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Advanced manufacturing technology adoption—the German experience

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Abstract

The decision process that organisations utilise when evaluating technology investment opportunities is a complex and even political process; however, the correct decision can provide the organisation with considerable operational and competitive benefits. The research presented in this paper presents the findings of a postal survey of the benefits provided by technology investments to large German manufacturers. It was found that only where middle management generated the idea for the advanced manufacturing technology (AMT) investment was success in that investment significantly more likely. Respondents who established a project team to plan the technology proposal, regardless of the department which generated the ideas for technology investment, were not significantly associated with a greater likelihood for success.

The respondents typically took between 3 and 12 months before making the final decision to invest, irrespective of the department generating the idea for the AMT, and a further 6 months to implement the AMT. Respondents who utilised a discounted cashflow analysis took significantly longer to make the final decision to invest. The greatest number of manufacturing outcomes of significantly higher importance was identified for respondents where Engineering, IT or R&D generated the AMT ideas. It was also determined that the respondents most frequently considered AMT investments in computer hardware or software and technical training for process workers to be necessary at the time of considering the investment. Middle management were found to be significantly more concerned than managers on other levels about opposition of workers to the AMT, while the process workers were significantly more concerned about interruptions to the process during installation.

Keywords: Technology management; Technology investment; German manufacturing

1. Introduction

The decision process that organisations utilise when evaluating technology investment opportunities is a complex and even political one (Nixon, 1995); however, the correct decision can provide the organisation with considerable operational and competitive benefits (Sohal, 1995; Torkkeli and Tuominen, 2002; Orr and Sohal, 1998). According to Olesen (1990), being willing and able to acquire technology and taking technology risks are two of the six characteristics of the most successful organisations. Advanced manufacturing technologies (AMTs) offer a wide range of benefits to the organisation (AMC, 1990), including improvements in quality, inventory control, customer lead times, machine use and efficiency, staff efficiency and morale, customer image, flexibility, and labour costs (Swann and O'Keefe, 1990; Kumar et al., 1996; Brown, 2001). The research presented in this paper examines the benefits provided by AMT investments to large German manufacturers. The results of the manufacturing futures surveys show that different technology strategies are being adopted by manufacturing companies around the world (De Meyer et al., 1985); however, the findings of this research are likely to apply to many other countries because the important elements and practices of manufacturing strategy for manufacturing companies around the globe are similar, regardless of the economic region (Ettlie, 1996). The paper is part of a global research programme on the effectiveness of investments in AMT in Australia, Britain, Canada, New Zealand, Norway, Singapore, South Africa, and USA (Sohal, 1997; Millen and Sohal, 1998; Schroder and Sohal, 1999; Burcher et al., 1999).

It can be argued that worker attitudes to workplace changes, such as the adoption of manufacturing technology, have a cultural foundation and that cultures that are less

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individualistic in nature, such as Germany, are also less resistant to these changes (Hofstede, 1991). For example, in the Australian context, resistance to manufacturing technology has traditionally been considered to be union based (Muhki et al., 1988). The following lists some barriers to high-technology investment in Australia which may also apply to the German context, but probably to different levels (Ward-Ambler, 1986):

1. a lack of low-cost equity financing,
2. a lack of business skills,
3. the high rate of technological change,
4. a lack of marketing skills,
5. a non-supportive community attitude.

Investing in AMTs is often difficult, if not impossible, to justify on the basis of traditional analytical techniques such as payback, return on investment, net present value and internal rate of return. They require quantifiable numbers, yet many of the benefits of AMTs are hard to quantify (Carter, 1992). In fact, management accounting techniques and information are often accused of constraining technology investment (Nixon, 1995), although relatively little is known about the actual influence of management accounting practices on these decisions (Litchfield, 1994). Many of the benefits, such as strategic consistency, are difficult to quantify and are largely ignored by economic justification methods (Swann and O'Keefe, 1990).

There are six stages in technology investment decision-making (King, 1975):

1. project generation,
2. estimation of cash flows,
3. progress through the organisation,
4. analysis and selection,
5. authorisation,
6. post-audit.

Studies have shown that more companies place an emphasis on stages two and three of this process than on the other stages (Litchfield, 1994; Dugdale and Jones, 1994). This means that companies gain little benefit from strategic technology planning or post-implementation feedback. An alternative technology evaluation approach, which incorporates difficult-to-quantify criteria in the analysis while providing justification in terms of corporate financial goals, includes the following stages (Boucher et al., 1993):

1. developing the criteria framework,
2. eliciting pairwise comparisons among criteria,
3. evaluating consistency of judgments,
4. computing the present worth of alternatives.

This alternative approach is supported by many international studies (Litchfield, 1994; Dugdale and Jones, 1994; Swann and O'Keefe, 1990a), which all determined that it is important to consider the whole process of investment decision-making, not just the theoretically well-developed area of cashflow analysis. It would appear that, to some extent, this need has already been identified by industry. For example, studies by Wallace (1992), Kumar et al. (1996) and Mohanty and Deshmukh (1998) found that the traditional, strictly financial assessment of technology performance is now being expanded by many companies to include such measures as:

1. customer satisfaction,
2. business-process competency,
3. the organisation's ability to change and learn in a growing number of companies.

Another approach that manufacturers can take when evaluating more innovative MT investment proposals is to regard the investment as an R&D project, rather than a capital investment (Carter, 1992). The decision makers can then apply the proper mixture of cashflow analysis and speculation to the analysis without the pressure to specifically quantify the outcome.

Little research has been conducted into the impact of technology adoption on manufacturers in Germany. Related is a study by Welge and Al-Laham (1997) which considers general characteristics of the strategic planning process of German companies. In Raafat's (2002) comprehensive bibliography on the adoption of AMT, no study on German companies is listed. However, there is some literature, which has explored this in parts of Asia, America, and for some European countries. Moreover, the literature suggests that many of the approaches to changes in the Asian manufacturing environment are adaptable and transferable to Western cultural context (Womack et al., 1990; Schonberger, 1982). Nevertheless, a study of German manufacturers may yield results specific to its environment, e.g. the German system of co-determination.

In the 1950s, Japan targeted high entry cost industries such as steel and ship building in which quality was very important (Halberstam, 1986). The advantage gained from using advanced production technology resulted in a strategic advantage for these Japanese industries. On the other hand, in industries in Korea in which the product lives are short and acceptable levels of quality are low (e.g. stuffed toy manufacture), technology has not been found to benefit the product or manufacturing process. These processes are now being relocated to other countries where labour costs are lower (Genzberger et al., 1994). This is supported by Gaither (1992), who found that industries such as clothing and toy manufacturing find difficulties with the adoption of technology which makes these investments unprofitable. Schroder and Sohal (1999) documented the influence of firm size and ownership structure on AMT adoption, and Abdel-Kader and Dugdale (1998) found differences between AMT and non-AMT investments.