model for the introduction of new and advanced technologies into these companies. The model is subsequently evaluated through its application in a number of SMEs and compares its performance through assessing the companies who adopted the model against those who decided not to use such a formal approach to Technology Implementation (TI).

Key words: SMEs, Advanced Manufacturing Technologies, Technology Implementation, Planning,

1. Introduction

The changing face of manufacturing industry is forcing companies to evolve at an unprecedented rate [1]. The requirement for mass customisation of products along with the need to ensure high product quality, low product cost and consistent and reliable delivery is placing increasing pressure on UK manufacturing industry. These issues are further exacerbated by increased competition from low labour cost countries where product quality is generally good and product cost is substantially cheaper.

In order to compete, UK manufacturing industries need to initially assess the technologies currently in place within their organisations and then, to assess how this technology meets their customer requirements now and in the future. The requirement to keep abreast of technological developments in order to improve productivity, quality, range of products and other performance measures is now paramount [2].

Despite the clear evidence for a need to acquire

technical skills and adopt new and effective technology into SMEs, many companies are reluctant to move towards a major financial and resource investment. Furthermore, many companies are especially reluctant to invest in automated and computer aided manufacturing technologies (considered as Advanced Manufacturing Technologies-AMT in this paper). The reasons for this are many. Primarily, companies are initially deterred by the extensive capital investment required to develop such technologies and secondly, the capabilities of the technology and the advantages it brings to the average SME are not fully appreciated by the companies concerned. These issues, coupled with fact that many SMEs do not have the technical and manufacturing infrastructure to support new technology, severely limits their success in various technology transfer initiatives [3].

A number of surveys undertaken in manufacturing based SMEs aimed at identifying the reasons why companies failed or resisted the implementation of AMT [4], [5], [6] showed that company directors believed that although financial constraints faired highly in their reasons for the failure to employ AMT, it was the lack of clear guidance and project management knowledge that was considered the major contributor. It therefore follows that the development of a simple yet effective Technology Implementation Model (TIM) which will allow for the development of a technological infrastructure in order to enable SMEs to operate on a more competitive footing is key to their future manufacturing success. In an attempt to bridge the gap in technology transfer knowledge, a TIM is required. However, the development of a successful model can only be achieved if the company's strategic aims are closely aligned with an effective manufacturing strategy. Correct alignment will ensure that resources are appropriately used and maximum benefit is delivered [7].

This paper proposes a TIM and chronicles the design, development and application of the model in selected SMEs. The model was designed by working with six manufacturing based SMEs who had taken the decision to employ AMT into their organisations. Three of the companies used the TI model where the other three companies used a less formalised TI approach deciding to undertake the process without conforming to the TI model.

2.Issues affecting AMT implementation

There is currently little information available that enables companies to be guided in the selection, purchase, implementation and subsequent development of new and advanced manufacturing technologies. Even with the limited information available [8], there is little or no evidence to support the success or otherwise of these models as they apply specifically to SMEs. This statement can be supported through the information gained from a survey into UK SMEs [4] in which it highlighted only 5% of SMEs had designed, applied and operated a formal technology implementation plan. Of these companies however, none of them had developed their model to an extent where it was possible to ensure that the technology was developed in a systematic way so that it effectively contributed to the company's overall manufacturing performance. This issue led to the companies abandoning the technology well before it was able to contribute effectively to company operations.

Chen & Small [9] support the above findings through their work and state that since management within companies has limited experience with the introduction of new and advanced technologies and few guidelines to assist them, not all technology installations are considered complete successes. Even many of those considered successful are not realizing the full benefits that are within their potential grasp. Unfortunately, many of the problems are often noticed only after implementation. It is becoming clear that many of the AMT failures today can be attributed to an inadequate planning process prior to the actual introduction and application of the technology in the company.

3. The need for an TI Model

The issue of whether AMT can be effectively utilised by SMEs remains uncertain. Work by Husband [10] on similar studies into the development of quality systems in SMEs supports this statement since it was seen that SMEs have such a wide range of specific issues peculiar to their own operating environment that the generic application of a systems approach

may not be universally achievable. There must be a need therefore to design and develop a TIM that is both suitable to the wide range of SMEs but is not so generic that it fails to provide adequate direction and guidance to the company. In order to do this, a series of key factors need to be addressed so as to allow for the development of a suitable TIM. These are:

- A cost-effective approach that aligns itself with the specific SME issues and will have relevance and purpose for all types of SME.
- A system to allow integration of the model into the strategic and operational frameworks of SMEs.
- A model that can adopt specific implementation methods and techniques that best suit SMEs.

These factors help to differentiate between generic issues relating to technology acquisition, introduction, application and development in SMEs. A specific and focused TIM is seen as an essential requirement for SMEs. It will be this approach that will enable the SME to gain significant benefit in terms of improved product and systems efficiency.

The TIM allows a framework to be developed around issues that are important to the SME concerned. Whilst these dimensions form the framework for a systems approach to technology management, it is important to ensure specific techniques and tools are available to help directly target improvements in the technology implementation and development process.

Figure.1. shows the development of a strategic model for the implementation of new technology. This model highlights the key elements of the strategy and is split into three key stages. The *foundation* elements provide the company with the underpinning capability and mechanisms to introduce and apply AMT into their workplace. The *operational* elements provide clearly defined stages in which the company can facilitate, monitor and control the TI process [11]. The *enabling elements* allow the company to interface with the customer, these can be considered as the value adding streams of the business and the growth areas for the company.

4.**The Development of a TI Model**

Technology management covers a wide array of practices typically used for bringing new technology to a company or to market. The introduction of AMT into SMEs however is still relatively new and untried and so many companies have managed and executed their technology projects in an ad-hoc way applying general rules of thumb as they progress. Generally, an SME finds little synergy exists between the experiences gained by larger industries due to the differences in their capacity and capability to implement AMT and so, many of the systems applied are not seen as being relevant to SMEs.

The work contained within this paper will deal primarily with the development ‘new technology lines’ and will address the issue of implementing new technology lines into an SME. The reason for doing so is that customer demands rarely remain static. There is a continuous need to improve product features and to ensure product quality, cost and delivery targets are continually met. Therefore, repeatable and predictable processes become critical to the SME. Technology management is becoming central to the operations of SMEs, whether due to increased competition, globalisation, customer pressure or, simply the need for better financial projections, many growing SMEs are looking for a methodological approach to technology management.

Today, SMEs are slowly coming to realise that their growth, competitiveness, and success depends on successful introduction of new and advanced technology to the market in a timely fashion. Speed is the new competitive weapon [12] and managers need to get a successful high quality product to production in record time while keeping costs down. New technology that is accurately matched to company requirements can greatly assist companies in achieving this goal. Support for this view is provided by Twiss [12] who finds that firms must be more innovative in new processing technologies and management practices, in order to improve their competitive positions and ensure survival. However, technology implementation is one of the riskiest, yet most important endeavors of the modern company.

During the work with the SMEs, it was decided that in order to measure the effectiveness of the model, three SMEs would be selected to follow the TI framework model this group of companies would be called the 'working group'. The other three SMEs would undertake their TI process with only basic consultancy intervention from the author and did not follow the TI framework during their respective project. This group would be called the 'control group'.

In order for an effective evaluation of the TI model to take place, a selection criteria was required to ensure that similar SMEs were used for the study as well as similar technologies were selected for analysis. This would then allow the study to concentrate solely on the effectiveness of the model.
The criteria for company and project selection was:

1. All companies were SMEs employing less that 25 people.
2. No company had experience of implementing TI previously
3. The technologies had to be similar in nature (e.g CAD/CAM, automated systems etc (although it would not be possible to use identical technologies due to differing company requirements).
4. All companies were to supply a technology champion for the duration of the TI process.

Working as a technology transfer adviser, technology gatekeeper and change manager within these organizations for a three year period, the author was able to formulate a TI Model, implement the model and subsequently adjust the model through working with the companies. As part of the TI strategy the author investigated the technology management practices that already existed in established corporations that could, through adaptation, contribute to the TI process. Also, through working closely with the two groups and formulating two separate 'Project Steering Groups' (PSGs), the author was able to provide guidance, support and assistance as well as being able to capture and disseminate best practice between the companies as their TI projects progressed. The PSGs also highlighted technical and organizational problems that arose from the TI projects and thus allowed the SMEs to avoid their potentially damaging effects. Formulation of the TIM was made through several iterations and as a result, the five-stage TIM was developed. It is this five staged approach that the 'working' group followed whereas the 'control' group followed a less formal TI process deciding to implement the technology between themselves within their respective PSG.

In order to assess the effectiveness of the TI Model, Measures of Performance (MoPs) were required to be established. It was decided that the following MoPs would be used.

- On-time delivery of the projects
- Cost run over analysis of the projects

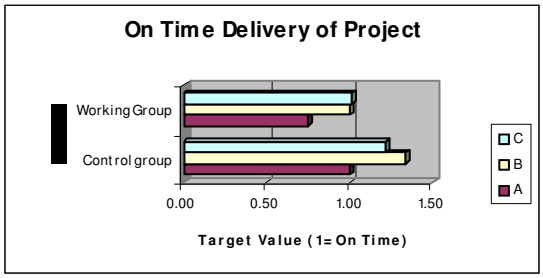
5. Results

As stated previously, in order to measure the effectiveness of the model, MoPs were developed. These MoPs were:

a) On-time analysis of the projects

This MoP was used to measure whether the model was able to show specific and measurable improvements in getting the technology to production quicker. Measured as a percentage in order to normalise the differences between the projects, the success of the working group in completing their projects on time and to plan against the control group can be seen in Figure 2. It can be seen that Company C within the 'working' group was the only project that over-shot its planned implementation time however, this was very small and almost insignificant whereas for the control group, Company A was the only project to be completed within time.

Figure 2 On Time Delivery Analysis

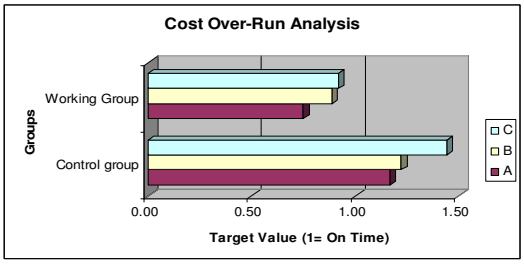


b) Cost over-run analysis.

Similar to the previous MoP, it measures the number of cost over-runs experienced through TI. The costs are analysed on the basis of budget allocated verses the actual costs. Figure 3 shows the analysis undertaken. Again the 'working' group companies performed far batter than the

'control group' as a result of the model framework.

Figure 3 Cost Over-Run Analysis



6.Conclusions

- The development of a TIM allowed for an effective approach to technology selection, purchase and implementation. All SMEs taking part in the programme valued the TIM and the guidance it provided.
- Of the SMEs taking part in this programme, all stated that the implementation stage was the most problematic area of the process. They had believed that the difficulties experienced here were as a result of them not spending quality time on the technology selection and planning stages of the TI process.
- The systematic development of a technology oriented culture is important if UK SMEs are to survive within the global marketplace. Whilst the development of a specific technology model will obviously aid in the development of the knowledge driven culture, further work has to be done in order to ensure that this work is diffused throughout SMEs in the UK.
- Refinement and the subsequent validation of the model will take the form of applying the model in more test-bed companies. The results of such a process will inform of any changes that will be required in order to ensure the model achieves optimal effectiveness in a range of different types of SME.

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Figure 1 The Technology Implementation Model