

Technology Strategy: Literature Review and Issues

Suriani Sukri^{a,b*}, Rushami Zien Yusoff^b, ^aSchool of Business Innovation and Technopreneurship, Universiti Malaysia Perlis, 01000 Kangar, Perlis, Malaysia. ^bSchool of Business Management, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia.
Email: *surianisukri@unimap.edu.my, rzy278@uum.edu.my

Technology strategies have attracted serious research attention in the recent past. In this paper, an attempt is made to review the status of the literature as it relates to technology strategies. A literature classification scheme is suggested. A total of 66 articles from refereed journals and international conferences are classified into content (technological capabilities, literature survey and performance measurement) as well as issues to do with process application. The methodology used to survey and study the relevant literature focuses on conceptual, descriptive, empirical, exploratory cross-sectional and exploratory longitudinal approaches. Based on this, possible research issues are also identified.

Key words: *Technology Strategy, Content-related issues, Process-related issues, Conceptual, Descriptive, Empirical.*

Introduction

For many years, American and European managers have been told by management gurus that technology strategies should be given special attention as the study on technology strategies has become increasingly important (Ford, 1988; Smith and Rogers, 2004). Ford (1988) in his research states that technology strategies are not similar to an R&D strategy; the latter is concerned only with acquiring technology through in-house activities. A technology strategy is an aspect of that strategy concerned with exploiting, developing and maintaining the sum total of a company's knowledge and abilities. The development of a technology strategy is the basis to foster future strategic behaviour that, in turn, leads to enhancing competitiveness and growth. This is supported by Zahra (1996) who verifies that by possessing a technology strategy, manufacturing companies are able to contribute and cope with its external environmental effects and demands. To address this uncertain environment, manufacturers should continue to examine their strategies, practices, capabilities and, in so doing, identify their impact and performance (Ketokivi and Schroeder, 2004; Germain et al., 2008).

To date, a number of studies have investigated the efficacy of a technology strategy (Parker, 2000; Li and Atuahene-Gima, 2001; Zahra and Nielsen, 2002; Wilbon, 2002; Gibbons and O'Connor, 2003; Ngamkroekjoti et al., 2005; Lin and Chang, 2006; Van de Velde, 2006; Chen et al., 2008; Jin et al., 2008; Muhammad et al., 2009; Chadee and Pang, 2008; Man et al., 2009; Ghazinoory and Farazkish, 2010; Dasgupta et al., 2014; Sikander, 2011; Husain, 2016; Nanayakkara et al., 2017). Most of these aforementioned studies are general and focused on the contexts of high-tech companies (Lin et al., 2006; Man et al., 2009; Li and Atuahene-Gima, 2001). Evidently, limited attention has been given to technology strategies of manufacturing industries, regardless of their importance and potential. It is this very gap in knowledge and understanding that makes the scope of study unique and wanting of further explanation (Man et al., 2009). In current and competitive scenarios, technology strategies assume significant and serious importance for research consideration.

The objective of this study is to provide an extensive literature review. 66 articles from reputable journals and international conferences have been identified. More specifically, the purpose of this study is to:

1. define what constitutes technology strategy research;
2. classify technology strategy research articles according their approach and methodology and;
3. explore trends in technology strategy research and to suggest a research agenda for future work.

This paper is structured as follows: (i) discussion of the literature classification scheme; (ii) identification of gaps between theory and practice and; (iii) a suggested research agenda.

Technology Strategy

Having an established and embedded technology strategy is an essential part in creating an organisation's strategic position (Zahra and Bogner, 2000). It is an essential precondition that takes advantage of current and effective technology. It works as a fundamental tool for rivalry and establishes practical and physical alternative actions (Itami and Numagami, 1992). In a similar way, organisations' core capabilities are dependent on technology as a primary foundation.

As a variable, technology has become essential for profit or not-for-profit organisations to maximise competitive advantages and to measure changes in performance. Zahra (1996) emphasised that technology has been widely recognised as a cornerstone of an organisation's competitiveness through several mechanisms, such as creating barriers to entry, attracting



new markets and customers and even changing the rules of competition in industry. Gillespie and Mileti (1977), in *Technology and the Study of Organisations*, broaden the importance of past technology to involve machine or equipment conceptualisation and incorporate delicate advancements and utilisation qualities of present-day industry.

Miles and Snow (1978) and Porter (1985) recommend the linkage between technology and strategy in that technology is assumed to be a noteworthy part in detailing different strategies. Furthermore, a technology strategy chosen by organisations could shape an emerging competitive nature within a select industry. In brief, the performance and achievement of an organisation is fundamentally derived from the application of a technology strategy. Essentially, a technology strategy is the process by which organisations utilise and deploy their technological resources and capabilities to achieve corporate objectives (Rieck and Dickson, 1993).

The evolution of a technology strategy is found in a number of studies and provide a definition, concept and application. Initially, a 'technology policy' was applied to determine the best alternatives for companies to acquire, develop and deploy technology to achieve business and strategic goals (Adler, 1989; Zahra and Covin, 1993). Zahra (1996), in multiple studies, stresses the acquisition and utilisation of technological resources and capabilities. A technology strategy enables new businesses to make informed decisions regarding the development and use of technological capabilities. Additionally, such a strategy empowers firms to make educated choices and to determine options, while simultaneously enhancing and utilising technological resources (Zahra and Bogner, 2000).

Narayanan (2001) in his book *Managing Technology and Innovation for Competitive Advantage* expands the idea of technology strategy as uncovered technology designs. Technology selections govern the type and degree of a company's primary technological capability and readiness of product and policy. The selections entail the liability of the resources for fraud, preservation, utilisation and neglect of technological capabilities. Two key points are central to a technology strategy. Firstly, carefully choosing a technology for the purposes of either acquiring, developing, deploying or divesting. Secondly, uncovering technology designs that are not only planned but can be further refined. A company demonstrates its commitment to a technology strategy by executing resources and through technology selection.

A study by Husain (2016) found that chief technology officers believed that a distinct focus is emphasised in technology strategies and their indicators. The process of acquiring technologies is achievable when there is no conflict of interest. If there was, this conflict of interest needed to be addressed prior to achieving effective technological alliances. This is

especially the case with equity interest, transparent digitisation, product, partnership and market development.

Definition of Technology Strategy

Research of technology strategies has attracted interest in the field of strategic management. Scholars have described technology strategy in several ways and from a range of perspectives. Existing research has been scattered and, as such, differing meanings are used to about technology strategies. Technology Strategy, according to Dodgson (1989), Burgelman et al. (1996) and Zahra et al. (1994), indicate the need for companies to strategically deploy technology. Companies need to align the strategy to ensure the linkage, support, connection and sustainability of technology. Adler (1989) explains that a ‘technology strategy is a pattern of decisions that sets the technological goals and principal technological means for achieving both those technological and business goals of the organisation.’

Technology strategy is defined differently by scholars from various fields of study and Table 1 below provides a detailed overview of definitions used in previous research.

Table 1: Various Definitions of Technology Strategy Reported in the Literature

Author	Definition of Technology Strategy
Maidique and Patch (1978)	Technology strategy’s earliest concept was based on six dimensions namely technology selection, level of competence, the timing of technology introductions, level of investment, organization and policies, and sources of technology.
Porter (1983a), Chiesa (2001) and Burgelman et al. (2003)	Technology strategy was a tool for effective use of technology to build new (offensive) or sustain (defensive) competitive advantages.
Porter (1985)	Effective deployment of the company’s technological capabilities and resources that can enhance the company’s financial performance and sustain the company’s competitive advantages.
Porter (1985b)	Suggested that a technology strategy must address at least three broad areas: (i) the technologies to be developed, (ii) the need to seek technology leadership in those technologies, and (iii) the role of technology licensing.
Maidique and Patch (1988)	Technology strategy consisted of a portfolio of choices and plans that enabled the firm to respond effectively to technological threats and opportunities.
Ford (1988)	A formal plan for technology resources that guided long-term

	decisions related to development, acquisition, implementation, and investment. Technology strategy consisted of policies, plans and procedures for acquiring knowledge and ability, managing that knowledge and ability within the company and exploiting them for profit.
Burgelman and Rosenbloom (1989)	Proposed an evolutionary process perspective and framed the substance of technology strategy on competitive positioning, technology and value chain, the scope of technology strategy and the depth of technology strategy.
Mitchell (1990)	Alternative frameworks for technology strategy. Technology strategy transportation, banks/financial services and even some wholesale/retail business were often focused around the following three generic issues; the physical system, operations or products (of the system).
Pavitt (1990)	A set of choices that needed to be made about technology development such as broad or specialized, product or process and whether to be a market leader or follower.
Wheelwright and Clark (1992)	The objective of a technology strategy was to guide the firm in acquiring, developing, and applying technology for competitive advantage.
Spital and Bickford (1992)	Technology strategy as the set of strategic decisions and action required by managers to transform input into output to gain competitive advantages.
Rieck and Dickson (1993)	Technology strategy was the process by which firms utilized their technological resources to achieve corporate objectives
Zahra and Covin (1993)	Technology policy embodied the choices companies made about acquiring, developing and deploying technology to reach the goals of their business strategy. Technology policy was the set of organisational decisions concerning aggressive technological posture, automation and process innovation and new product development.
Zahra et al., (1994)	Technology strategy specified its components and dominant orientation; it denoted the aspect of a firm's possible technological choice and action.
Zahra (1996a)	Technology strategy articulated a firm's plans to effectively develop, acquire, and deploy technological resources and capabilities that contributed to its competitive position and achieve superior financial performance.
Zahra (1996b)	Technology strategy was the plan that guided a new venture's decisions on the development and use of technological

Pegels and Thirumurthy (1996)	capabilities. Technology strategy was defined as the approaches firms used to translate R&D efforts into the advanced product and process technologies that had the potential to provide competitive advantage result to improve firm performance.
Zahra and Bogner (1999)	Technology strategy was the sum of a firm's choices on how to develop and exploit its technological resources that can profoundly affect a company's performance and survival.
Zahra and Bogner (2000)	Technology strategy was the most essential component in the formation of the organisation's strategic posture.
Narayanan (2001)	Technology strategy was the revealed pattern of the firms' technology design. His ideas identified two key points of technology strategy, firms' selection on types of technology whether to acquire, develop, deploy or divest, and on an uncovered firms' technology designs that were not only planned but rather additionally refined.
Gibbons and O'Connor (2003)	Technology strategy referred to the set of choices the firm makes about the state and quality of the know-how it incorporated into the design, development and production of its product or service.
Ngamkroekjoti, Speece and Dimmitt (2005)	Technology strategy played a role in how much scanning they used, with a more proactive technology strategy requiring more extensive scanning. Environmental turbulence, including changes in technology, can cause failure in NPD if scanning did not make companies aware of the situation.
Lin and Chang (2006)	Technology strategy was counted as one of the most important attributes for the achievement.
Larsson (2007)	Technology strategy was defined as "the pattern or plan that integrated an organisation's major goals, policies, and action sequences into a cohesive whole with respect to the physical things, know-how, and procedures used to produce products and services".
Chadee and Pang (2008)	A firm's technology strategy was defined as the firm's deliberate commitment and willingness to proactively develop and acquire relevant technologies, utilized these technologies widely in the organisation and consistently upgraded its employees to ensure that technologies were fully embraced within the organisation.
Meyer (2008)	'The operational expression of a technology strategy was the set of projects that an organisation wanted to implement.

	Determining a strategy included selecting the projects and the portfolio of projects’.
Ghazinoory and Farazkish (2010)	Technology strategy was one of the most important aspects of any firm’s strategic posture, especially in dynamic environments such as the nanotechnology-based industry.
Dasgupta, Gupta and Sahay (2011)	Technology strategy can be briefly and broadly defined as a portfolio of choices and plans that a firm used to address the technological threats and opportunities in its external environment. The broad objective of technology strategy can be used to guide a firm in acquiring, developing and applying technology for competitive advantage.

Source: Various definitions of technology strategy from 1978 – 2011.

From Table 1 above, it can be seen that technology strategy definitions have significantly evolved and that these definitions have been refined from multiple from various perspectives. In brief, past studies have defined technology strategy as an organisation’s plans to effectively develop, acquire, and deploy technological resources and capabilities that can contribute to its competitive advantage and organisational performance. In light of previous definitions, this study adopts the definition provided by Zahra (1996): that technology strategy is an essential plan to develop, acquire, and deploy technological resources and capabilities that contribute to competitive advantage and organisational performance.

Critical review of the literature on Technology Strategy

Researchers have presented different technology strategy dimensions as a result of their research. Zahra (1996) distinguished six dimensions of technology strategy as a model that guided a new venture's decisions on the development and deployment of technological resources and capabilities. The six dimensions are (i) pioneering posture, (ii) selecting the company’s technological innovation posture and capabilities (introducing new products to the market first), (iii) determining the number of products to be introduced to the market, (iv) technology sourcing using a venture's internal and external R&D sources (in-house R&D activities, licensing, strategic alliances and acquisition of the technology) and; (vi) R&D spending at a technological level through a combination of applied and basic research projects and patenting use. The study highlighted the important roles of a technology strategy in utilising the organisation’s technological resources and capabilities.

In an empirical study of 103 manufacturing-based firms, representing 28 established industries, Zahra and Covin (1993) state that technology policy is a set of organisational decisions and specific dimensions. The dimensions are technological posture (Oster, 1999), the level of automation of plants and facilities, the adoption of the latest technology in the

production, and capital allocation for new equipment and machinery (Hayes and Wheelwright, 1984) and the intensity of the firm's product development activities (Zahra, 1996). The findings support a strong positive relationship between technology strategy and organisational performance.

Studies by Maidique and Patch (1982) outline a technology policy entailing six dimensions; namely: (i) the type of technology, (ii) the desired level of competence (nearness to the state of the art), (iii) internal versus external sources of technology, (iv) R&D investment, (v) the timing of technology introductions and, (vi) R&D organisation. The six dimensions of the strategy are derived from Zahra et al. (1994). The derivations focus on the company's technological innovation posture and capabilities (the first to the market, fast follower, imitator and application), dominant technological thrust and company goals, globalisation of its technology strategy (a company engaged in a global technology strategy), technology sourcing (use of external and internal sources of technology), the nature of technological investments, the technologies offered by the company after some time and the organisational mechanisms for technological resources (technology experienced executive). Notwithstanding this, Narayanan (2001) formulates two strategic dimensions, which are technological leadership in pioneering technological advancement and company objectives. Finally, select other studies illustrate technology strategy as positively linked with organisational performance (Zahra and Bogner, 2000; Adler, 1989; Dowling and McGee, 1994). On the other hand, Kalay and Lynn (2008) stated that there has been no effect of technology strategy on performance.

There are an abundance of studies about technology strategy (Porter, 1985; Adler et al., 1989; Bell and McNamara, 1991; West, 1992; Kerin et al., 2015; Kotabe, 2004; Dussague et al., 1992; Utterback, 1994; McGrath, 1995; Cho, 1996; Wilbon, 2002; Husain, 2016; Parker, 2000; Zahra and Nielsen, 2002; Gibbons and O'Connor, 2003; Ngamkroekioti et al., 2005; Lin and Chang, 2006; Van de Velde, 2006; Muhammad et al., 2009; Chadee and Pang, 2008; Man et al., 2009; Ghazinoory and Farazkish, 2010; Sikander, 2011). Table 2 below presents previous studies and their research context. Some studies were qualitative and in the form of conceptual papers that explained technology strategy as well as proposing potential variables in the research field. Given this, there is a need to empirically test the proposed variables which are covered in this study.

Table 2: Past Research on Technology Strategy

Author	Country	Context	Methodology	Research Design
Porter (1985)	-	Firm	Conceptual	Qualitative
Adler et al., (1989)	-	Firm	Conceptual	Qualitative
Bell and McNamara (1991)	-	High-tech ventures	Conceptual	Qualitative
Kerin et al., (1992)	-	Firm	Conceptual	Qualitative
Kotabe (1992)	-	Firm	Conceptual	Qualitative
Dussague et al., (1993)	-	Firm	Conceptual	Qualitative
Utterback (1994)	-	Firm	Conceptual	Qualitative
McGrath (1995)	-	High-technology companies	Conceptual	Qualitative
Cho (1996)	Korea	Government R&D programs in Korea	Empirical	Quantitative
Zahra (1999)	USA	176 manufacturing companies in Southeastern state	Empirical	Quantitative
Wilbon (1999)	USA	31 Computer software IPO firms	Descriptive	Quantitative/ Content analysis
Parker (2000)	Europe USA Asia Middle East Africa	78 organisations operating in the telecommunications industry	Exploratory cross-sectional	Quantitative/ Exploratory study
Li & Atuahene-Gima (2001)	China	300 new technology ventures from a sample frame of 500 firms in Beijing	Empirical	Quantitative
Zahra and Nielsen (2002)	USA	149 in 1996 and 97 in 1999 from 600 companies of 20 US based manufacturing technologies.	Exploratory longitudinal	Quantitative/ Longitudinal study
Wilbon (2002)	USA	168 high-technology firms	Exploratory cross-sectional	Exploratory study and content

Gibbons and O'Connor (2003)	Ireland	359 Irish SMEs		Empirical	analysis Quantitative
Ngamkroeckioti et al., (2005)	Thailand	SMEs in the Thai food industry		Conceptual	Qualitative study was conducted using semi-structured in-depth interviews with food expert
Lin and Chang (2006)	Taiwan	144 Electrical and Electronic Manufactures Association	Taiwan	Empirical	Quantitative
Van de Velde (2006)	Europe	Corporate and university spin-offs in Flanders		Empirical	Quantitative/ Content analysis Experiment and survey
Lin, Chen & Wu (2006)	USA	US technology enterprises		Empirical	Quantitative
Muhammad et al., (2008)	Malaysia	61 Malaysian industrial automation company		Empirical	Quantitative/ Empirical
Chadee and Pang (2008)	China	ICT firms from China, South Korea, Thailand and Philippines		Empirical	Quantitative
Man et al., (2009)	China	118 technology-based small and medium-sized enterprises		Empirical	Quantitative
Ghazinoory and Farazkish (2010)	Iran	Iranian Nano-composite companies		Exploratory cross-sectional	Qualitative and quantitative
Sikander (2011)	Malaysia	E & E		Empirical	Quantitative

			manufacturing industry		
Althonayan and Sharif (2010)	UK	Airlines (International Airlines)	industry	Empirical	Qualitative/Case study
Husain (2016)	India and United Arab Emirates (UAE)	India and Dubai companies in different sectors of industry		Empirical	Quantitative

Source: Past research on technology strategy from 1985 – 2016.

In terms of the research context, most studies on technology strategy involved manufacturing industries in different regions. For example, Lin and Chang (2006) studied 144 companies from Taiwan Electrical and Electronic Manufactures Association. With regards to 20 US-based manufacturing technology industries, Zahra and Nielsen (2002), in their exploratory longitudinal study, focused on 149 companies in 1996 and 97 companies in 1999. Sikander (2011) studied a Malaysian manufacturer and Ghazinoory and Farazkish (2010) Iranian Nano-composite companies. Other than this, previous research centred on manufacturing companies in developing countries (Chadee and Pang, 2008; Man et al., 2009; Gibbons and O'Connor, 2003; Ngamkroeckioti et al., 2005), manufacturing companies in developed countries (Zahra and Nielsen, 2002; Lin and Chang, 2006; Althonayan and Sharif, 2010) and manufacturing companies in underdeveloped, but resource rich countries like Iran (Ghazinoory and Farazkish, 2010). Focused research on manufacturing companies in Malaysia has been limited and this study aims to close that research gap.

As shown in Table 2 above, different methodologies were used and included conceptual, descriptive, empirical, exploratory cross-sectional and exploratory longitudinal. Malhotra and Grover (1998) used a descriptive methodology to understand technology strategy and associated performance measurement issues. They stated that ‘data for study is taken from an existing database, review, case study, taxonomy or typology approaches.’ They go on to explain exploratory cross-sectional as the “objective of the study is to become more familiar through a survey, in which the information is collected at one point in time” and exploratory longitudinal as a ‘survey methodology where data collection completed at two or more points of time within the same organisations’.

With reference to the literature review, qualitative studies identify the variables of technology strategy. However, these variables have not been empirically tested for manufacturing companies in a developing country (Husain, 2016); whereas most of quantitative studies in technology strategy have examined the relationship between variables and organisational



performance (Zahra and Nielsen, 2002). Man et al. (2009) suggests that elements of copyright and other means of intellectual capital protection should be considered in developing a technology strategy. This suggestion affirms the relevancy variables in relation to the copyright and patents of organisational performance. Moreover, Sikander (2011) suggests that more research needs to be undertaken in a broader context and recommends consideration of other variables. Bearing in mind the propositions of previous researchers, this study aims to examine the impact of an innovative technology strategy on organisational performance. In the context of the Malaysian manufacturing industry, the study also seeks to analyse the moderating effects of external environmental factors that either strengthen or weaken the relationship. Ultimately, testing the strength and sustainability of the relationship between strategy and organisational performance, is the goal of this research.

Conclusion and Recommendations

This paper attempts to study and synthesise the diverse range of literature as it relates to technology strategy. This study presents a review of major contributions on the relationship between technology and strategy, the definition of technology strategy, the process of technology strategy formulation and the identification of primary assessments related to technology. The authors are currently conducting further research in this area. Technology strategy cannot be viewed in isolation for manufacturing companies; it needs to be viewed in accordance to their relationship with a technologically competitive environment.

REFERENCES

- Abdel-Maksoud, A., Dugdale, D. & Luther, R. (2005). Non-financial performance measurement in manufacturing companies. *The British Accounting Review*, 37(3), pp.261-297.
- Abdullah, M.R.B. & Abdul Jalil, S. (2006). Industrial structure and concentration in Malaysian manufacturing industry. *International Journal of Management Studies (IJMS)*, 13, pp.83-101.
- Abidin, N.Z., Adros, N.A. & Hassan, H. (2014). Competitive strategy and performance of quantity surveying firms in Malaysia. *Journal of Construction in Developing Countries*, 19(2), p.15.
- Aboody, D. & Lev, B. (2001). R&D productivity in the chemical industry. *New York (disponible en www. baruch-lev. com)*.
- Adler, P.S. (1989). Technology strategy. *Research in technological innovation, management and policy*, 4, pp.25-251.
- Adler, P.S., Riggs, H.E. & Wheelwright, S.C. (1989). Product Development Know-How: Trading Tactics For Strategy. *MIT Sloan Management Review*, 31(1), p.7.
- Ahmad, K. & Zabri, S.M. (2016). The application of non-financial performance measurement in Malaysian manufacturing firms. *Procedia Economics and Finance*, 35, pp.476-484.
- Althonayan, A., & Sharif, A. M. (2010). Aligning business and technology strategy within the airline industry. *International Journal of Business Information Systems*, 6(1), 79-94.
- Bell, C.G. & McNamara, J.E. (1991). *High-tech ventures: The guide for entrepreneurial success*. Perseus Publishing.
- Burgelman, R.A. (2003). *Strategy making and evolutionary organisation theory: Insights from longitudinal process research* (No. 1844).
- Burgelman, R.A., Maidique, M.A. & Wheelwright, S.C. (1996). *Strategic management of technology and innovation* (Vol. 2). Chicago: Irwin.
- Chadee, D.D. & Pang, B. (2008). Technology strategy and performance: a study of information technology service providers from selected Asian countries. *Service Business*, 2(2), pp.109-126.



- Chen, J., He, Y.B. & Jin, X. (2008). A study on the factors that influence the fitness between technology strategy and corporate strategy. *International Journal of Innovation and Technology Management*, 5(01), pp.81-103.
- Chiesa, V. (2001). Formulating Technology Strategy In Dynamic Contexts. *World Scientific Book Chapters*, p 55-112.
- Cho, H.D., Lee, J.K. & Ro, K.K. (1996). Environment and technology strategy of firms in government R&D programmes in Korea. *Technovation*, 16(10), pp.553-560.
- Dasgupta, M. & Gupta, R.K. (2014). Technological innovation and technology strategy: proposing an interface. *International Journal of Business Excellence* 9, 7(2), pp.129-147.
- Dasgupta, M., Gupta, R. K., & Sahay, A. (2011). Linking technological innovation, technology strategy and organisational factors: A review. *Global Business Review*, 12(2), 257-277.
- de Meyer, A. (2008). Technology strategy and China's technology capacity building. *Journal of Technology Management in China*, 3(2), pp.137-153.
- Dowling, M.J. & McGee, J.E. (1994). Business and technology strategies and new venture performance: a study of the telecommunications equipment industry. *Management Science*, 40(12), pp.1663-1677.
- Dussauge, P., Hart, S. & Ramanantsoa, B. (1992). *Strategic technology management* (No. hal-00708987).
- Ford, D. (1988). Develop your technology strategy. *Long range planning*, 21(5), pp.85-95.
- Germain, R., Claycomb, C. & Dröge, C. (2008). Supply chain variability, organisational structure, and performance: the moderating effect of demand unpredictability. *Journal of operations management*, 26(5), pp.557-570.
- Ghazinoory, S. & Farazkish, M. (2010). A model of technology strategy development for Iranian nano-composite companies. *Technological and Economic Development of Economy*, 16(1), pp.25-42.
- Gibbons, P.T. & O'CONNOR, T.O.N.Y. (2003). Strategic posture, technology strategy and performance among small firms. *Journal of Enterprising Culture*, 11(02), pp.131-146.
- Gillespie, D.F. & Mileti, D.S. (1977). Technology and the study of organisations: An overview and appraisal. *Academy of Management Review*, 2(1), pp.7-16.



- Hayes, R.H. & Wheelwright, S.C. (1984). Restoring our competitive edge: competing through manufacturing, Wiley, New York.
- Husain, Z. (2016). Technology strategy framework for firms in growing economies. *Journal for Global Business Advancement*, 9(3), pp.248-274.
- Itami, H. & Numagami, T. (1992). Dynamic interaction between strategy and technology. *Strategic Management Journal*, 13(S2), pp.119-135.
- Jin, C., Wei, Y. & Yubing, H. (2008). The Research on the Influence Factors for Fitness between Technology Strategy and Corporate Strategy. In *2008 International Symposiums on Information Processing* (pp. 472-476). IEEE.
- Kalay, F. & Lynn, G. (2015). The impact of strategic innovation management practices on firm innovation performance. *Research Journal of Business and Management*, 2(3), pp.412-429.
- Kerin, R.A., Varadarajan, P.R. & Peterson, R.A. (1992). First-mover advantage: A synthesis, conceptual framework, and research propositions. *Journal of marketing*, 56(4), pp.33-52.
- Ketokivi, M. & Schroeder, R. (2004). Manufacturing practices, strategic fit and performance: a routine-based view. *International Journal of Operations & Production Management*, 24(2), pp.171-191.
- Kotabe, M. (1992). *Global sourcing strategy: R & D, manufacturing, and marketing interfaces* (p. 1992). New York: Quorum Books.
- Larsson, C., Strand, M., Persson, A. & Syberfeldt, A. (2017). Communicating continuous improvement in manufacturing companies: Divergencies between current practice and theory. In *PMAA-Performance Measurement Association Australasia 1-3 march 2017, Dunedin*.
- Li, H. & Atuahene-Gima, K. (2001). Product innovation strategy and the performance of new technology ventures in China. *Academy of management Journal*, 44(6), pp.1123-1134.
- Lin, B.W., Chen, C.J. & Wu, H.L. (2006). Patent portfolio diversity, technology strategy, and firm value. *IEEE Transactions on Engineering Management*, 53(1), pp.17-26.
- Lin, F.H. & Chang, H.Y. (2006). The Study of Computer Industry Company. *Journal of Information Technology and Applications (資訊科技與應用期刊)*, 1(1), pp.9-16.



- Maidique, M.A. (1982). Corporate strategy and technological policy. *Readings in the Management of Innovation*, pp. 273-285.
- Malhotra, M.K. & Grover, V. (1998). An assessment of survey research in POM: from constructs to theory. *Journal of operations management*, 16(4), pp.407-425.
- Man, T.W.Y., Chan, K.F. & Lau, T. (2009). Technology strategy, external environment, and the performance of technology-based SMEs in China. In *ICSB World Conference Proceedings* (p. 1). International Council for Small Business (ICSB).
- Mark Dodgson ed. (1989). *Technology Strategy and the Firm: management and public policy*. Addison Wesley Publishing Company.
- McGrath, M.E. (1995). Product strategy for high-technology companies: how to achieve growth, competitive advantage, and increased profits, Irwin Professional Pub.
- Miles, R.E., Snow, C.C., Meyer, A.D. & Coleman Jr, H.J. (1978). Organisational strategy, structure, and process. *Academy of management review*, 3(3), pp.546-562.
- Muhammad, N. M. N., Jantan, M., & Keong, C. C. (2008). Technology Strategy and Firm's Revenue Growth: Empirical Evidence of Malaysian Industrial Automation Industry. *International Journal of Business and Management*, 3(7), 97-106.
- Nanayakkara, S. M., Wickramasinghe, V., & Samarasinghe, G. D. (2017, May). Emotional intelligence, technology strategy and firm's non-financial performance. In *2017 Moratuwa Engineering Research Conference (MERCon)* (pp. 467-472). IEEE.
- Narayanan, V. K. (2001). *Managing technology and innovation for competitive advantage*. Pearson Education India.
- Ngamkroekjoti, C., Speece, M., & Dimmitt, N. J. (2005). Environmental scanning in Thai food SMEs: the impact of technology strategy and technology turbulence. *British Food Journal*, 107(5), 285-305.
- Oster, S. M. (1999). Modern competitive analysis. *OUP Catalogue*.
- Parker, A. R. (2000). Impact on the organisational performance of the strategy–Technology policy interaction. *Journal of Business Research*, 47(1), 55-64.
- Pavitt, K. (1990). What we know about the strategic management of technology. *California management review*, 32(3), 17-26.



- Pegels, C. C., & Thirumurthy, M. V. (1996). The impact of technology strategy on firm performance. *IEEE Transactions on Engineering Management*, 43(3), 246-249.
- Porter, M. E. (1985). Technology and competitive advantage. *Journal of business strategy*, 5(3), 60-78.
- Rieck, R. M., & Dickson, K. E. (1993). A Model of Technology Strategy: practitioners' forum. *Technology Analysis & Strategic Management*, 5(4), 397-412.
- Sikander, A. (2011). *Strategic technology management and the performance of firms in the electrical and electronics manufacturing industry of Malaysia (1986-1995)-An exploratory study* (Doctoral dissertation, Murdoch University).
- Smith, D. J., & Rogers, M. F. (2004). Technology strategy and innovation: the use of derivative strategies in the aerospace industry. *Technology Analysis & Strategic Management*, 16(4), 509-527.
- Spital, F. C., & Bickford, D. J. (1992). Successful competitive and technology strategies in dynamic and stable product technology environments. *Journal of Engineering and Technology Management*, 9(1), 29-60.
- Utterback, J. M. (1994). How Companies Can Seize Opportunities in the Face of Technological Change. In *Mastering the Dynamics of Innovation*. Harvard Business School Press Boston, Mass.
- Van de Velde, E. (2006). *The performance of corporate spin-offs and the implications for their technology strategy* (Doctoral dissertation, Ghent University).
- West A. (1992). *Innovation strategy*. Prentice Hall Direct.
- Wheelwright, S. C., & Clark, K. B. (1992). Competing through development capability in a manufacturing-based organisation. *Business horizons*, 35(4), 29-43.
- Wilbon, A. D. (2002). Predicting survival of high-technology initial public offering firms. *The Journal of High Technology Management Research*, 13(1), 127-141.
- Zahra, S. A. (1996). Technology strategy and financial performance: Examining the moderating role of the firm's competitive environment. *Journal of Business venturing*, 11(3), 189-219.
- Zahra, S. A., & Bogner, W. C. (2000). Technology strategy and software new ventures' performance: Exploring the moderating effect of the competitive environment. *Journal of business venturing*, 15(2), 135-173.



- Zahra, S. A., & Covin, J. G. (1993). Business strategy, technology policy and firm performance. *Strategic management journal*, 14(6), 451-478.
- Zahra, S. A., & Nielsen, A. P. (2002). Sources of capabilities, integration and technology commercialisation. *Strategic Management Journal*, 23(5), 377-398.
- Zahra, S. A., Sisodia, R. S., & Das, S. R. (1994). Technological choices within competitive strategy types: a conceptual integration. *International Journal of Technology Management*, 9(2), 172-195.