# State of the Art Review

# Adoption of new technologies and organisational practices: are there innovation benefits?

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**SOTA Review No 7: October 2018**

**In increasingly competitive environments, the ability to innovate successfully is a key corporate capability, and depends on the wide-ranging, complex decisions faced by firms in their day-to-day operations. International studies report innovation returns from the adoption of advanced manufacturing technologies (AMTs), although these returns may be lagged due to initial disruption effects. Likewise, work practices such as innovation strategies, innovation culture and leadership, team-working and multi-functionality are important for innovation. In addition, adoption decisions are not necessarily made in isolation, and there is evidence of higher innovation returns when adoption decisions are made simultaneously.**

**Individual business surveys rarely consider all three areas (innovation; technology adoption; work practices), therefore we know little about the importance of organisational culture as a pre-condition for the technology adoption–innovation relationship. In addition, longitudinal or panel data is necessary to investigate possible lags to any cause-and-effect relationships.**

## Background

Decisions around the adoption, use and organisation of resources are critical, but our understanding of the likely returns to innovation is still quite limited. What returns to innovation are firms likely to see when they introduce 'new ways of doing things'? If a firm changes how the work place is organised will that benefit innovation? If a new technology is adopted now, will firms innovate more successfully than before? Moreover, when will the benefits of these changes be realised?

This review focuses on AMTs and work practices, and considers their impact on firms' innovation success. AMTs relate to a series of process innovations which enable firms to take advantage of numerical and digital technologies to optimise elements of a manufacturing process (e.g. computer-aided manufacturing (CAM), Automated Materials Handling (AMH) and robotics). It is generally accepted that the primary benefit of AMT use is cost-efficient flexibility in the manufacturing function (Sohal 1996), due to increased flexibility, reduced costs and improved quality (Corbett and

VanWassenhove 1993; Lei and Goldhar 1990; Meredith 1988; Parthasarthy and Sethi 1992).

The organisation of work is how work is planned, organised and managed – via production processes, job design, task allocation, rules, procedures, communication, responsibilities, management and supervisory styles, work scheduling, work pace, career development, decision-making processes, interpersonal and interdepartmental relationships (Valeyre et al., 2009). While many organisational 'types' have been identified (e.g. Discretionary Learning, Lean Production), it is unlikely that firms abide by a pure organisational type, as various types of work practices may be adopted in an ad-hoc fashion across different units and departments (Arundel et al., 2007). It is important to note that while work practices may include HR and/or management practices (see Bloom and van Reenen (2007), in general they refer to a broader range of practices by which firms organise work.

While there is a large literature on what influences and motivates adoption of new technologies and work practices by firms, studies on their subsequent role in shaping firms' innovation activities are relatively scarce (Spanos and Voudouris 2009; Seeck and Diehl 2017).

## Evidence

### AMTs and Innovation

While the empirical evidence is somewhat limited, there is growing evidence that AMT adoption and use benefits innovation (Barge-Gil et al., 2011, Bourke and Roper, 2016, Raymond et al., 2009, Santamaría et al., 2012, Santamaría et al., 2009, Hewitt-Dundas, 2004). A positive relationship between AMT adoption and innovation outputs has been reported across small firms (Raymond et al., 2009) and for those firms which do not undertake R&D (Barge-Gil et al., 2011). AMT use is reported to be a critical factor in the generation of product and process innovations in low-and-medium technology (LMT) firms but of less importance in the case of high technology firms (Santamaría et al., 2009), and is important in the achievement of service innovations (Santamaría et al., 2012). In addition, there is evidence that having more flexible production systems may also allow firms to adopt more complex innovation strategies with potentially higher returns (Hewitt-Dundas, 2004).

Early studies of AMT adoption documented the difficulties which firms face in the effective implementation of AMTs, suggesting the potential for time-lags in the effect of AMTs on innovation (Tyre and Hauptman, 1992). However, empirical studies to date have largely been cross-sectional in nature and have not considered the possibility of timing effects in the AMT-innovation relationship. A recent exception illustrates that disruption effects are evident from AMT adoption in the short-term while positive innovation benefits occur six-plus years (Bourke and Roper, 2016). In addition, strong complementarities between simultaneously adopted AMTs suggest the value of disruptive rather than incremental AMT implementation strategies (Bourke and Roper, 2016).

### Work Practices

Previous studies show the positive influence of innovation strategies and information-sharing (Cuijpers et al., 2011, Peeters and Van Pottelsberghe, 2006), culture (Hogan

and Coote, 2014) and leadership (Love and Roper, 2015, Garcia-Morales et al., 2012) on innovation performance. In addition, Arundel et al. (2007) report that in countries where work practices are employed that support high levels of discretion in solving complex problems (e.g. high-performance work practices (HPWP)), firms tend to be more active with respect to 'in-house' innovation. However, where work practices are in place that constrain on-the-job learning and problem-solving and employees are given little discretion, firms' innovation activity tends to involve the adoption of innovations developed elsewhere. Jensen et al. (2007) report that combining science, technology and innovation (STI) and doing, using and iterating (DUI) practices benefit new product and service innovation. Therefore firms which combine the production and use of codified scientific and technical knowledge and informal processes of learning and experience-based know-how are more likely to innovate.There is also growing evidence that 'bundles' or 'systems' of HR practices rather than individual HR practices benefit innovation (Seeck and Diehl, 2017), with commitment rather than compliance practices (Verburg et al., 2007) and strategic rather than functional practices (Wang and Zang, 2005) being of most benefit.

In relation to the ideation or exploratory stage of the innovation process, multi-functional working and team-working have been shown to play a positive role (Love, Roper, and Bryson 2011; Love and Roper 2004), as team and workforce diversity are linked to enhanced creativity as engaging with a broader range of perspectives, less likely to resist change and new ideas and develop more novel solutions (Shipton et al. 2006).

## Overview and Evidence Gaps

Successful adoption of technology and work practices benefits firm innovation. Appropriating the potential benefits of AMTs can be difficult, and may only be realised after an initial disruptive effect. In addition, simultaneous adoption of different AMTs appears a sensible implementation approach, as sequential adoption may result in continuous disruption. Work practices, such as innovation strategies, innovation culture and leadership, team-working and multi-functionality, benefit innovation. In addition, there is growing evidence of the positive impact of HPWP for innovation, particularly in-house innovation. Also, bundles of strategic or high-commitment HRM practices can be beneficial.

To date, innovation scholars have either considered the impact of technology adoption on innovation or work practices on innovation. However, given the importance of organisational culture as a pre-condition for successful AMT implementation (Zammuto and O'Connor, 1992), a more cohesive approach may be useful. For instance, are firms with stronger skill endowments better able to accelerate the process of effective AMT implementation? At present, advancing the knowledge base in this area is constrained by data availability, as many surveys focus solely on innovation or technology adoption or workplace organisation. In addition, longitudinal or panel data is necessary given the likely lags in any cause-and-effect relationships. Furthermore, it is also important to note that while the evidence base in this area is growing, few empirical studies pertain to the UK.

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