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Themes of study in manufacturing strategy literature

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Abstract

Purpose – A literature review within the manufacturing strategy (MS) discipline with a focus on thematic developments is provided. Based on recent studies, a set of challenges posed to manufacturing enterprise of the future are summarized, and thematic areas are analyzed in relation to meeting those challenges. The paper aims to discuss these issues.

Design/methodology/approach – Based on a select set of 506 articles published in top-ranked refereed international journals in the discipline of operations management, major and subthemes are identified and the publication trends in these themes are provided with time and across geographical regions, namely: North America, Europe, and other parts of the world.

Findings – MS literature is predominantly focussed on the economic objectives of firms without a due focus on the social and environmental perspectives. MS literature covers 11 major thematic areas, namely: MS components and paradigms, manufacturing capabilities (MCs), strategic choices (SCs), best practices (BPs), the strategy process (SP), supply-chain management (SCM), performance measurement, transnational comparisons, global manufacturing, environmental/green manufacturing, and literature reviews. The research in two areas – SCs, and MCs – has been in decline, while the research in BPs, the SP, and transnational comparisons is growing (in absolute figures). Various research opportunities for future studies are identified.

Research limitations/implications – The literature review is limited in its selection of articles and journals, however, the identified trends clarify the state of research by the MS research community at large.

Practical implications – For researchers, multiple new research directions are identified in order to advance knowledge in the field of MS. The publication trends also highlight thematic areas where most of the MS body of knowledge is currently available and can be utilized by practitioners.

Originality/value – The paper's novelty comes from: first, a broader and deeper review of thematic areas that has not been researched before, second, trends in thematic areas by time, across geographical regions, and including time-region dyads, and third, coverage provided by MS literature in meeting challenges posed to manufacturing enterprise of the future.

Keywords Manufacturing strategy, Literature review, Challenges to manufacturing, Publication trend, Thematic development, Theme

Paper type Literature review

1. Introduction

Manufacturing strategy (MS) plays an important role in achieving the business strategy (BS) of a manufacturing firm. In practice, its importance can be traced back in history through highlighting some events including 1750-1850 England in The Industrial Revolution (Deane, 1979), the early twentieth Century Ford Assembly Line (Hounshell, 1984), and the late twentieth century Toyota Production System (Spear and Bowen, 1999). The successes achieved by firms such as Ford and Toyota are naturally attributed, among other factors, to the MSs deployed. The development and

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deployment of specific MSs were pertinent to the needs of corresponding eras. As a result of globalization, today's manufacturing organizations are facing a myriad of challenges that include highly competitive and diverse marketplaces, an uncertain and risky business environment, and changing customer needs (Manyika *et al.*, 2012). At the same time, social and environmental issues are becoming paramount (Geyer *et al.*, 2003; Kuivanen, 2008; Qiu, 2009; Garetti and Taisch, 2012). MS has become a complex undertaking both in terms of what constitutes MS and how it should be formulated (Adamides and Pomonis, 2009; Da Silveira and Sousa, 2010).

In academic circles, many authors have stressed the importance of the MS concept since the 1960s (Skinner, 1969, 1974, 1985; Hayes and Wheelwright, 1984; Hill, 1985; Voss, 1995). The multiple streams of inquiry that now exist include defining MS (Skinner, 1969, 1974; Hayes and Wheelwright, 1984; Schroeder *et al.*, 2002; Da Silveira and Sousa, 2010), the process of devising a sound MS (Adamides and Pomonis, 2009; Swamidass *et al.*, 2001; Löfving *et al.*, 2014), linking MS with BS (Joshi *et al.*, 2003; Ward and Duray, 2000; Kathuria and Igbaria, 1997; Swink *et al.*, 2007), developing MCs (Swink *et al.*, 2005; Jayanthi *et al.*, 2009; Choudhari *et al.* 2013), competing through best practices (BPs) (Cagliano and Spina, 2000; Brown and Bessant, 2003; Karim *et al.*, 2008), competing through strategic choices (SCs) (Safsten *et al.*, 2007; Platts *et al.*, 2002; Chien *et al.*, 2010; Olhager, 2003), and so forth.

The role of literature reviews is considered vital for their analysis of the published literature of a discipline, a synthesis of frameworks for developing insights, and identification of research gaps in attempting to meet the challenges posed by existing and future needs of the discipline. Williams and Plouffe (2007) assert that examination of knowledge development using systematic literature review of an academic field is "a critical step in any discipline's growth and maturity."

There is a lack of literature reviews that analyze the burgeoning body of literature in the MS discipline. Since the publication of Dangayach and Deshmukh (2001a), MS literature has expanded tremendously. It is not entirely clear how the existing MS literature can inform future inquiries for addressing the fresh set of challenges posed by the global and uncertain marketplace. This paper presents a comprehensive review of MS literature since its beginning with a focus on thematic developments and their relevance to fresh challenges. By providing an historical overview, and detailing the current status and future trends, we attempt to identify new research opportunities. In particular, the paper attempts to answer the following questions:

- What are the major themes of study within the MS literature and how have they evolved?
- To what extent do these themes address the challenges posed to the manufacturing enterprise of the future?
- How are these themes changing with time and by geographical region, and what research designs and methodologies are related to these themes?

These questions are important for many reasons: first, identification of major and subthemes will help in organizing the burgeoning body of literature in the MS discipline; second, mapping themes onto challenges posed to manufacturing enterprise of the future will reveal research gaps for future studies; and third, trends by time and geographic regions will identify mature and emerging themes of study, contribution of researchers to-date from diverse geographical regions around the world, and prominent research methodologies used in each theme.

The rest of the paper is organized as follows. Section 2 synthesizes a set of challenges posed to manufacturing enterprise of the future and elaborates on the state of the art of literature reviews in the MS discipline. Section 3 details the methodology used for literature review. Section 4 provides results of our analyses: the thematic developments in MS literature especially in view of future challenges, and the use of research designs in the themes of study in MS literature. Section 5 discusses our major research findings and provides future research directions. Finally, conclusions and research limitations are presented in section 6.

2. Background

2.1 Challenges to the manufacturing enterprise in the future

Globalization impacts all facets of our social, economic, and political lives. Access to international markets, information, low-cost resources in the developing economies, and efficient supply-chain and logistics services have transformed the way manufacturing organizations are doing business (Geyer *et al.*, 2003; Kuivanen, 2008; Manyika *et al.*, 2012). Researchers and practitioners have identified a set of challenges that manufacturing firms will face growingly in the future. These challenges can be classified in terms of economic, social, and environmental dimensions.

Challenges in the economic dimension. A set of recent events, roughly outlined below, present new economic challenges for manufacturing organizations in the future:

- The "low cost" advantage of offshoring to developing economies is diminishing as rising wages are improving the standards of living in developing economies (Renschler and Lawrence, 2012). Thus, the value proposition for customers in the developed economies is decreasing if the firms are focussed on gaining "low cost" advantage through offshoring. This forces firms in the developed economies to rethink their business models.
- The "purchasing power" of consumers in developing economies is increasing with rising wages, thereby giving rise to attractive local markets in developing economies (Renschler and Lawrence, 2012; TiM, 2011). This trend results in diversity of customer base and needs.
- At the same time, improving manufacturing and innovation capabilities in developing economies are raising the level of competition in local and global markets (Kuivanen, 2008) – competition in terms of both inputs (resources) and outputs (products and services) of a firm.
- With improving manufacturing and innovation capabilities, firms in developing economies are competing for innovation offshoring and more value-added activities (Renschler and Lawrence, 2012; Thomas *et al.*, 2012) – competition in terms of both inputs (resources) and outputs (products and services) of a firm at more value-added segments of businesses.
- Firms in countries with developing economies are raising the need of engaging in new forms of organizational arrangements, partnerships, and networks with firms in developed economies (Fleury *et al.*, 2007).
- The complexity of operations under conditions of geographical distribution and rapidly changing consumer lifestyles and preferences are increasing business risks and uncertainties for manufacturing organizations (Manyika *et al.*, 2012).

Clearly, these include business level requirements in the economic dimension for manufacturing organizations in the future and to address these requirements following capabilities are being suggested for manufacturing firms in the developed economies:

Agile manufacturing. Become a responsive organization that is able to respond quickly both in volume and variety (Saad and Gindy, 2007; Thomas *et al.*, 2012). Manufacturing firms need to invest in and operate with agility (Manyika *et al.*, 2012) while making major commitments in the international markets as well as preparing to manage demand risks. Manufacturing firms need to be agile, adaptive, and efficient in the future (TiM, 2011; Castro *et al.*, 2012).

Collaborative design and engineering. To achieve a faster delivery of products to the marketplace, manufacturing firms need to design and engineer products in a responsive way (Thomas *et al.*, 2012). Changing customer requirements and responsiveness in product design require responsiveness in process engineering capabilities too (Qiu, 2009; Bennett, 2014).

Human knowledge and capabilities. Manufacturing firms in the future would require a high level of human skills and knowledge to carry out these tasks. Organizations would need to get involved in developing, enhancing, and extending human competencies and knowledge (Manyika *et al.*, 2012; Thomas *et al.*, 2012; Renschler and Lawrence, 2012). Fleury *et al.* (2007) write about the aging of workers and issues related to the work organization in future.

New Business Models. Organizations would need to develop new business models in order to gain a competitive advantage in the future. In the future, manufacturing firms should focus on providing solutions rather than products. This would generate additional value for customers and open up new sources of revenue for the firms (TiM, 2011; Hanisch, 2008; Kuivanen, 2008). A number of authors have emphasized the importance of including customer service elements during the production and post-production stages to create additional values for customers (Manyika *et al.*, 2012; Kowalkowski *et al.*, 2011; Baines *et al.*, 2009; Hanisch, 2008; Kuivanen, 2008; Lightfoot *et al.*, 2013). However, the sustainability of this solution is questionable since each manufacturing job produces two service jobs (Thompson, 2011). Others have suggested utilizing innovation as a source of competitive advantage (Thomas *et al.*, 2012; Kuivanen, 2008).

Analytical rigor. In order to facilitate quicker and more accurate decision making, development and dissemination of precise knowledge and business intelligence is important (Thomas *et al.*, 2012). Focussing on the use of big data and analytics would become imperative to support the development of business intelligence (Manyika *et al.*, 2012; Bennett, 2014).

Dynamic capabilities. Firms would need to develop new manufacturing management paradigms in order to become change capable and responsive. Organizations would require reconfigurable capabilities in manufacturing as well as supply chain and logistics functions (Thomas *et al.*, 2012). Fleury *et al.* (2007) and Arafa and ElMaraghy (2011) highlight the need for dynamic capabilities in manufacturing firms that must make strategic decisions in a turbulent and uncertain environment.

Networked organization. Fleury *et al.* (2007) highlight a number of topics related to organizations in the global economy. These include patterns of organizations, approaches to strategic decision making, challenges to strategic and operations decisions subject to changes in workforce profiles, the impact of new global players on networks, and the need for new techniques, methods, and tools. In the global economy, the demand side is

more uncertain and turbulent and that, in turn, would require reconfigurable organizational networks (Manyika *et al.*, 2012). Others have also suggested developing strong and sustained partnerships in local and global supply chains (TiM, 2011; Renschler and Lawrence, 2012).

Challenges in the social and environmental dimensions. Another phenomenon happening as a result of increased offshoring of manufacturing and innovation to the developing economies is the rising levels of unemployment and social issues in the developed economies, thereby affecting the purchasing power of consumers in those economies (Geyer *et al.*, 2003; Thompson, 2011; Garetti and Taisch, 2012, Berlin *et al.*, 2013) thus causing societal issues in the developed economies.

A number of authors in the recent years have emphasized a need for socially and environmentally sustainable global manufacturing enterprises in the future. Geyer *et al.* (2003) sketch a framework of four scenarios, for manufacturing in Europe in the future, using two dimensions. The first dimension pertains to the modality of policy making. It is related to geo-political developments, centralization/decentralization of decision making, and coordination among policy areas. The second dimension is related to public values, consumer behavior, and demand patterns. Sustainable times, one of the scenarios in this framework, can be achieved when both the two dimensions are in their highs, i.e., European citizens support government coordination of sustainability, a global governance system for sustainable development emerges, and clear policies for sustainable development that involve broad stakeholders are defined and implemented. In this scenario, socially responsible technology development and resource utilization will be emphasized. The notion of competitiveness is broadened to include environmental and social aspects of production and consumption (this includes an emphasis on renewable energy resources, optimization of product lifecycles, service orientation in product design, high qualified labor force, and public acceptance of new technology) (Garetti and Taisch, 2012).

Qiu (2009) states that competitive manufacturing enterprises are responsible for the environmental impact of their products and services, and they need to adopt technologies for reducing waste during production. Moreover, technologies for reusing or recycling obsolete products are emphasized. Manufacturing has to play a role in ensuring community welfare, and in the globalization environment each country needs to decide its own course of development based on local factors such as structure of the industry, the level of automation, and the price of the workforce (Kuivanen, 2008; Berlin *et al.*, 2013). Hanisch (2008) emphasizes that in the future manufacturing organizations would need to adopt technologies consciously and ethically so that they include and value employees. There needs to be a balance between people and automation for societal sustainability purposes.

In the aforementioned, a number of business level requirements are identified qfor the manufacturing enterprise of the future. First and the foremost is the requirement of caring for social and environmental level benefits rather than individual (firm) level benefits. This can be enacted when clear policies that are based on economic, social, and environmental objectives are put in place. Putting such integrated policies in place would provide corresponding direction and focus to manufacturing organizations in the future in terms of their product and service offerings. Similarly, the extant literature emphasizes the need of putting in place social transparency of resources and opportunities.

Manufacturing firms would need to develop capabilities to address these business level requirements. In the future, they would need to balance adoption of advanced

technologies with human-resource employment (Hanisch, 2008). Manufacturing firms can focus on maximizing their profits through the use of advanced technologies and automation, which may improve their operational performance. However, this comes at the cost of labor unemployment. And one adverse impact of high unemployment in a society is the purchasing power of customers, which affects the very economic cycle the firm is trying to maximize. Geyer *et al.* (2003) also argue that manufacturing firms in the future would need to abstain from "low cost" production and focus on the total economic, social, and environmental cost of a product. This concept implies that in the future manufacturing firms would need to weigh which parts of the production value chain can beneficially be deployed in the developed and the developing countries. With regard to adhering to socially and environmentally conscious regulations, innovative mechanisms with the involvement of civic society and governments would need to be devised for ensuring adoption and adherence of regulations. Similarly, the use of technologies in products, services, and processes that have higher adverse impacts on environment would need to be avoided in the future (Thomas *et al.*, 2012; Qiu, 2009; Geyer *et al.*, 2003).

From this discussion, future business challenges and their implications for manufacturing firms are summarized in Table I. As future manufacturing organizations are envisaged to address not only economic but also social and environmental concerns, each row of the table corresponds to one of the economic, social, and environmental dimensions. The column titled "Business Level Requirements" highlights challenges of doing business in a global environment, as reported in various publications. Similarly, "Capabilities Required within Manufacturing Organizations" are a proposed set of capabilities required to address the business level requirements.

Here we are not making an attempt to develop a comprehensive framework of the challenges for sustainable manufacturing enterprise of the future. The objective is, however, to furnish a sufficient set of challenges and requirements for manufacturing enterprise of the future as highlighted by researchers and practitioners in recent years. Though it can be argued that economic, social, and environmental perspectives have been idealized in the past, and research and development is being carried out under their respective banners, our purpose is to re-emphasize the same and present an integrated understanding of the three perspectives that pose new requirements for manufacturing enterprise of the future. These ideas have been emphasized in recent publications as "future challenges to manufacturing." Developing a comprehensive framework would require a full-blown research study and would need the involvement of government and non-government bodies from economic, social, and environmental backgrounds as well as involvement of manufacturing firms in the developed and developing countries.

2.2 MS and literature reviews

The literature of the MS discipline can be reviewed through different lenses: methodological developments – where the focus is on identifying various research designs and methods reported in literature (Minor *et al.*, 1994; Dangayach and Deshmukh, 2001a), thematic developments – where the focus is on content (Schroeder *et al.*, 1986; Miller and Roth, 1988; Swink and Way, 1995; Bozarth and McDermott, 1998; Minor *et al.*, 1994; Dangayach and Deshmukh, 2001a) and the process (Kim and Arnold, 1996; Boyer, 1998) of MS, and theoretical developments – where the focus is on the use and the development of theory in the MS discipline (Ketokivi and Schroeder, 2004; Schroeder *et al.*, 2002).

Table I.
Challenges to manufacturing enterprises in the future

	Business level requirements	Capabilities required within manufacturing organizations
Economic (Ec)*	1. Changing and more diverse customer needs (Renschler and Lawrence, 2012; Manyika *et al.*, 2012)	1. Agile/Adaptive, mass customization and responsiveness (Manyika *et al.*, 2012; Thomas *et al.*, 2012; Saad and Gindy, 2007; TiM, 2011; Qiu, 2009) (Ec-1)*
	2. Higher competition for doing business and accessing resources in the developed and the developing economies (Renschler and Lawrence, 2012; TiM, 2011)	2. Collaborative and responsive design and engineering (Qiu, 2009; Thomas *et al.*, 2012) (Ec-2)*
	3. Tapping into new markets in the developing economies (Renschler and Lawrence, 2012; TiM, 2011; Manyika *et al.*, 2012)	3. Extend human knowledge and capabilities (Manyika *et al.*, 2012; Renschler and Lawrence, 2012; Hanisch, 2008; Thomas *et al.*, 2012) (Ec-3)*
	4. Higher risk and uncertainties of doing business in future (Manyika *et al.*, 2012)	4. Focus on solutions rather than products (TiM, 2011; Hanisch, 2008; Kuivanen, 2008) (Ec-4)*
		5. Focus on innovation (Manyika *et al.*, 2012; Thomas *et al.*, 2012; Renschler and Lawrence, 2012; Kuivanen, 2008; TiM, 2011) (Ec-5)*
		6. Servitization (Manyika *et al.*, 2012; Kuivanen, 2008; Kowalkowski *et al.*, 2011; Baines *et al.*, 2009) (Ec-6)*
		7. Analytical rigor (business intelligence, digital networks and technologies) (Manyika *et al.*, 2012; Thomas *et al.*, 2012) (Ec-7)*
		8. Develop (dynamic) capabilities (Fleury *et al.*, 2007; Thomas *et al.*, 2012) (Ec-8)*
		9. Manage networks of organizations (Manyika *et al.*, 2012; Kuivanen, 2008; Fleury *et al.*, 2007) and partnerships with suppliers (Renschler and Lawrence, 2012; TiM, 2011) (Ec-9)*
Social (Sc)*	1. Caring and striving for societal rather than individual (firm level) benefits (Geyer *et al.*, 2003; Hanisch, 2008; Kuivanen, 2008)	1. Balance human resources and automation, and caring for employees (Hanisch, 2008) (Sc-1)*
	2. Integrated policies involving economic and social organizations for socially sustainable future (Geyer *et al.*, 2003)	2. Responsible technology deployment considering implications for society (Hanisch, 2008; Geyer *et al.*, 2003) (Sc-2)*
	3. Social transparency of resources, opportunities, benefits, and costs (Fleury *et al.*, 2007)	3. Rationalization of manufacturing and innovation between the developed and the developing economies (Geyer *et al.*, 2003) (Sc-3)*
		4. Coordination with civic society and adherence to socially conscious regulations (Geyer *et al.*, 2003) (Sc-4)*
Environmental (Env)*	1. Environmental impact of products and services (Geyer *et al.*, 2003; Qiu, 2009)	1. Ability to produce environment friendly products and services (Qiu, 2009; Thomas *et al.*, 2012; Geyer *et al.*, 2003; Renschler and Lawrence, 2012) (Env-1)*
	2. Integrated policies involving economic and environmental organizations for environmentally sustainable future (Geyer *et al.*, 2003)	2. Responsible technology deployment considering implications for environment (Hanisch, 2008; Geyer *et al.*, 2003) (Env-2)*

Notes: Ec, Economic Sc, social, and Env, environmental. *Codes assigned to perspectives and challenges

A number of researchers have reviewed MS literature from a thematic coverage viewpoint, i.e., Minor *et al.* (1994), Swink and Way (1995), and Dangayach and Deshmukh (2001a). Of these, Swink and Way (1995) provides a traditional narrative literature review whereas articles by Minor *et al.* (1994) and Dangayach and Deshmukh (2001a) are quantitative in nature. Minor *et al.* (1994) inform the use of empirical research methods in MS and provide a framework for classifying and comparing a sample of empirical research publications. With respect to thematic coverage, they only classify publications in accord with "content" or "process" variables. Swink and Way (1995) classify MS literature into two major themes: strategy content and strategy process (SP) (Adam and Swamidass, 1989). Strategy content is considered to be composed of subthemes: strategic types, and SCs and performance where the latter provides coverage to topics, namely: competitive priorities, process design, and infrastructure. Similarly, the theme SP is considered to be composed of subthemes: strategy formulation, and justification and implementation of strategic decisions. Swink and Way (1995) developed this framework by borrowing concepts from Adam and Swamidass (1989) and the streams of study prevalent in literature.

Dangayach and Deshmukh (2001a) review 260 articles from refereed international journals and conference proceedings. They use a classification scheme for themes to which each paper belongs. This scheme is seemingly built using both top-down and bottom-up approaches for theme identification. For the top-down part, they have borrowed the framework of Voss (1995), providing major themes of content and process as well as subthemes within content, namely: MCs, SCs, BPs, and performance measurement. Through analysis of publications, they have identified two additional major themes namely: transnational comparison and literature reviews.

Table II summarizes thematic coverage provided by each of these MS literature reviews as well as the literature reviews of the closely related discipline of operations management. Within operations management, Chase (1980) provides a useful mechanism for segregating literature. He classifies literature on the bases of the dimensions of micro/macro and people/equipment. Though the framework provides a useful mechanism, it is clearly limited, as on one side micro/macro demarcation can turn very fuzzy and on the other side the people/equipment dimension is very narrowly focussed considering the complexity of today's manufacturing organizations. The idea, however, can be further developed to make it more relevant today. Amoako-Gyampah and Meredith (1989) provide another way of conceptualizing operations issues. They present four broad classes: operations policy, operations control, service operations, and productivity and technology. Clearly, the issues being faced by today's manufacturing organizations are too complex to be encompassed by this framework. For example, the contemporary stream of research on BPs shall be cutting across each topic of this framework. Pannirselvam *et al.* (1999) inherit the same issues as they unify the frameworks of Chase (1980) and Amoako-Gyampah and Meredith (1989). The last two literature reviews of Pilkington and Fitzgerald (2006) and Taylor and Taylor (2009) are based on indicative topics provided in the *International Journal of Operations and Production Management* (*IJOPM*) statement of coverage, which seems a broad and ad-hoc list of topics for research, should authors wish to submit their papers at *IJOPM*.

The classification framework for assessing thematic coverage in MS literature used by Dangayach and Deshmukh (2001a), primarily based on Voss (1995), is perhaps the most broad and structured framework. The paper in hand uses primarily the thematic classification framework of Dangayach and Deshmukh (2001a), but at the same time keeps in consideration and borrows various concepts such as global networks,

Table II.
Selective frameworks for thematic classification in MS/OM and their coverage

	Manufacturing strategy				Operations management			
	Minor *et al.* (1994)	Swink and Way (1995)	Dangayach and Deshmukh (2001a, b)	Chase (1980)	Amoako-Gyampah and Meredith (1989)	Pannirselvam *et al.* (1999)	Pilkington and Fitzgerald (2006)	Taylor and Taylor (2009)
Framework/ Criteria of Classification	New framework comprising of categories: study design, method and focus, and results and contribution for assessing empirical studies in MS	Broader themes borrowed from Adam and Swamidass (1989) i.e. content (Strategic types, strategic choices (competitive priorities, process design, infrastructure)) and strategy process (strategy formulation, and justification and implementation)	Themes borrowed from Voss (1995) framework i.e. Content (manufacturing capabilities, strategic choices, best practices, and performance measurement) and process Identification of additional themes namely: transnational comparison and literature review	Using a classification framework based on "research orientation" (micro- or macro-level) and 'research emphasis' (people or equipment), a total of 10 topics in OM were identified e.g. work measurement, inventory control, scheduling, facility location, quality control, capacity planning	Classify OM topics into four classes namely: operations policy, operations control, service operations, and productivity and technology	Borrowed framework from Chase (1980) and Amoako-Gyampah and Meredith (1989), resulting into 17 topics of study in OM discipline	Based on citations and co-citations of papers published in *IJOPM*, clusters of major themes are identified	Indicative topics provided in *IJOPM* statement of coverage were used as a framework for classifying major themes
Thematic Coverage	Identification of publications by "content" or "process" variables	Through narrative reasoning, research gaps and research propositions for future studies are presented	Identification of papers by "content" or "process" variables Identification of papers within each subtheme Publication counts by major theme	"Publication counts" in each theme and by: "journal", "focus"	A total of 17 OM topics are identified that are divided as per above classification "Publication counts" in each topic and by: "major journal"	"Publication counts" in each theme and by: "selective OM journals", "research methods used", "number of authors', "selective conferences"	Topic clusters of articles published in *IJOPM* that include: MS, Japanese Manufacturing, Competitive Strategy, Resource-based View, Processes/ BPR, Measurement, and Case method	"Publication counts" by major topics between the years 2004-2009

servitization, resource-based view, learning and knowledge, and bundles of practices from Voss (1995, 2005), consistency between MS and various components of manufacturing organization, and defining MS from Adam and Swamidass (1989), justification of strategic decisions from Swink and Way (1995), and details of structural and infrastructural decisions from Wheelwright (1984) and Skinner (1985). Figure 1 shows the resulting framework. Within content, the major themes of MS components and paradigms, SCM, global manufacturing, and environmental/green manufacturing emerge from a bottom-up analysis of our sample articles.

This paper attempts to review MS literature through the lens of thematic developments. A brief comparison between the two previous quantitative literature reviews in MS and this paper is provided in Table III. Minor *et al.* (1994) and Dangayach and Deshmukh (2001a) report simple counts, however, the paper in hand goes four steps beyond these literature reviews to unearth complex relationships among the data. First, it identifies and compares subthemes against time, geographic regions, and combined time-geographic regions in order to unfold important trends in literature. Second, it provides an account of cross-tabulations among subthemes and various research design methods used in MS literature in order to develop deeper insights. Third, it provides key findings of selected papers in each of the subthemes. And, fourth, this paper discusses the extent to which thematic developments in MS literature provide coverage to addressing the challenges of manufacturing enterprise of the future. This identifies new themes in MS literature to be studied.

3. Research methodology

3.1 Selection of articles

MS literature was searched on the popular business and management journal database, Business Source Premier, using the keywords: "manufacturing strategy" or "manufacturing strategies" in the title, abstract, keywords, and full text search fields. The search returned a total of 2,185 articles spanning a period of 45 years, 1966 to 2010.

The search results from *Business Source Premier* were exported to Microsoft Excel via RefWorks – bibliographic management software. RefWorks helped exporting and saving search results from Business Source Premier into Microsoft Excel. Each of the 2,185 papers was given a unique numerical identifier which remained the same in all subsequent analyses.

A subset of articles appearing in refereed international journals belonging to OM journal ranking schemes of Vastag and Montabon (2002), Vokurka (1996), Olson (2005), and Dangayach and Deshmukh (2001a) was shortlisted for further analysis. As these ranking schemes used different criteria for ranking OM journals (some used the impact factor and others used relevance, visibility, and quality perceptions), all of the ranking schemes were utilized for shortlisting articles in order to avoid losing important articles that would have undermined the quality of this review. As a result, a subset of 610 articles belonging to 34 journals (Table IV) was shortlisted for further analysis.

This subset of 610 articles was screened individually by two researchers for a relevancy check and for building subsequent consensus for inclusion in the review. Relevancy was defined as a function of the level of abstraction in a manufacturing organization. Papers that discussed MS at the levels of production floor or higher were considered relevant and were included in the review, while those that discussed MS at the machine level were considered not relevant and were not included in the review. As a result of this check, 506 articles were shortlisted for thematic analysis.

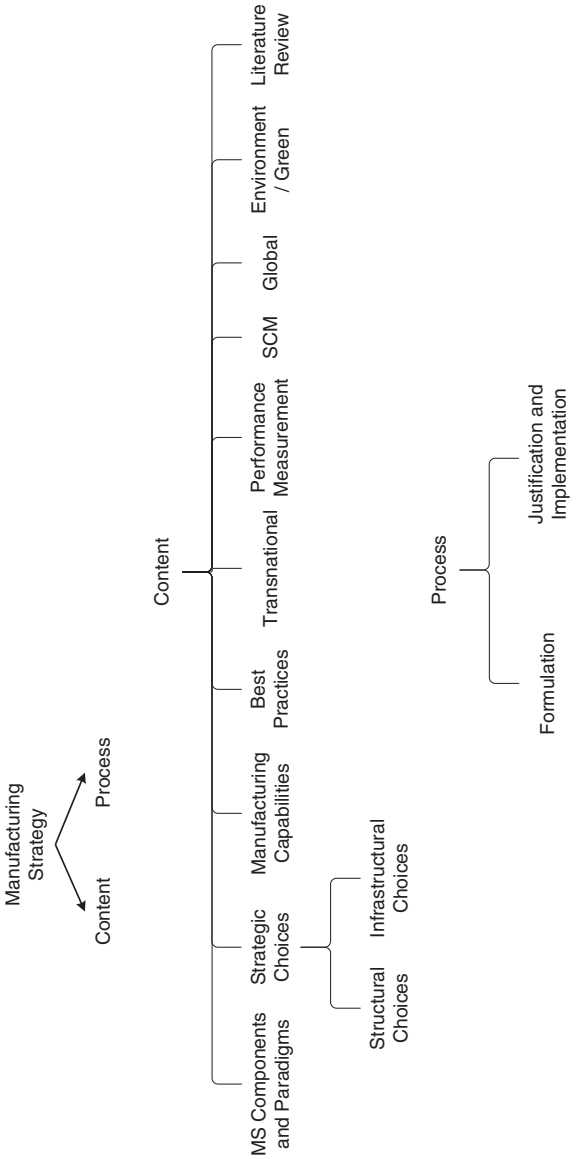

Figure 1.
Major and subthemes identified from manufacturing strategy literature

	Current paper	Dangayach and Deshmukh (2001a)	Minor *et al.* (1994)
Identification of major themes of research	X	X	
Identification of subthemes of research	X		
Research contribution by selected papers	X	X	X
Research findings by subtheme	X		
Publication counts by major theme	X	X	X
Publication counts by subtheme	X	X	
Publication trends "major theme" and "time"	X		
Publication trend "subtheme" and "time"	X		
Publication trend "major theme" and "geographical regions"	X		
Publication trend "subtheme" and "geographical regions"	X		
Publication trend "major theme" and "region-time"	X		
Publication trend "subtheme" and "region-time"	X		
Publication counts "major theme" and "journals"	X		
Publication trend "major theme" and "journal ratings"	X		
Publication trend "major theme" and "research designs"	X	X	X

Note: X, coverage provided by the article

Table III. An analysis of systematic literature reviews in manufacturing strategy with respect to their coverage to thematic developments

3.2 Classification of articles

For each of the 506 papers, topics within a study were recorded by copying headings used within the article. Thereafter, a series of data reduction steps – such as removal of redundant words (prepositions and plurals), re-phrasing, first level abstractions (sentence structure improvements), and second level abstractions (topic abstraction) – were carried out. The first level abstraction identified subthemes, and second level abstractions identified the major theme of the study. The classification framework provided in Figure 1 was kept in front in order to abstract the theme or subtheme of a paper. For example, consider Table V. There are two example cases in this table. In the first case "Outsourcing – Risk Analysis" is abstracted as a subtheme because outsourcing is the main topic of this study. Now as per the classification framework of Voss (1995), used in Dangayach and Deshmukh (2001a), outsourcing is a structural choice (SLC) related to process span where the latter includes both outsourcing and vertical integration. Therefore, the major theme of this study becomes SLCs. It should be noted that during first level abstracting, we have retained the suffix of risk analysis along with the subtheme outsourcing. This is useful for subsequent qualitative data analysis and discussions. The second example in Table V follows the same procedure.

The identification of subthemes was not a straightforward process. There were cases when the objective of a paper was to find linkage between two subthemes as per our framework. A decision rule was set in such cases. The subtheme of the study was chosen based on the dependent variable in the paper. There were also cases when a paper used headings that made different subthemes as per our classification. In such a case, the subtheme of the paper was chosen taking help from the paper title, which most of the time revealed the overall purpose of the paper and helped abstract the subtheme of a paper.

Articles were also classified as empirical or conceptual. For this paper, empirical studies are those that make use of primary data whereas conceptual studies make use of secondary data. Primary data is the one that is collected first hand from respondents, whereas secondary data is the one that is collected or reconstructed from already published resources. Conceptual research is either based on secondary data or focussed

Journal title	Vokurka (1996)	Dangayach and Deshmukh (2001a, b)	Vastag and Montabon (2002)	Olson (2005)
Academy of Management Journal	x	x	x	
Academy of Management Review	x		x	
Business Horizons			x	
California Management Review		x	x	
Computers & Industrial Engineering	x			x
Decision Sciences	x	x	x	x
European Journal of Operational Research	x		x	x
European Management Journal		x	x	
IEEE Transactions on Engineering Management		x		
IIE Transactions	x		x	x
Industrial Engineering	x			
Integrated Manufacturing Systems		x		
Interfaces	x	x	x	x
International Journal of Operations & Production Management	x	x	x	x
International Journal of Production Economics	x	x	x	x
International Journal of Production Research				
International Journal of Technology Management		x		
Journal of Business Logistics			x	x
Journal of General Management		x		
Journal of International Business Studies			x	
Journal of Management		x		
Journal of Manufacturing Systems	x	x		x
Journal of Operations Management	x	x	x	x
Journal of the Operational Research Society	x		x	x
Long range planning		x		
Management Science	x	x	x	x
Manufacturing & Service Operations Management				x
Omega	x	x	x	x
Operations Research	x		x	x
Production & Inventory Management Journal	x	x	x	x
Production & Operations Management		x	x	x
Production Planning & Control		x		
Sloan Management Review	x	x	x	
Strategic Management Journal	x	x	x	

Note: X, coverage provided by the article

Table IV.
Journals included in classification schemes of various authors

on developing models of reality, methods, or techniques. On the other hand, empirical research is based on primary data and is interpretive and deductive in nature. Moreover, quantitative study is defined as "composed of variables, measured with numbers, and analyzed with statistical procedure" (Creswell, 1994). Similarly, qualitative study is defined as understanding social phenomena based on "holistic pictures, words, detailed view of informants, conducted in a natural setting" (Creswell, 1994). Nakata and Huang (2005), and Page and Schirr (2008) combine these two topologies to form four basic research designs: conceptual qualitative, conceptual quantitative, empirical qualitative, and empirical quantitative. This scheme was used to classify 506 articles in our analysis.

The precise definition of empirical has varied in the literature. Nonetheless, there is almost a consensus in the literature that any study based on some sort of data is classified as empirical even though it might have developed some conceptual research

Serial no	Paper title	Topics in the article	Subtheme: (remove prepositions/plurals and structure improvement) – 1st level abstraction	Major theme – 2nd level abstraction
1	A closed loop outsourcing decision model for developing effective manufacturing strategy	Closed loop outsourcing decision model China risk management Current trends in outsourcing	Outsourcing – risk analysis	Structural choices – process span
129	Manufacturing strategy, the business environment, and operations performance in small low-tech firms	Manufacturing strategy configuration Stability of manufacturing strategy	MS configurations – stability	Manufacturing capabilities

Table V.
Example for abstracting theme and subtheme

based on empirical data. Some researchers have used classification schemes of conceptual vs empirical, and qualitative versus quantitative (Minor *et al.*, 1994; Dangayach and Deshmukh, 2001a). Both Minor *et al.* (1994) and Dangayach and Deshmukh (2001a, b) define empirical studies as those that are based on some sort of data. Most of the studies in literature do not distinguish between type of data – primary or secondary, while explicating empirical research. However, we choose the classification of empirical and conceptual used by various researchers (Albaum and Peterson, 1984; Li and Cavusgil, 1995; Bowen and Sparks, 1998; Nakata and Huang, 2005) who define empirical research as based only on primary data. They classify research based on secondary data as conceptual. We call it conceptual quantitative, using typologies developed by Nakata and Huang (2005) and Page and Schirr (2008). We could have called it empirical-primary and empirical-secondary data. However, we decided to use an existing classification from literature rather than creating a new one.

Finally, the sample papers were also classified by regions, i.e., North America (NA), Europe, and others (other parts around the world). A paper belongs to a region if its author(s)'s association is with an institution that is in the region. A number of studies (e.g. Usdiken and Pasadeos, 1995; Leonidou *et al.*, 2002; Chen and Hirschheim, 2004; Nakata and Huang, 2005; Lockett *et al.*, 2006; Svensson and Deakin, 2007; Whitelock and Fastoso, 2007) have investigated differences between European, North American, Australian, Latin American, and other researchers while reviewing literature from various domains (international marketing, information systems, management, and organization studies). However, the author's regions are normally classified based on their institutional affiliation (Whitelock and Fastoso, 2007).

It is postulated that research designs and orientations vary from one region to another. Europeans use a smaller sample size but have a higher response rate than North Americans (Leonidou *et al.*, 2002). It is also reported that US journals, which publish research mainly from US researchers, are more likely to be positivist, quantitative, cross-sectional, and survey oriented (Chen and Hirschheim, 2004).

Svensson and Deakin (2007) studied journals from the US, Europe, and Australia to explore regional research orientations. They found that quantitative research design and the North American paradigm of research values are reflected in US journals. Australian journals reflect the Australian research values while the European journals identity is based upon a mix of empirical research design along with a multi-national paradigm of research values.

The studies have found that the choice of research topics and research findings with a domain vary from one region to another. For example, Leonidou *et al.* (2002) found that the link between marketing strategy variables and export performance is stronger in studies conducted in Europe. Research on international branding is hardly conducted outside of Europe and North America (Whitelock and Fastoso, 2007). Usdiken and Pasadeos (1995) found substantial differences in terms of choice of topics and research approaches. Given sufficient historical evidence of regional differences, we choose to do a thematic analysis by region.

3.3 Coding

Themes and subthemes were coded alphabetically with each code having a unique identity throughout the database. Alphabetical codes are preferred over numerical codes, which are less likely to be remembered, are more prone to mistakes, and are difficult to edit. Having entered all the data into Excel, the database was edited for duplications, errors, and missing data. The coded data were used for counting and further analyses.

3.4 Analysis

One researcher who had a background in quantitative analysis of literature led the team, and the remaining two researchers made analyses of the relevant shortlisted papers. The teamwork involved off-and-on daily meetings and weekly presentations of research findings and project progress.

Two types of analyses are conducted in this review – quantitative and qualitative. The quantitative analysis consists of identifying publication trends within each subtheme. The evolution of these trends is analyzed with time and across geographical regions as previously explained, i.e., North America (NA), Europe, and others. About 55 papers belong to multiple regions. Similarly, for qualitative review, a subset of studies is shortlisted and their main findings are tabulated. The shortlisting of studies for this purpose is based on considerations such as old and new studies, studies having high citations, and studies offering new ideas in relation to meeting the challenges posed in Section 2.1.

4. Results

4.1 Identification of themes

Following the methodology detailed above, themes of study emerging from MS literature and driven by the Dangayach and Deshmukh (2001a) paper are highlighted in Figure 1. Eleven major themes and a number of subthemes are identified. Working definitions of major themes are as follows.

MS components and paradigms. This theme includes literature on the definition of MS, its components, paradigms, and/or general articles on MS.

MCs. This includes literature on competitive priorities, i.e., cost, quality, flexibility, delivery, etc.; MCs to realize competitive priorities; typologies, taxonomies, and generic

MSs; resource-based view, knowledge, and learning; order winning and qualifying criteria; etc.

SCs. This theme includes literature on SLCs and infrastructural choices (ICs) pertaining to manufacturing. SLCs include: capacity, process focus, technology choice, vertical integration and outsourcing, and facility/plant choice, whereas ICs include: planning and control, organization, human-resource management, purchasing, and product and/or process development (PPD).

BPs. This includes literature on BPs such as agile and virtual manufacturing, mass customization, advanced manufacturing technology, JIT, lean manufacturing, etc.

SP. This includes literature on strategy formulation, and implementation. Similarly, various approaches and methods for formulating strategy are also part of this theme.

SCM. Because this belongs to inter-organizational operations of a group of firms, this is identified as a stand-alone theme.

Performance measurement. Articles on measuring performance and design of measures are included in this theme.

Transnational comparisons. Comparative studies between countries or geographical regions pertaining to MS practices are included in this theme.

Environmental/green manufacturing. Studies focussing on environmental factors are included in this theme.

Global manufacturing. Because of the growing body of literature in international manufacturing, this theme is identified. Currently, the following subthemes emerge: global SLCs, global ICs, global MSs, and global SCM

Literature review. This includes studies on MS literature reviews.

4.2 Analysis of themes and subthemes

Table VI summarizes publication trends in major themes of study. Each theme is cross-tabulated with time, region, and time-region dyad as shown in the table.

A significant portion of publications focus on three themes: MCs (17 percent), SCs (25 percent), and BPs (23 percent). It is evident that research interest in MCs and SCs is decreasing with time whereas interest in BPs is growing gradually (Figure 2). In percentages, from among the three themes, NAs have focussed more on the theme of SCs, whereas Europeans and Others have focussed more on BPs.

Another significant theme of study has been the strategy making process (15 percent). The research interest in the strategy making process as well as performance measurement, SCM, and global manufacturing is growing with time. The comparison of publications in major themes by region is shown in Figure 3.

Table VII provides publication trends in subthemes with time, region, and time-region dyad.

Table VIII provides research findings of salient articles in each theme/subtheme. The articles were selected considering their citations, diversity of topics covered, and relevance to future challenges discussed earlier in Section 2.1. The remaining section elaborates on each of the subthemes.

MS components and paradigms. There are a limited number of publications that qualify for this theme. Though the publication trend in this theme has declined significantly since 1980s, we occasionally find papers that view MS from completely new lenses and thus become very important. For example, Schroeder *et al.* (1986) define MS in terms of mission, objectives, policies and distinctive competence. Wheelwright (1984) suggests that decision categories in MS include capacity, facilities, technology,

Table VI.
Main themes researched in manufacturing strategy literature

		By years (%)			By region (%)			By years within region (%)								
								North America			Europe			Others		
	Total	2000	1990	1980	NA	Europe	Others	2000	1990	1980	2000	1990	1980	2000	1990	1980
Total Studies	506	226	239	41	261	206	94	94	139	28	102	90	14	62	30	2
MS Components and paradigms	2	1	1	10	2	2	1	1	1	11	3	1	7	0	3	0
Manufacturing capabilities	17	14	20	12	18	15	15	15	22	14	13	17	14	13	17	50
Strategic choices	25	21	27	37	28	24	16	22	29	43	24	26	14	15	17	50
Best practices	23	26	20	24	21	26	22	26	18	18	27	22	36	23	23	0
Strategy process	15	18	14	7	14	17	20	19	12	7	17	19	7	18	27	0
Supply chain management	3	4	1	0	3	2	2	6	2	0	4	1	0	3	0	0
Performance measurements	2	4	2	0	2	2	3	3	1	0	2	3	0	5	0	0
Transnational comparisons	4	6	3	2	1	5	10	3	0	0	4	7	7	15	0	0
Environment/green manufacturing	2	1	4	0	3	0	3	2	4	0	0	1	0	2	7	0
Global manufacturing	6	4	8	2	6	5	5	1	10	4	6	3	7	6	3	0
Literature review	2	1	1	5	2	1	2	1	1	4	1	0	7	2	3	0

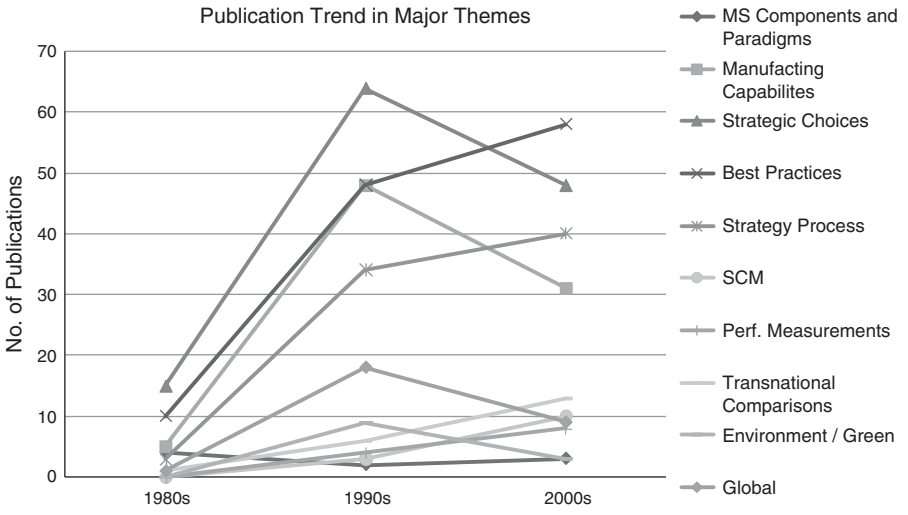

Figure 2. Publication trends in major themes of MS literature

vertical integration, workforce, quality, production planning and control (PPC), and organization. Voss (1995) conceptualizes that manufacturing organizations compete using one of the three manufacturing paradigms: MCs, SCs, and BPs. This very concept is also reiterated in Da Silveira and Sousa (2010). MS components and paradigms have mostly been studied keeping the economic perspective in mind, and there is a severe deficiency of social and environmental perspectives in conceiving, formulating, and implementing MS.

MCs. MCs constitute 17 percent of the total MS publications. Research interest in this theme is declining with time and across the regions. This major theme comprises the following subthemes: competitive priorities; typologies, taxonomies, and generic MSs; MCs and (manufacturing) goal; and miscellaneous, which includes resource-based view, tradeoff and cumulative capabilities, and business performance.

Competitive priorities constitute 30 percent of the publications within MCs. Interest in competitive priorities is declining with time and across the regions (Figure 4, Table VII). Mostly, organizations have focussed on the four competitive priorities of quality, cost, delivery, and flexibility (Ward *et al.*, 1998). From within these priorities, flexibility and delivery time have been given the most attention. However, relatively few if any studies have discussed servicing as a competitive priority (Armistead and Clark, 2007). Manufacturing firms focus on multiple manufacturing priorities simultaneously (Noble, 1997) and flexibility is a source of dealing with environmental uncertainty (Gerwin, 1993). Innovation does not appear as a competitive priority in MS literature. Moreover, the conceptualization of competitive priorities from social and environmental perspectives is found to be completely missing (see Table VIII).

One significant set of studies included in MCs (21 percent) is related to typologies, taxonomies, and generic MSs (together called configuration models; Bozarth and McDermott, 1998). Interest in this subtheme is growing with time and across geographical regions (Figure 5, Table VII). Configuration models play an important role in developing, implementing, and changing MSs (Bozarth and McDermott, 1998). Manufacturing firms use the generic MSs of quality customizers, low emphasizers,

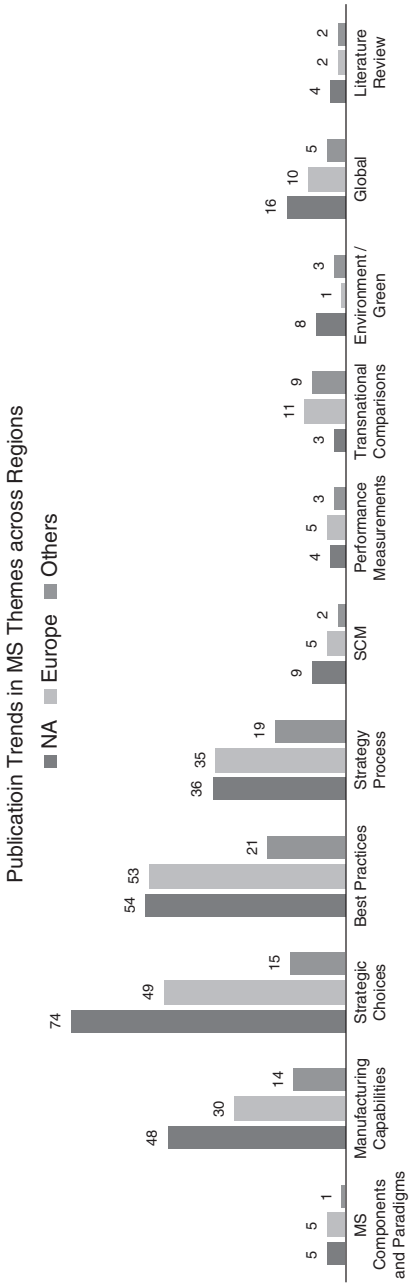

Figure 3.
Comparison of publications across region

Table VII. Manufacturing strategy literature

		By years (%)			By region (%)			By years within region (%)								
								North America			Europe			Others		
	Total	2000	1990	1980	NA	Europe	Others	2000	1990	1980	2000	1990	1980	2000	1990	1980
Subthemes researched																
Total studies	506	226	239	41	261	206	94	94	139	28	102	90	14	62	30	2
MS components and paradigms	2	1	1	10	2	2	1	1	1	11	3	1	7	0	3	0
Manufacturing capabilities	*17*	*14*	*20*	*12*	*18*	*15*	*15*	*15*	*22*	*14*	*13*	*17*	*14*	*13*	*17*	*50*
Competitive priorities	30	19	35	40	31	33	29	7	40	50	31	33	50	25	20	100
Typologies, taxonomies and generic MSs	21	32	15	20	19	20	29	36	10	25	23	20	0	38	20	0
Manufacturing capabilities and goal	24	19	29	0	23	20	29	21	27	0	15	27	0	25	40	0
Others (RBV, tradeoffs, Bus. perf., etc.)	25	29	21	40	27	27	14	36	23	25	31	20	50	13	20	0
Strategic choices	*25*	*21*	*27*	*37*	*28*	*24*	*16*	*22*	*29*	*43*	*24*	*26*	*14*	*15*	*17*	*50*
Structural choices	37	46	31	33	39	37	0	43	37	42	54	22	0	0	0	0
Capacity choices	13	14	15	0	7	22	–	11	7	0	15	40	–	–	–	–
Facility and plant choices	9	9	5	20	14	0	–	22	7	20	0	0	–	–	–	–
Technology choices	28	27	20	60	34	17	–	33	27	60	23	0	–	–	–	–
Process Span (VI, outsourcing)	17	23	15	0	10	28	–	22	7	0	23	40	–	–	–	–
Focus	34	27	45	20	34	33	–	11	53	20	38	20	–	–	–	–
Infrastructural choices (%)	63	54	69	67	61	63	100	57	63	58	46	78	100	100	100	100
Planning and control (%)	61	62	64	50	58	68	60	67	58	43	73	67	50	44	80	100
Strategic manufacturing planning (%)	16	6	25	0	23	10	22	13	33	0	0	17	0	25	25	0
Quality and productivity (%)	8	0	11	20	8	10	11	0	13	0	0	17	0	0	0	100
Production planning and Control	55	69	46	60	50	62	56	75	33	67	75	50	100	50	75	0
Budget, accounting and cost Control	20	25	18	20	19	19	11	13	20	33	25	17	0	25	0	0
Organization	11	8	11	20	11	10	7	0	12	29	9	11	0	11	0	0
Human resources	11	12	11	10	13	3	13	17	12	14	0	6	0	11	20	0
Sourcing	8	4	9	10	7	6	7	0	12	0	0	6	50	11	0	0
Product and/or process development	9	15	5	10	11	13	13	17	8	14	18	11	0	22	0	0

(*continued*)

Table VII.

		By years (%)			By region (%)			By years within region (%)								
								North America			Europe			Others		
	Total	2000	1990	1980	NA	Europe	Others	2000	1990	1980	2000	1990	1980	2000	1990	1980
Best practices	*23*	*26*	*20*	*24*	*21*	*26*	*22*	*26*	*18*	*18*	*27*	*22*	*36*	*23*	*23*	*0*
Agile, mass-cust., and virtual manuf.	16	31	0	0	13	15	19	29	0	0	29	0	0	29	0	
AMT and Information systems	16	14	19	20	20	15	10	13	28	20	18	10	20	14	0	
CIM	8	5	13	0	7	9	10	4	12	0	7	15	0	7	14	
FMS	16	14	17	30	15	17	24	17	12	20	11	20	40	14	43	
JIT, Lean and cellular Manufacturing	21	17	23	30	28	13	19	21	32	40	11	15	20	21	14	
WCM	6	2	13	0	4	8	5	4	4	0	0	20	0	0	14	
Miscellaneous (BPR, Group Tech., Jap. Tech. etc.)	17	17	17	20	13	23	14	13	12	20	25	20	20	14	14	
Total studies	506	226	239	41	261	206	94	94	139	28	102	90	14	62	30	2
Sub-topics reasearched																
Strategy process	*15*	*18*	*14*	*7*	*14*	*17*	*20*	*19*	*12*	*7*	*17*	*19*	*7*	*18*	*27*	*0*
Strategy formulation	88	83	94	100	97	86	84	100	94	100	71	100	100	82	88	
Conceptual frameworks and approaches	25	27	22	33	23	30	19	33	13	0	33	24	100	11	29	
Methods	13	12	13	33	9	10	25	6	7	50	8	12	0	33	14	
Alignment of MS with:	38	42	38	0	51	30	31	50	60	0	25	35	0	33	29	
Business strategy	23	29°	17		28	11	0	44	11		0	17		0	0	
Other functions	62	43	83		61	89	60	33	89		100	83		33	100	
Manufacturing task and others	15	29	0		11	0	40	22	0		0	0		67	0	
Miscellaneous	24	18	28	33	17	30	25	11	20	50	33	29	0	22	29	
Strategy justification and implementation	12	18	6	0	3	14	16	0	6	0	29	0	0	18	13	
Supply chain management	*3*	*4*	*1*	*0*	*3*	*2*	*2*	*6*	*2*	*0*	*4*	*1*	*0*	*3*	*0*	*0*
Performance measurements	*2*	*4*	*2*	*0*	*2*	*2*	*3*	*3*	*1*	*0*	*2*	*3*	*0*	*5*	*0*	*0*
Transnational comparisons	*4*	*6*	*3*	*2*	*1*	*5*	*10*	*3*	*0*	*0*	*4*	*7*	*7*	*15*	*0*	*0*
Environment/green manufacturing	*2*	*1*	*4*	*0*	*3*	*0*	*3*	*2*	*4*	*0*	*0*	*1*	*0*	*2*	*7*	*0*
Global manufacturing	*6*	*4*	*8*	*2*	*6*	*5*	*5*	*1*	*10*	*4*	*6*	*3*	*7*	*6*	*3*	*0*
Global structural choices	25	11	33	0	25	20	20	0	29	0	17	33	0	0	100	
Global infrastructural choices	14	11	17	0	19	10	0	0	21	0	17	0	0	0	0	
Global manufacturing strategies	43	67	28	100	31	60	60	100	21	100	50	67	100	75	0	
Global supply chain management	18	11	22	0	25	10	20	0	29	0	17	0	0	25	0	
Literature review	*2*	*1*	*1*	*5*	*2*	*1*	*2*	*1*	*1*	*4*	*1*	*0*	*7*	*2*	*3*	*0*

Table VIII. Main research findings from salient articles in each theme/subtheme

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
MS components and paradigms		Wheelwright (1984), Schroeder *et al.* (1986), De Meyer and Ferdows (1987), Leong and Ward (1995), Voss, (1995, 2005), Morita and Flynn (1997), da Silveira and Sousa (2010)	MS can be defined in terms of mission, objectives, policies and distinctive competence Decision categories in MS include: capacity, facilities, technology, vertical integration, workforce, quality, production planning and control, and organization Management focal points of attention from the perspective of implemented MS include: action flexibility, changing role of workforce, quality, information system, up keeping of existing systems, resizing the structure, automation and product-process adjustment Six Ps of MS: planning, proactiveness, pattern of actions, portfolio of MCs, programs of improvement, performance measurement An attempt is made to find linkages among three MS paradigms proposed by Voss (1995). There are three paradigms of choice in MS that include: fit, BPs, and capability	Ec in general
MCs				
Competitive priorities		Ward *et al.* (1998), Nobel (1997), Williams *et al.* (1995), Curkovic *et al.* (2000), Zhang *et al.* (2007), Jayaram *et al.* (1999), Holweg (2005), Chang *et al.* (2003), Swamidass and Newell (1987), Olhager (1993), Gerwin (1993), Armistead and Clark (2007)	Empirical findings suggest that firms focus on all four competitive priorities (quality, cost, delivery, flexibility) rather than trading some with others Better performing firms focus on multiple manufacturing priorities simultaneously as opposed to a particular priority Firms' quality assurance process and an ability to deliver quality products significantly improve firms' performance Quality has two dimensions: product quality and service quality, and both dimensions are related to overall firm performance Product model variations significantly increase order processing time, whereas product type variations do not significantly impact order processing time	Ec Ec Ec6 Ec Ec Ec2 Ec1, 8 Ec1, 8 Ec6

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Variables affecting responsiveness can be grouped into three – product, process and volume. An interplay among those results into responsive of a specific system Time-based performance significantly impact organizational performance. Organizations focus in a system, change organizational hierarchy, and invest in information management in order to realize time based performance. Manufacturing flexibility requires shorter part changeover times. Specific manufacturing flexibility types are relevant to specific business strategy. Manufacturing flexibility affects profitability, sales, cost, revenue, and assets of an organization. A theoretical model of the content of manufacturing flexibility is proposed and various dimensions of flexibility are identified for dealing with environmental uncertainty A framework is proposed for devising after-sales strategy of an organization as part of its pursuit to gain competitive advantage	
Typologies, taxonomies, generic MSs		Miller and Roth (1994), Frohlich and Dixon (2001), Zhao *et al.* (2006), Kathuria (2000), Devaraj *et al.* (2004), Kotha and Orne (1989), Cagliano *et al.* (2005), Bozarth and McDermott (1998)	Five MS groups are identified: "caretakers", "designers", "innovators", "idlers", "servers", and "mass customizers". The taxonomy has further been developed to: "quality customizers", "low emphasizers", "mass servers", "specialized contractors" based on realized strengths of firms rather than competitive capabilities Following groups are identified in small manufacturers: do all, speedy conformers, efficient conformers, and starters Plants having a fit between generic MSs (common patterns of competition) and operational objectives experience higher level of performance	Ec1-6, 8 in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Product-based strategy is most stable; capability-based strategy is rising; market-based strategy is struggling and cost-based strategy is declining Configuration models play important role in developing, implementing, and changing MSs	
Manufacturing capabilities and goal	Manufacturing capability	Jayanthi *et al.* (2009), Roth and Miller, (1992), Swink *et al.* (2005), Swink and Hegarty, (1998), Ketokivi (2006), Corbett (1992), Das (2001), Vickery (1991)	Different evolutionary stable MSs have corresponding MCs and competitive practices MCs are built through resource improvements, quality management programs, and advanced process technology Strategy integration plays a strong, central role in the creation of manufacturing cost efficiency and new product flexibility capabilities. Furthermore, strategy integration moderates the influences of product-process development, supplier relationship management, workforce development, just-in-time flow, and process quality management practices on certain MCs Specific MCs realize specific product differentiations Demand uncertainty and variability, technology, and competitive strategy either enable or constrain the selection of various flexibility strategies The competitive capabilities of mix and volume flexibility, and delivery reliability are brought about improvement programs such as just-in-time systems, product flow streamlining, and worker involvement Manufacturing priorities are facilitated through developing manufacturing flexibilities Production competence (overall ability of manufacturing to support a product-market strategy) is a means to realize business performance	Ec1-3, 8 in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
	Goal	Narasimhan and Jayaram (1998), Wacker (1996), Rangone (1996)	Manufacturing goal achievement is a process of causal linkages between supply management, information systems and process improvements. Achieving manufacturing goals results into customer responsiveness and firm performance Statistical variations in lead times cause difficulty in controlling manufacturing goals Overall manufacturing goal is realized by a hierarchy of lower level objectives	Ec1-3, 8 in general
Miscellaneous	Tradeoffs and cumulative models of capability	GroBler and Grubner (2006), Da Silveira (2005a, b), Rosenzweig and Roth (2004), Corbett and Wassenhove (1993), Noble (1995), Amoako-Gyampah and Meredith (2007), Szwejczewski *et al.* (1997)	Quality leads to delivery which is a basis of flexibility and cost efficiency A heuristic method for tradeoff improvements is proposed MCs: conformance quality, delivery reliability, volume flexibility, and low cost are acquired cumulatively and in this sequence Production competence (overall ability of manufacturing to support a product-market strategy) is a means to realize business performance The cumulative model of capabilities is found to be true in multiple countries The sequence of capabilities development in Ghana was found to be in the order: quality, cost, delivery, and flexibility which is different from the developed countries Manufacturing firms quoting a short lead time show higher delivery performance which is contrary to tradeoff theory	Ec1-3, 8 in general
	Capability and business performance	Ward *et al.* (1994), Choe *et al.* (1997), Kim and Arnold (1993), Gilgeous (1994)	Investments in structural programs coupled with more involvement of mangers in strategic processes or investments in infrastructural programs increase business performance A manufacturing organization can improve its performance significantly by aligning manufacturing structure with business strategy	Ec1-6 in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			An organization's manufacturing function is very competent if it has a strong competitive capability, where strategically less important capabilities are not considered A model is proposed that links strategy needs of business with actions at shop floor level	
	Resource-based view, knowledge and learning	Henriksen and Rolstadas (2010), Shaw and Edwards (2005), Schroeder *et al.* (2002), Mohanty and Deshmukh (1999)	Lean management focusses more on tacit knowledge while mass manufacturing focusses more on explicit knowledge. An integrated approach to knowledge management in manufacturing organizations needs involvement across organization at all levels Competitive advantage for a manufacturing firm is realized through proprietary processes and equipment, which is driven by internal and external learning An organizational learning model is proposed to help evaluate MSs and select AMT based on strategic, tactical and monetary factors	Ec3, 8 in general
Strategic choices				
Capacity management		Gupta and Wang (2007), Dekkers (2002), Olhager *et al.* (2001)	A model is proposed for identifying near optimal policies for capacity allocation in make-to-stock and make-to-order business Decision models that include sourcing and capacity management, product development, and manufacturing technology scan are developed for strategic capacity management A framework is proposed for long-term capacity management that includes perspectives of MS, sales and operations planning	Ec in general
Facility and plant management		Schmenner (1982), Montreuil and Venkatadri (1991), Elango (2005)	Four types of plants are identified namely: product plant, market area plant, process plant, and general purpose plant. Each one of these differs in its characteristics from others A proactive methodology is proposed for designing dynamic	Ec Ec Ec, Sc

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			layouts for expansion phase of manufacturing systems	
			While locating plants overseas, acquisition of local firms are preferred over Greenfield operations if plants are characterized by human capital intensity. The converse is true in cases when plants are characterized by physical capital intensity	
Technology management		Safsten *et al.* (2007), Meredith *et al.* (1986), Kleindorfer and Partovi (1990), Sonntag (2003), McKone and Schroeder (2002), Wacker (1988), Montagno *et al.* (1995), Narasimhan *et al.* (2010)	An appropriate level of automation results into improved manufacturing performance and competitiveness. Thus automation is considered as a form of MS	Ec 7
			An AHP based model relates marketing and MS with technology choice	Ec7
			MS is a critical link to manufacturing firms for adapting to technological changes	Ec7
			A theoretical framework for understanding plant context, process technology and product development practices is introduced. Organizational, environmental and strategic context leads to technology practices	Ec, Sc2
			Organizations which have upper level managers equipped with technological knowledge and know-how will achieve higher returns	Ec3
			A methodology for implementing ERP and Real Time Monitoring System is proposed	Ec7
			There exist positive complementarities between product – process (PPT) integration and supplier integration w.r.t. quality, delivery, and process flexibility, and between PPT integration and customer integration w.r.t. quality and new product flexibility	Ec
Process span	Vertical Integration	Tannous and Mangiameli (1993), Platts *et al.* (2002)	A model is developed to evaluate and compare various strategic alternatives from focussed factory to vertical integration continuum	Ec
			A multi-attribute decision criterion is proposed for taking make vs buy decisions of organizations based on criteria belonging to	Ec7

(*continued*)

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			technology and manufacturing processes, supply-chain management and logistics, support systems and costs	
	Outsourcing	Kumar *et al.* (2010), Dekkers (2000), Bengtsson (2008), Gray *et al.* (2009), Webster *et al.* (1997), Lehtinen (1999)	A decision model for outsourcing is proposed based on enablers and barriers	Ec7, 9
			A method is proposed to assist in strategic decision making, phases of development, engineering, and production planning in outsourcing situations	Ec2, 9 Ec5, 8 Ec9 Ec1, 9
			There is no significant relation of outsourcing on plant performance and innovation capability. However, firms' investments in technological and organizational capabilities have higher impact on plant performance and innovation capability	Ec9
			Cost as a competitive priority plays a significant role in sourcing decisions, whereas conformance quality does not have a significant effect	
			The use of subcontracting in manufacturing provides flexibility to organizations which leads to agility and competitive advantage	
			The subcontractor system in Finnish industry informs that better managing inbound logistics and cooperating with other companies results into subcontractors' success	
Focus		Safizadeh *et al.* (1996), McDermott *et al.* (1997), Bozarth (1993), Hallgren and Olhager (2006a), Miltenburg (2008), Pesch (1996), Walbank (1992), Wemmerlov (1984), Flynn and Flynn (1999), Olhager and Rudberg (2002b)	Process choice is strongly correlated with degree of production customization and competitive priorities of quality and cost	Ec1, 2, 8 in general
			The utility of product-process matrix is decreasing with time with advent of new technologies (such as CNC machines and SMED), management practices (JIT, cellular manufacturing), and advances in information systems	
			Manufacturing organization focus (manufacturing, market, or manufacturing-market congruence) is related to organizational performance	
			Manufacturing focus can be differentiated relative to customer	

(*continued*)

Table VIII.

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			order decoupling point rather than on product, process, or manufacturing task An MS framework for factory-within-factory is proposed consisting of: production systems, manufacturing outputs, manufacturing levers, MCs, competitive analysis and linkages among these Plant focus and market responsiveness should not be regarded as conflicting goals The effective use and performance of manufacturing policies such as make-to-forecast, make-to-order, and make-to-capacity is aided by a set of common actions such as: maximize quality, minimize setup times, minimize lead times, and maximize flexibility Differences between MTO, ATO, and MTS are explained with respect to their implications on planning and control function. Environmental complexity is related with manufacturing performance, the relationship is moderated by various factors including the use of multifunctional employees, communication of MS, coordination of decision making, product design simplicity etc The process choice decision affects the manufacturing planning and control systems at the lower levels where physical reality of the plant becomes apparent	
Planning and control	Strategic manufacturing planning	Hill and Westbrook (1997), Garvin (1993), Cohen and Lee (1988), Li *et al.* (2005), D'Amours *et al.* (1999)	For strategic development of manufacturing, firms should use strategic analysis that adheres to coverage, verification, segmentation, and definition An integrated model is proposed for meshing manufacturing strategic planning with business strategy that also aids in day-to-day manufacturing decisions	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			A model is proposed for linking decisions and performance in material – production – distribution supply-chain A strategic control approach driven by external and internal factors is developed and its implications on product and/or process decisions are studied Higher networking flexibility can be achieved when organizations engage in tighter relationships that also results into better scheduling performance	
	Production planning and control	Olhager and Ostlund (1990), Ozbayrak *et al.* (2004), Smunt (1987), Persentili and Alptekin (2000), Pil and Holweg (2004), Ronen and Rozen (1992), der Meijden *et al.* (1994), Larsen and Alting (1993)	Because of inapplicability of pull strategy in all manufacturing environments, a method for combining push and pull systems is developed for an integrated strategy Methods for calculating product and/or process costs under push and pull control strategies are developed and their implications on production control are illustrated Worker forgetting in a batch production environment can increase optimal lot sizes A method is developed and implemented for comparative analysis of push and pull strategies in an environment where product variety is high Mitigating product variety's negative effects on production through modularity, mutability, late configuration, and option bundling, depends on the order-fulfillment strategy A strategic master production scheduling model is suggested as a means to carve out connection between production plan and manufacturing Gap between sales and manufacturing can be bridged using simple forecasting techniques coupled with improved cooperation and coordination between the two functions A unified approach for selecting production control philosophy is suggested	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Product flexibility measure is used to select appropriate production planning and control strategies such as JIT or MRP Activity based costing is used to estimate manufacturing and product costs under JIT and MRP environments.	
	Productivity and quality	Brown (1998), Brush and Karnani (1996), Helms and Barker (1993), Gunasekarar *et al.* (1994)	Different strategies are proposed to optimize total productivity for attaining overall growth, cost reduction, upgrading technical efficiency and management effectiveness	Ec
			Plant size is not, however, plant focus is correlated with productivity	Ec
			Productivity is reduced by poor quality of management and poor organization	Ec
			Knowledge worker and support services play a significant role in improving productivity and quality in manufacturing organizations	Ec3
	Budget, accounting and cost control	Walley *et al.* (1994), Fry *et al.* (1998), Ozbayraka and Akgun (2006), Storck (2010), Cattani *et al.* (2010), Sutton (1991)	Adoption or non-adoption of modern accounting methods in manufacturing firms is influenced by pressure from management, ownership and history, sister companies, availability of resources to name a few Financial accounting and standard costing systems influence operations decisions A system dynamics is proposed based framework to support improvements in strategic requirements of product diversity and cost reduction Production planning and control strategies (push and pull) have direct impact on company financial performance Flexible factory amortizes fixed costs of capacity more effectively than focus strategy and thus can result into higher profits even with higher-cost production for the standard goods The accountant needs to learn product costing from the design process beyond the realms of his conventional training	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
Organization		Bates *et al.* (1995), Harrison and Storey (1996), Nemetz and Fry (1988), Mascarenhas (1984), Balkin and Gomez-Mejia (1990), Tranfield and Smith (2002)	An agenda is proposed for studying organizational realities of manufacturing BPs	Ec
			A firm with well implemented MS exhibits a group-oriented culture and "coordinated decision making", "decentralized authority" and "loyal workforce"	Ec3
			Implications of flexible manufacturing technologies on organization design are presented compared on mass production in terms of various key dimensions	Ec2
			Increased interdependence between subsidiaries of international operations requires use of system-sensitive members and personal communication	Ec9
			Corporate and business unit level strategies significantly predict pay package design, pay level relative to market, and corporate strategy is a significant predictor of pay administration policies	Ec3
			There exist three team-working archetypal forms in manufacturing organizations: "self-directed", "lean" and "project"	Ec3
				Ec3
			Large institutional changes toward teamwork impact managers' interpretive schemes	
HRM		Stratman *et al.* (2004), Safizadeh (1997), Chien *et al.* (2010), Youndt *et al.* (1996), Kinnie and Staughton (1993), Papke-Shields and Malhotra (2001), Snell and Dean Jr (1994)	Allocating permanent workers to upstream build operations is superior to deploying temporary workers, regardless of lot size and product complexity	Ec3 in general
			Involvement of employees across the manufacturing organization in providing information is important during the strategy making process	
			A non-parametric frontier approach is proposed for estimating indirect workforce requirements based on the past best performance adjusted to expected productivity growth	
			An HR system focussed on enhancing human capital improves manufacturing performance moderated by a sound MS	

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			HR practices namely: education and training, pay systems and structures, and staffing arrangements play a significant role in implementing MS	
			Involvement and influence of manufacturing executive are needed for strategy alignment	
			In integrated manufacturing, compensation systems emphasize group-based incentives, salary and seniority-based pay	
Sourcing		Narasimhan and Das (1999), Weber *et al.* (1991), Kekre *et al.* (1995)	Strategic sourcing can be considered to target volume and modification strategies that influence new product flexibility.	Ec9 in general
			Criteria and methods for vendor selection are presented specially in the case of JIT	
			Manufacturing firm's supplier based can be reduced and quality levels increased by focussing on operating decisions and environmental factors such as wider product lines, lower levels of competition, and greater frequency of product changes	
Product and/or process development		Karger and Murdick (1966), Lu and Botha (2006), Olhager (2003), Jun *et al.* (2005)	Strategic planning of products is essential and should include innovations along the directions of product design, marketing programs and manufacturing processes	Ec2
			A theoretical framework for process development is proposed based on intra-functional enablers, inter-functional enablers, and learning enablers	Ec2
			Various market, product, and production factors are identified that influence the positioning of order penetration point in the manufacturing value chain	Ec2
			Analytical methods are developed that capture uncertainty, iteration and evolution, and estimation of the product development cycle time	Ec2, 7

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
Best practices				
Agility, mass customization, and virtual Manufacturing	Agile and virtual manufacturing	Zhang and Sharifi (2007), Giachetti *et al.* (2003), Lin (2004), Brown and Bessant (2003), Vázquez-Bustelo *et al.* (2007), McCarthy and Tsinopoulos (2003), Offodile and Abdel-Malek (2002), Webster *et al.* (2004), Calvo *et al.* (2008)	Groups of agile manufacturers include: quick, responsive and proactive players A measurement framework is proposed for specifying and using measures in order to align system design with enterprise strategy Suppliers can choose to be dedicated OEM service providers or can sell their own brands; either strategy can be effective in network innovation agility Agility practices realize competitive advantage to a firm leading to operational, market and financial performance A framework for collecting and organizing information on manufacturing routines and capabilities is proposed that facilitate developing strategic agility A virtual MS for SMEs is proposed for them to gain competitive advantage A conceptual scale for measuring virtuality of manufacturing organizations is developed Sustainability criterion in agile manufacturing is a ratio of utility and entropy	Ec1 in general
	Mass customization	Squire *et al.* (2006), Tu *et al.* (2004), Duray (2002), Spring and Dalrymple (2000)	There exist tradeoffs between customization and manufacturing cost and delivery lead time There exist statistically significant and positive relationships among customer closeness, modality based practices and firm customization capability	Ec1 in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			The use of mass customization approaches that match non-mass customized product line characteristics increases financial performance of firms A customization process is developed identifying typologies of customization problem solving situations and custom build option types	
AMT and information systems	AMT	Tracey *et al.* (1999), Kengpol and O'Brien (2001), Krinsky and Miltenburg (1991), Boyer (1999), Demeester *et al.* (2004), Mechling *et al.* (1995), Voss (1986), Gupta *et al.* (1997)	AMT is strongly related to manufacturing managers' participation in strategy formulation A decision support tool is developed for assess the value of investing in Time Compression Technologies for achieving rapid product development A tool called "state-price net present value" is developed for strategic analysis of AMTs Plants invest in technology incrementally rather than using an all-or-none approach An organization production system is proposed analogizing with biological cell system capable of reacting to a wide variety of changes in its environment autonomously SMEs can respond to customer needs in global markets by exploiting AMT's agile manufacturing and time-based capabilities AMT implementations without clearly defined strategic objectives fail Decentralization interacts positively with AMT strengths, whereas formalization and mechanistic structure interact negatively	Partially Ec1, 7
	Information systems	Stratman and Roth (2002), Mondragon *et al.* (2004), Olhager and Rudberg (2002a)	A multi-item "ERP competence" construct and measurement scale is developed Information systems support agility of an organization; however, they are insufficient alone to do so	Ec7, 9 in general

(*continued*)

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			E-business strategy impacts two decision categories of MS: vertical integration, and manufacturing planning and control	
CIM		Mertins and Jochem (2005), Milling (1997), Rowlinson *et al.* (1994), Marri *et al.* (2000), Hitomi (1991)	An overview of architectures, methods and tools of enterprise engineering is provided CIM implementation is advised to be a step-by-step strategy of adding new technology to the existing applications driven by a concise CIM strategy CIM implementation in the innovation process within a firm calls for eliciting social requirements from the outset of project and addressing them alongside CIM implementations improve SMEs' performance in the areas of: improved quality, responsiveness, effective sales and marketing information, increased production line productivity, increased staff productivity, lower overhead costs, reduced WIP inventory, reduced lead time, less floor space, and reduced set-up costs An integrated manufacturing system is a procedure of product design, process design, implementation and management. CIM is recognized as an IMS with a common database	Ec7, 9 in general
FMS		Geiskopf *et al.* (2009), Bi *et al.* (2008), Demeester *et al.* (2004), Babic (1999), Gupta and Goyal (1992), Rajput and Bennett (1988), Perrone and Diega (1996), Gien *et al.* (2003), Huang *et al.* (2008), Mohamed *et al.* (2001), Primrose and Verter (1996), Liu and McCarthy (1999), Gupta (1989)	A model for interfacing MS analysis and manufacturing system design is developed Reconfigurable manufacturing system paradigm is proposed to be the most effective in dealing with uncertainties and changes An organic model of a production system is conceptualized for realizing flexibility Tradeoffs exist between various types of flexibility. However, scheduling environment, product variety and system configuration can be effective in containing them Problems are identified for the automation of low volume / high variety assembly operations and possible solutions are recommended	Ec7 in general

(*continued*)

Table VIII.

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			A hybrid model based on an analytical hierarchical process and nominal group techniques is developed for strategic adoption of FMS; Evolutionary algorithm based, fuzzy logic based approaches are developed for manufacturing system design; a Petri net-based approach is developed for FMS scheduling Changes in machine flexibility influence various measures of performance of FMS namely: make span, routing flexibility, capacity flexibility, and inventory effects Measuring flexibility of production system is not considered inevitable by managers before deciding to invest in FMS. Integration is not synonymous with flexibility A mixed integer programming based model is developed for FMS scheduling problems Worker resistance, lack of training, and low motivation lead to slow adoption of FMS	
JIT, lean and cellular manufacturing		Sriparavastu and Gupta (1997), Billesbach (1991), Fullerton and McWatters (2001), Prasad (1995), Bartezzaghi *et al.* (1992), Funk (1989), Sanchez and Perez (2001), Hines *et al.* (2002), Krishnamurthy and Yauch (2007), Bidanda *et al.* (2005), Fraser *et al.* (2007), Vakharia (1986), Goncalves and Resende (2004), Nair and Narendran (1998)	Easy to follow guidelines are provided for a JIT/TQM program implementer Corporate endorsement and policy, employee education, reorganization of production process and a metric based performance process are keys to implementing JIT Quality implementation, waste reduction, and continuous improvement philosophies embedded in JIT can enhance firm performance. Benefits include: faster production flow, better synchronization of: marketing and production, and production and logistics Alternate inventory cost reduction strategies are experimented in JIT control environment Strongest indicators of lean production are: technical visits and assistance from/to suppliers, teamwork in employees, modularity and supplier involvement in design	Ec2, 8 in general

(*continued*)

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			An integrative approach is developed for empirically studying OM practices covering "lean thinking, strategic cost management, marketing and policy deployment areas"	
			Lean and agile MSs can be pursued together though adopting a leagile infrastructure	
			Human issues such as communication, teamwork and training, technical issues and a structured implementation process lead to successful implementation and operation of manufacturing cells	
			Organizations face tradeoff strategic and operational costs in implementing cellular manufacturing systems	
			Evolutionary algorithm based, fuzzy logic based approaches are developed for manufacturing system design	
			A clustering algorithm is developed that uses sequence data for cell formation	
			Standard financial reporting methods are inadequate to accurately reflect operational improvements realized through early stages of a lean program	
WCM		Harrison (1998), Wisner and Fawcett (1991), Collin (1992), Chan (1993), Fawcett and Myers (2001)	WCM requires as a priori major process improvements for flow improvements and employee commitment	Ec in general
			WCM requires broadening performance measurement criteria consistent with competitive priorities of cost, quality, flexibility, dependability, and innovation	
			Characteristics of WCM are identified and relevance of tradeoffs is discussed	
			A holistic model for linking marketing and MS is developed that provides guidelines for exceeding world class status	
			Employee development and integrated product development are antecedents to JIT manufacturing, and manufacturing automation that affect firm performance	

(*continued*)

Table VIII.

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
Miscellaneous (BPR, Group Tech., and others, etc.)		Finch (1986), Rastogi and Mohanty (1994), Pesch *et al.* (1993), Maull *et al.* (1995), Herzog *et al.* (2009), Laugen *et al.* (2005), Sousa (2003), Cagliano and Spina (2000), Karim *et al.* (2008)	A strategy for implementing Japanese manufacturing techniques in SMEs is introduced Different strategies are proposed to optimize total productivity for attaining overall growth, cost reduction, upgrading technical efficiency and management effectiveness Turn around in plants takes time and it depends upon changes in work habits, responsibilities, and relationships among the people in the plants Considerable research scope exists in BPR in the areas of strategy, human factors, and performance measures A strategic approach to BPR and a positive impact of performance measurement is needed for BPR performance Process focus, pull production, equipment productivity and environmental compatibility quality as BPs. Whereas, E-business, new product development (NPD), supplier strategy and outsourcing may become BPs in future Customer focus practices are contingent on a plant's MS. Quality is a two dimensional construct: product quality and service quality, both relate to firm performance Manufacturing program's performance is a function of alignment with changing manufacturing priorities and past experience of program implementation Product quality and reliability are more whereas price is relatively a lesser competitive factor in manufacturing firms Efficient supply-chains lead to high financial performance	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
Other themes				
Supply chain management		Caniato *et al.* (2009), Cagliano *et al.* (2006), Da Silveira and Cagliano (2006), Taps and Steger-Jensen (2007), Hammami *et al.* (2008), Pagh and Cooper (1998), Stock *et al.* (1998)	Lean production model influences integration between information and physical flows in a supply-chain whereas ERP does not	Ec
			Dyadic Inter-organizational Information systems (IOISs) are associated with priorities of stable SC (i.e. cost, delivery, and quality), whereas multilateral IOISs are associated with priorities of dynamic SC (i.e. flexibility and quality)	Ec7, 9
			International joint ventures should design supply-chains in accordance with product innovation or cost efficiency focus	Ec9
			Decisions, cost factors and constraints should be considered as important factors in supply-chain design in delocalization context	Ec9
			A framework is proposed for taking postponement and speculation strategies in relation to logistics and manufacturing within the context of supply-chain settings.	Ec
			Changes in competitive environment require rethinking logistics strategy of a firm	Ec
Performance measurement		Amoako-Gyampah and Acquaah (2008), Sarkis (2003), Barker (1993), Neely *et al.* (1994), Nandulla and Dutta (2000), Blenkinsop and Burns (1992), Hyland *et al.* (2007)	In a developing economy environment, competitive strategy and MSs of cost, quality, delivery and flexibility have strong positive relationship. However, only quality influences performance	Ec
			Analytical network process approach lends a quantitative model for performance measurement and dynamic evaluation of MS performance	Ec7
			A time-based approach is suggested as a tool for value adding performance measurement	Ec2, 7
			In UK, performance measurement systems influence the realization of MSs in those firms that focus primarily on quality or time, and not in those firms that focus on cost reduction	Ec

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Auction-based models for manufacturing system development are proposed real-time control, anticipation of deadlocks, and evaluation of various performance metrics like machine utilization, AGV utilization, waiting times, work in process	Ec
			The need of developing a dynamic, iterative approach for performance measurement systems is proposed in order to cope with changes	Ec8
			Continuous improvement is believed to improve quality conformance, customer satisfaction, productivity, and delivery reliability	Ec
Transnational comparisons		Dangayach and Deshmukh (2001b), Rho *et al.* (2001), Voss and Blackmon (1998), Avella *et al.* (2001), Mellor and Gupta (2002), Dangayach and Deshmukh (2006), Horte *et al.* (1987), Christiansen *et al.* (2003), Lau (2002)	Different type of business strategy deploys specific advanced manufacturing systems configured through different manufacturing technologies	Ec in general
			Inconsistency between MS and its practice plays a more significant role in discriminating between superior and inferior groups of performers in US and Korea than in Japan	
			There is a difference in strategic time orientation between Japan and Europe in the adoption of MSs and links between MS and corporate strategy	
			Practices of MS in various countries: pursuit of excellence and focussing on quality and delivery in Spain; quality, high innovation rate, faster product development and continuous improvement as competitive priorities in India; customer focus, quality, and technology focus as competitive priorities in Australian and European firms; process control as a fundamental strategy in Japan; worker motivation and process quality in Sweden; low price and aesthetic designs in Denmark; product quality and low cost in USA (electronics industry)	

(*continued*)

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
Environment/green manufacturing		Anand and Ward (2004), Sarkis (2001), Klassen (1993), Klassen and Whybark (1999), Azzone and Noci (1998), Florida (1996), Newman and Hanna (1996), Mohanty and Deshmukh (1998)	Unpredictability and volatility are two dimensions of environmental dynamism and each of them warrant the use of different types of flexibility Long-term sustainability of a manufacturing organization is dependent upon sustainability of natural environment MS is a link between environmental excellence and operations management A new construct "environmental technology portfolio", is developed that improved both environmental and manufacturing performance A framework is proposed that can act as a tool for designing environmental performance measurement system Innovation in manufacturing process is positively related with adoption of environmentally conscious MSs MS should have regular interaction with social and regulatory issues particular environmental issues Green productivity is a paradigm shift focussing on socially appropriate production of products and consumption of resources	Env in general
Global manufacturing	Global infrastructural choices	Fawcett (1993), Shi (2003), Palaniswami and Lingaraj (1994)	There exists a potential tradeoff between reduction in manufacturing costs and increases in logistics costs in global operations A framework comprising manufacturing value creation process, internationalization process, and inter-firm collaboration formation process is proposed to tackle international manufacturing issues Implications of international sourcing systems on firms' performance are explored especially those firms which are revitalizing through FMS, JIT and TQM	Ec in general and Ec9 in particular

(*continued*)

Table VIII.

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
	Global structural choices	Vos (1991), Skalbeck and Vora (1990), Verter and Dincer (1992), Kotabe and Swan (1994), Haung (1992)	An approach for production allocation in global operations is proposed based on economic and non-economic (labor supply; government regulations; community attitudes; infrastructural facilities; availability of land, room for expansion; and organizational structure of the firm)	Ec7, 9
			Transnational production sharing can become an integral part of operating strategy of a manufacturing firm and different practices can be deployed for this purpose	Ec9
			An integrated analysis of capacity, technology and location is necessary for designing global MSs	Ec9
			US firms and their foreign affiliates are moving toward global rationalization in technology development and global sourcing relationships	Ec7, 9
			A mathematical model is presented for making international location decisions based on variable costs and a set of assumptions	
	Global manufacturing strategies	Miltenburg (2009), Buxey (2005), Bolisani and Scarso (1996), Klassen and Whybark (1994), De Toni *et al.* (1992), Ferdows *et al.* (1986), Vereecke and Dierdonck (2002), Vereecke *et al.* (2006)	A framework linking MS objects (generic international strategies, manufacturing networks, network manufacturing outputs, network levers, network capability, and factory types) is proposed for examining international manufacturing network	Ec in general and E9 in particular
			Textiles, clothing and footware production is increasingly being offshored via subcontracting and under "badging" of foreign designs. To survive, local firms should focus on quality or customer service for niche markets to develop technologically advanced products	
			Organizations go for offshore production for cost benefits, market seeking, or strategic assets seeking purposes	
			Some barriers to international operations include: lack of global view, lack of MS, managing international networks	
			Besides competitive priorities of cost, quality, delivery, and	

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			flexibility, other factors that influence internationalization decision to include: market orientation, experience, and product characteristics Global MSs by firms in Western Europe, America and Japan are identified and projects are made to how these MSs and needed capabilities may change in future A tool for operationalizing Ferdow's model of international plants is proposed and shortcomings in the model are identified A typology of plants, operating in international networks, is developed based on knowledge flows between them	
	Global supply-chain management	Fawcett and Closs (1993), Arntzen *et al.* (1995), Hammami *et al.* (2008)	Logistics plays an important support role in a firm's total-effort to coordinating global production operations A global supply-chain model (GSCM) was used by Digital Equipment Corporation for determining its global manufacturing and distribution strategy Guidelines and recommendations are provided as regard designing global supply-chains based on analytical models	Ec in general and E9 in particular
Literature reviews		Adam and Swamidass (1989), Dangayach and Deshmukh (2001a), Swink and Way (1995), Minor *et al.* (1994), Skinner (2007)	Analyzing the "content" and "process" variables used within literature, gaps were identified and new themes for future research were provided MS literature was review utilizing Voss (1995) framework of MS paradigms The state of empirical research in MS is captured and future research directions and propositions are provided The story of the evolution of MS is presented	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
SP				
Strategy formulation	Conceptual approaches and framework	Wang and Cao (2008), Papke-Shields *et al.* (2006), McCarthy (2004), Ketokivi and Schroeder (2004), Swamidass *et al.* (2001), Menda and Dilts (1997), Kim and Arnold (1996), Mills *et al.* (1995), Platts (1993), Ho (1996), Adamides and Pomonis (2009), Kiridena *et al.* (2009)	While planning for MS, the mediating role of competitive priorities is not suitable in the case of manufacturing paradigms There exist four strategic manufacturing planning groups in industry that vary w.r.t. the degree of "rationality" and "adaptability" in planning. Moreover, the planning process evolves over time Manufacturing organizations are considered as complex adaptive systems and a fitness landscape theory is proposed for MS formulation Institutional perspective explains variances in the adoption and implementation of manufacturing practices more than explained by strategic or structural contingency perspectives Manufacturers use one of the following alternatives with or without a top-down approach to develop MS: a coherent set of actions, manufacturing/process improvement programs, developing core MCs Building upon Hill (1989), an expanded MS formulation process is developed A process model of formulating MS is proposed that more closely links competitive priorities with action programs A framework is proposed for assisting in designing MS processes that proves useful in identifying gaps in past strategy analysis and ongoing formation of strategy MS is found to have negative correlation with environmental uncertainty and managerial choice in the contingency model. MS is an evolutionary process that emerges as a result of fitness among product, process and supply-chain decisions	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Deeper structures in MS processes represent a progression of strategic initiatives in four phases namely: initiation, consolidation, commitment, and realization affected by nature of initiatives, causal relationships between phases and internal and external contextual factors	
	Methods	Barad and Gien (2001), Crowe and Cheng (1996), Mills *et al.* (1998), Chiadamrong (1999), Lee *et al.* (2002)	A QFD based methodology is proposed to link improvement needs of strategy level with the operational level in manufacturing firms, as well as strategic planning A method for representing MS content is developed that provides traceability of action plans as well as feedback for strategy improvement A fuzzy multi-criteria decision support method is developed for MS selection A simulation-based model is developed for MS formulation through what-if analysis under dynamic manufacturing environment	Ec7 in general
Strategy formulation	Alignment of MS with business strategy	Joshi *et al.* (2003), Ward and Duray (2000), Tunalv (1992), Anderson *et al.* (1991)	Misalignment between strategic and operational levels is detrimental to manufacturing performance; however organizational factor such as tenure of manufacturing manager and association with organization moderate this relationship The relationship between competitive strategy and performance is mediated by MS Firms with MS are more successful in their business performance as well as place high importance on preventive quality programs	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Manufacturing managers should get involved in the making of business strategy. Moreover, MS formulation process should be improved by linking with various functional strategies	
	Alignment of MS with other functional strategies	Fry *et al.* (1995), Tayles and Walley (1997), Santos (2000), Kathuria and Igbaria (1997), Hausman *et al.* (2002), Berry *et al.* (1999), Bozarth and Berry (1997), Weir *et al.* (2000), Adamides and Voutsina (2006)	Standard cost accounting systems are not consistent with plant characteristics and do not support MS Emphasis of management accounting practices may change with changing competitive, marketing and MSs Concurrent existence of manufacturing priorities (cost, quality, flexibility, and delivery) causes contradictions for human practices. Coherence is required in such cases Success of IT applications in manufacturing organizations depends upon their fit with MS (competitive priorities and process structure) Harmonized working between marketing and manufacturing has mediating impact on marketing – manufacturing interface morale and business performance The need and methodologies for aligning MS with marketing strategy and needs In UK manufacturing firms, functional strategies are not developed separately from business strategy, but are sections of the business plan developed by managing director MS and marketing strategy co-evolve as resource and capability building processes A double helix model is proposed for managing marketing and MSs in a co-evolutionary way	Ec in general
	Alignment of MS with manufacturing task	Kathuria and Porth (2003), Swink *et al.* (2007), Martinez-Olvera (2010), Choudhari *et al.* (2013), Rosenzweig *et al.* (2003)	Alignment between manufacturing managers and MS is important in order to avoid pursuing dissimilar strategies Each strategic integration type (corporate, suppliers, customers, and product-process) has related costs/benefits on business performance mediated by MCs	Ec in general

(*continued*)

Table VIII.

Major theme	Subtheme	Selective papers	Main research findings from salient papers	Coverage to future challenges
			Impact of misalignment between strategic and operations levels of a manufacturing firm is gauged through simulation models on business performance A framework covering six decision areas within MS is developed for designing constructs and conducting empirical research	
	Miscellaneous	Fine and Hax (1985), Barker (1990), Brown *et al.* (2007), Prochno and Corrêa (1995), Paiva *et al.* (2008), Acur *et al.* (2003), Platts and Gregory (1990)	A methodology for designing and implementing MS is developed and tested in an actual manufacturing environment An input adaptive strategy for implementing MS is proposed World class plants incorporate both strategic operations content and operations processes while low performing plants do not In turbulent environments, the development of MS calls for proactivity and inter-functional communication An organizational knowledge ("know what" and "know how") based process is proposed for formulating MS Competitive priorities, improvement goals and action programs are significantly better aligned in firms having formal strategy Supply-chain integration leads to improved business performance An approach for auditing MS formulation processes is developed	Ec in general
Strategy justification and implementation		Hallgren and Olhager (2006b), Thun (2008), Tan and Platts (2004), Ketokivi and Heikkila (2003), Gianesi (1998)	A quantification framework and approach is developing for measuring, linking, comparing, and modeling MS related issues Intensity of competitiveness has an impact on the choices taken in MS A software tool is proposed for generating action plans in relation to MSs A management tool is proposed for linking operational actions with operational performance A need of formal mechanisms for integrating operations decisions horizontally with other functions and vertically within manufacturing function is raised	Mostly Ec7

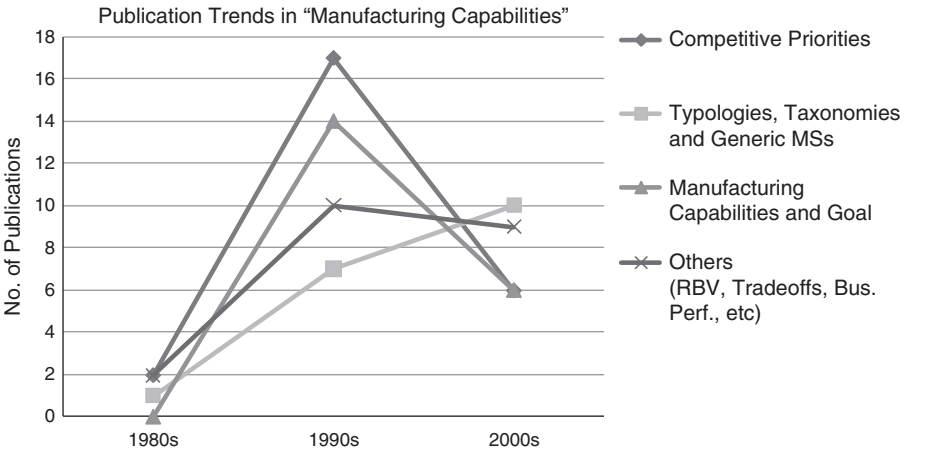

Figure 4.
Publication trends in "competing through manufacturing"

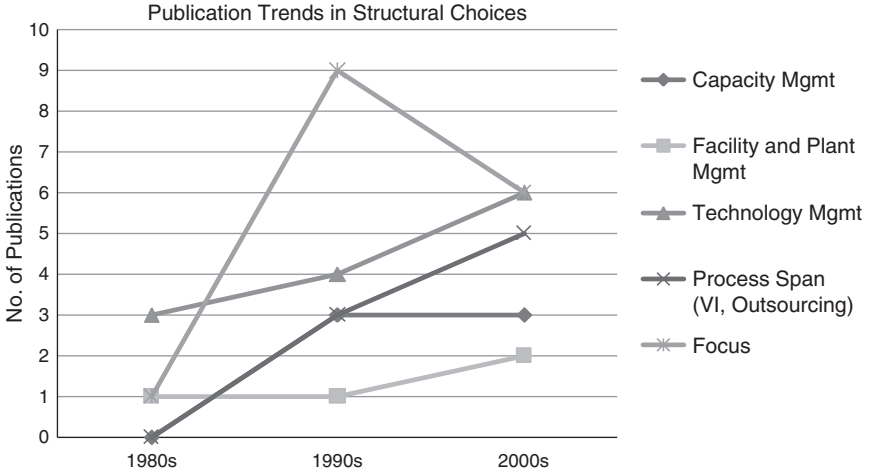

Figure 5.
Publication trends in structural choices

mass servers, and specialized contractors based on realized strengths of firms rather than competitive capabilities (Frohlich and Dixon, 2001). A number of such configurations have been identified by researchers (as shown in Table VIII), and they render corresponding capabilities and competitive advantage to manufacturing firms, mostly from the economic perspective.

MCs and Goal is another subtheme that constitutes 24 percent of the publications within the major theme of MCs. Research interest in this subtheme is, however, declining with time and across the regions (Figure 4, Table VII). Manufacturing organizations need to align their structure and capabilities with BS in order to gain a competitive advantage (Choe *et al.*, 1997; Kim and Arnold, 1993). MCs are built through resource improvement, quality management programs, and advanced process technology (Roth and Miller, 1992). Different MCs and competitive practices realize different product differentiation (Swink and Hegarty, 1998) and correspond to specific

evolutionary stable MSs (Jayanthi *et al.*, 2009). MCs literature mostly informs what capabilities are required to realize certain competitive priorities. Another stream of literature related to capabilities is tradeoff vs cumulative capability theories. There is growing evidence in literature of cumulative capabilities (Amoako-Gyampah and Meredith, 2007; Rosenzweig and Roth, 2004; GroBler and Grubner, 2006), though these days support for tradeoff theory appears only rarely in literature (Da Silveira, 2005a, b). Recently, the role of knowledge and learning in manufacturing organizations has been emphasized under the umbrella of resource-based view. It is argued that lean management practices focus more on tacit knowledge while mass customization focusses more on explicit knowledge of organizations (Henriksen and Rolstadas, 2010). Similarly, internal and external learning drive proprietary processes and equipment, which bring about competitive advantage for a manufacturing firm (Shaw and Edwards, 2005).

SCs. This major theme constitutes 25 percent of the publications and thus makes up the largest body of knowledge in MS literature. Overall, the interest in this theme is declining with time (Figure 2). Geographically, NAs have shown continuously declining interest since the 1980s, whereas Europeans show a persistent interest since the 1990s. SCs can be divided into two subthemes: SLCs and ICs.

SLCs. SLCs constitute 37 percent of publications within the major theme of SCs. Research interest in this subtheme is growing with time and across geographical regions of Europe and NA. This subtheme is further divided into the following topics: capacity choices, facility choices, technology choices, process span (that includes decisions regarding vertical integration and outsourcing), and process focus.

Capacity choices constitute 13 percent of the publications within SLCs. The research interest in this area is persistent since 1990s (Figure 5). Europe has focussed more on capacity choices than NA. Salient topics researched to date include, but are not limited to: capacity allocation decisions in make-to-stock and make-to-order businesses (Gupta and Wang, 2007), sourcing vs capacity management in the light of product development and technology management (Dekkers, 2002), and strategic capacity management, including perspectives of MS, sales, and operations planning (Olhager *et al.*, 2001).

Facility choices include 9 percent of the studies, which makes it the least researched area within the SLCs. Only NAs have studied this subtheme. Important topics studied to date include: type of plants and their characteristics (Schmenner, 1982), dynamic layouts of plants (Montreuil and Venkatadri, 1991), and plant location decisions (Elango, 2005). Mostly, this subtheme has been studied from the economic perspective; however, some considerations of human capital while taking plant-related decisions have also been made (Elango, 2005).

Technology choices constitute 28 percent of the studies within SLCs. Research interest in this topic is increasing gradually – in absolute figures (Figure 5). Salient topics studied to date include: the relation of automation with manufacturing performance (Safsten *et al.*, 2007), technology choice driven by marketing strategy and MS (Meredith *et al.*, 1986), and the importance of plant context in choosing process technology (Sonntag, 2003) to name a few. Most studies in this theme focus on providing analytical tools for making decisions; however, some studies also consider human capabilities and social factors (see Table VIII). There are hardly any studies that focus on the interplay between technology choices and the agile and dynamic capabilities required by today's manufacturing organizations. Apparently, overall the tilt of studies is toward the economic perspective without any due considerations for the social and environmental perspectives.

Another important choice within SLCs is process span. This includes outsourcing vs vertical integration decisions and constitutes 17 percent of the publications in SLCs. Research interest in this topic is growing with time and across both NA and Europe (Figure 5, Table VII). Vertical integration is one of the least studied topics. Within outsourcing, the topics that have been studied include enablers and barriers of outsourcing (Kumar *et al.*, 2010); phases of development, engineering, and production planning in outsourcing situations (Dekkers, 2000); and competitive priorities and outsourcing (Gray *et al.*, 2009) to name a few. A very limited number of studies focus on analytical models for outsourcing decisions.

The most researched choice within SLCs is focus (34 percent). Focus pertains to orientation and organization of the production process. Research interest in this area has been declining during the 2000s (Figure 5, Table VII). As far as regional interest in this theme, Europe shows a growing and NA shows a declining interest. Some topics that have been studied to date include: the relationship of process choice with competitive priorities of quality and cost (Safizadeh *et al.*, 1996), the criteria for making focus decision (Hallgren and Olhager, 2006a), a framework for designing factory within a factory (Miltenburg, 2008), and moderators of the relationship between environmental flexibility and process focus (Flynn and Flynn, 1999). It appears that a significant portion of the literature on process focus is related to the impact it has on MCs and performance.

ICs. ICs constitute 63 percent of the publications within SCs. Research interest in this subtheme has slightly reduced since the 1990s. Region wise, the interest is persistent in NA, while Europeans show declining interest. This subtheme comprises the following topics: planning and control, organization, human-resource management, sourcing, and PPD.

Planning and control embodies the biggest chunk of publications (61 percent) within the ICs. Research interest in planning and control is stagnant in percentage terms since the 1990s and is declining in absolute figures (Figure 6, Table VII). Both regions, Europe and NA, are showing a growing interest in this topic. Planning and control

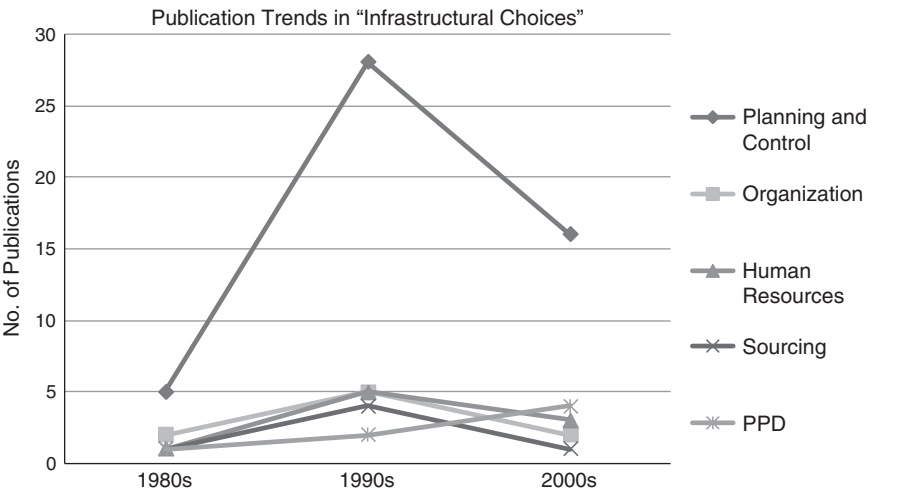

Figure 6.
Publication trends in infrastructure choices

comprises the following subtopics: strategic manufacturing planning; quality and productivity; PPC; and budget, accounting, and cost control.

Some topics that have been studied within strategic manufacturing planning include: strategic analysis and manufacturing development (Hill and Westbrook, 1997), a strategic control approach for product and/or process decisions (Li *et al.*, 2005), linking strategic planning with BS (Garvin, 1993), and strategic analysis of integrated production – distribution systems (Cohen and Lee, 1988).

PPC is the most studied area within planning and control, and research interest is growing with time and across regions. Some salient topics of study within PPC include push and pull control systems (Olhager and Ostlund, 1990; Ozbayrak *et al.*, 2004; Persentili and Alptekin, 2000), order-fulfillment strategy in an environment of high product variety (Pil and Holweg, 2004), production scheduling (Ronen and Rozen, 1992), and forecasting (der Meijden *et al.*, 1994).

Another area of study within planning and control, and the least studied one, is productivity and quality management (Table VII). Salient topics studied to date include strategies for optimizing total productivity of firms (Brown, 1998) and the effect of worker knowledge on quality and productivity (Gunasekarar *et al.*, 1994). Budget, accounting, and cost control contain the following main topics: the effect of financial accounting and costing on operations decisions (Fry *et al.*, 1998), system dynamics as a tool for reducing cost and improving product diversity (Ozbayraka and Akgun, 2006), PPC strategies, and financial performance (Storck, 2010) to name a few.

As can be seen from Table VIII, the coverage of topics in planning and control is only from the economic perspective. Even the topics do not focus on any specific challenge of the economic perspective as outlined in Table I. Moreover, the social and environmental perspectives are found to be completely missing.

"Organization" constitutes 11 percent of the publications within infrastructural decisions (Table VII). Research interest in this topic is declining with time and across regions. Some of the salient topics studied to-date include: the impact of BPs on the organization of the manufacturing function (Bates *et al.*, 1995), organization culture and MS (Harrison and Storey, 1996), communication and coordination mechanisms in distributed organization (Mascarenhas, 1984), and institutional changes and teamwork (Tranfield and Smith, 2002). Though the magnitude of research in this area is much lower, it is envisaged that this area holds significant research opportunities in the future for conceptualizing a global and networked organization of manufacturing firms with an enhanced need of coordination, teamwork, (de-)centralization, and organizational culture.

HR choices constitute 11 percent of the publications in ICs. Research interest is almost stagnant with time and across geographical regions (Table VII). Salient topics studied to date include, but are not limited to, allocation of permanent or temporary workers (Stratman *et al.*, 2004), HR system and manufacturing performance (Youndt *et al.*, 1996), HR practices and MS implementation (Kinnie and Staughton, 1993), and executive involvement in strategy alignment (Papke-Shields and Malhotra, 2001). The need to understand HR practices and choices becomes inevitable when organizations are operating in a global environment.

Sourcing is the least researched topic within ICs, and it constitutes 8 percent of the publications. Research interest is declining with time and across regions. Topics studied to date include strategic sourcing for volume and modifications (Narasimhan and Das, 1999), criteria for selecting vendors (Weber *et al.*, 1991), and supplier base and

quality requirements (Kekre *et al.*, 1995). The authors of this paper envisage that strategic sourcing and vendor management can be a source of competitive advantage in the future, especially in an era of globalization, and should be researched as such.

An emerging topic within the ICs is PPD. It constitutes around 9 percent of the publications within ICs; however, the interest is growing with time and across geographical regions. Salient topics studied to date include: framework for process development (Lu and Botha, 2006), order penetration point in the manufacturing value chain (Olhager, 2003), and product development cycle time (Jun *et al.*, 2005). This area is envisaged to be of high importance in the future while visualizing a global manufacturing enterprise in which geographically distributed firms would engage in concurrent engineering of products and processes.

Manufacturing BPs. Manufacturing BPs is the second largest area and constitutes around 23 percent of the publications in MS literature (Table VII). Research interest is growing across the world. This includes a multitude of practices grouped into the following subthemes, agile, mass customization and virtual manufacturing; advanced manufacturing technology (AMT) and information systems; computer integrated manufacture (CIM); flexible manufacturing systems (FMS); just-in-time (JIT), lean and cellular manufacturing; world class manufacture (WCM); and miscellaneous. Each one of these subthemes is discussed below.

Agile manufacturing is emphasized to address the challenge of high volatility and uncertainty in the business environment expected in the future. Interest in this subtheme started only during the 2000s; however, it stands now as one of the most researched BPs to date (Figure 7, Table VII). All three geographical regions have shown interest in this BP. According to Gunasekaran and Yusuf (2002) mass customization, teamwork, and virtual organization are all enablers of agility. Salient topics researched to date include: taxonomy of agile manufacturers (Zhang and Sharifi, 2007), network innovation agility (Lin, 2004), manufacturing routines and capabilities for strategic agility (McCarthy and Tsinopoulos, 2003), agile practices and organizational outcomes (Brown and Bessant, 2003; Vázquez-Bustelo *et al.*, 2007), and measurement of virtuality (Webster *et al.*, 2004). Similarly, within mass customization, important topics studied to date include tradeoffs between mass customization and manufacturing cost and delivery

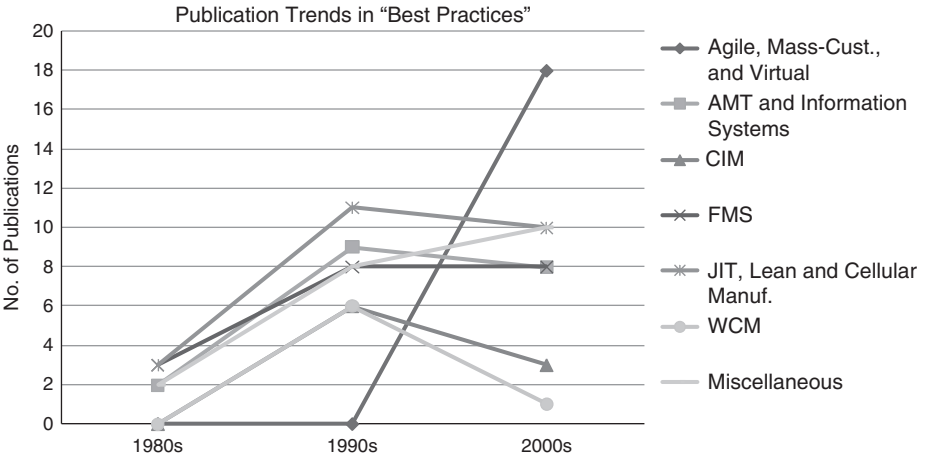

Figure 7.
Publication trends in best practices

(Squire *et al.*, 2006), the customization process (Spring and Dalrymple, 2000), and mass customization and financial performance (Duray, 2002).

Another significant subtheme, AMT and information systems, constitutes 16 percent of the publications in BPs. Research interest in this subtheme is gradually declining with time and across Europe and NA. Others started research in this subtheme during the 2000s. Salient topics include decision support tools assessing investment in AMT (Kengpol and O'Brien, 2001; Krinsky and Miltenburg, 1991), AMT implementation (Voss, 1986), and the impact of decentralization on AMT (Gupta *et al.*, 1997). Similarly, in information systems some of the researched topics include developing an ERP competence construct (Stratman and Roth, 2002), information systems and agility (Mondragon *et al.*, 2004), and e-BS (Olhager and Rudberg, 2002a).

FMS constitutes 16 percent of the publications within BPs. Overall the research interest in this stream of research is declining with time (Figure 7). NAs seem to be reviving interest in this area during the 2000s, while Europeans and Others show continuously declining interest (Table VII). Salient topics researched to date include interfacing MS and manufacturing system design (Geiskopf *et al.*, 2009), reconfigurable manufacturing systems (Bi *et al.*, 2008), the organic model of a production system (Demeester *et al.*, 2004), measuring the flexibility of production system and machines (Mohamed *et al.*, 2001), and worker resistance to FMS (Gupta, 1989).

CIM constitutes 8 percent of the publications within BPs. CIM envisioned broadening the scope of AMT and FMS from the production floor to the organization level encompassing computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided process planning (CAPP) in its premise. The analysis reveals that little interest was shown by management researchers in CIM during 1990s, which further declined during 2000s. CIM community has published in the areas such as product modeling, process modeling and its execution, reconfigurable and flexible systems, enterprise architectures, interoperability, and enterprise ontology. CIM community visualizes that competitive advantage for manufacturing organizations lies in integration of stand-alone automated manufacturing and management systems. Research interest in CIM is declining with time and across geographical regions. Important topics researched to date within the context of MS include: architectures and tools of enterprise engineering (Mertins and Jochem, 2005), implementation of CIM (Milling, 1997; Rowlinson *et al.*, 1994), and CIM and product and process design (Hitomi, 1991).

JIT/Lean/Cellular is the most researched subtheme within MS literature, constituting 21 percent of the publications. Research interest in this area is growing, in absolute figures. Lean combines the concepts of JIT and cellular manufacturing, re-incarnates the fundamental philosophy of appropriately organizing resources, devising operating policies and causing continuous improvements, and at the same time offers a methodology to implement lean management principles. Salient topics researched to date include, the role of JIT in quality implementation, waste reduction, and continuous improvement (Fullerton and McWatters, 2001); inventory control and JIT (Prasad, 1995); indicators of lean production (Bartezzaghi *et al.*, 1992); leagile manufacturing (Hines *et al.*, 2002); clustering algorithm for forming cells (Goncalves and Resende, 2004); and human issues in cells (Krishnamurthy and Yauch, 2007).

SCM. This theme constitutes about 3 percent of the publications in MS literature (Table VII). SCM is identified as a separate theme for the reason that it focusses on the inter-operations of multiple firms rather than the operations of a single firm.

The interest in this theme is growing with time and across the regions. Some salient topics studied to date include the integration of physical and information flows in a supply-chain (Caniato *et al.*, 2009), inter-organizational information systems (Cagliano *et al.*, 2006), supply chain design with innovation and cost focus (Da Silveira and Cagliano, 2006), and postponement and speculation strategies in supply chains (Pagh and Cooper, 1998). These topics highlight joint operations, performance measures, and competitive priorities. Thus, it is hoped that further research in this theme will allow understanding the type of relationships among supply chain partners in the developed and the developing countries and understanding the factors that enable or inhibit these relationships.

Performance measurement. This theme constitutes 2 percent of the publications in MS literature, and the research interest is growing with time and across geographical regions. Salient topics studied to date include developing countries and manufacturing performance (Amoako-Gyampah and Acquaah, 2008), a quantitative model of MS performance measurement (Sarkis, 2003), time-based performance measurement (Barker, 1993), the relationship of performance measurement with MS realization (Neely *et al.*, 1994), and performance measurement and continuous improvement (Hyland *et al.*, 2007). Because of the fundamental and pervasive nature of this theme, its importance is envisaged by the authors of this paper to be paramount and highly significant in meeting the challenges facing future manufacturing enterprise.

Transnational comparisons. This theme constitutes 4 percent of the publications in MS literature, and the research interest is growing with time (Table VII). Of the three regions, NA has focussed the least on this theme. The theme mostly corresponds to exploring MS practices in various countries, for example, pursuit of excellence and focussing on quality and delivery in Spain (Avella *et al.*, 2001); quality, high innovation rate, faster product development, and continuous improvement as competitive priorities in India (Dangayach and Deshmukh, 2006); customer focus, quality, and technology focus as competitive priorities in Australian and European firms (Mellor and Gupta, 2002); process control as a fundamental strategy in Japan (Voss and Blackmon, 1998); worker motivation and process quality in Sweden (Horte *et al.*, 1987); low price and aesthetic designs in Denmark (Christiansen *et al.*, 2003), and product quality and low cost in the US electronics industry (Lau, 2002). With globalization, there is a growing need to empirically test existing models and develop new models for investigating relationships among business performance, MS, manufacturing performance, and action programs in developing country scenarios.

Environment/green manufacturing. This is a new theme and it constitutes 2 percent of the publications in the MS literature. The interest started during the 1990s, and, of the regions, NA and others have shown a slight research interest. Salient topics studied to date include unpredictability and volatility as two dimensions of environmental uncertainty (Anand and Ward, 2004), sustainable manufacturing organization and environment (Sarkis, 2001), environment technology portfolio as a new construct for joint environment and manufacturing performance (Klassen, 1993), innovation and environmentally conscious MSs (Azzone and Noci, 1998), capabilities for green manufacturing (Florida, 1996), and a four-phase model for realizing green productivity (Mohanty and Deshmukh, 1998).

Global manufacturing. This theme constitutes 6 percent of the publications in MS literature. Research interest has declined during the 2000s. NAs are showing a declining interest; however, Europeans and others are showing persistent interest.

The following subthemes seem to be emerging from the literature: global SLCs, global ICs, global MSs, and global SCM.

Within global ICs, topics that have been studied to date include tradeoffs between manufacturing and logistics costs (Fawcett, 1993), the inter-firm collaboration and value creation process (Shi, 2003), and international sourcing and firm performance (Palaniswami and Lingaraj, 1994). Similarly, topics within global SLCs include production allocation (Vos, 1991), transnational production sharing (Skalbeck and Vora, 1990), integrated analysis of capacity, technology and location in global operations (Verter and Dincer, 1992), and rationalization of technology development (Kotabe and Swan, 1994). Significant research opportunities exist in all facets of the global infrastructural and SLCs.

About one-half of all publications in global manufacturing are dedicated to global MSs. Research interest is growing since the 1990s. Topics researched to date include, but are not limited to, framework for analyzing international manufacturing networks (Miltenburg, 2009), barriers to international operations (Klassen and Whybark, 1994), determinants of internationalization (de Toni *et al.*, 1992), global MS in various countries (Ferdows *et al.*, 1986), and typology of international plants (Vereecke *et al.*, 2006). Clearly, there exist significant opportunities for research in this subtheme.

Likewise, researchers have also focussed on global SCM issues. Topics such as coordination of global production operations (Fawcett and Closs, 1993) and designing global supply-chains (Hammami *et al.*, 2008) have been discussed. There is a need of developing frameworks for manufacturing network operations that emphasize communication, collaboration, and coordination for their effective performance.

SP. Besides MS Content, the SP as the second pillar stone of MS constitutes 15 percent of the publications in the MS literature. The interest in SP is growing with time and across the geographical regions (Figure 3, Table VII). The subthemes abstracted from the MS literature are formulation, and justification and implementation.

A major chunk of publications in SP belongs to strategy formulation: 88 percent. Research interest is growing in NA, however, declining in Europe and others (Figure 8, Table VII). This subtheme embodies literature on three topics: conceptual approaches

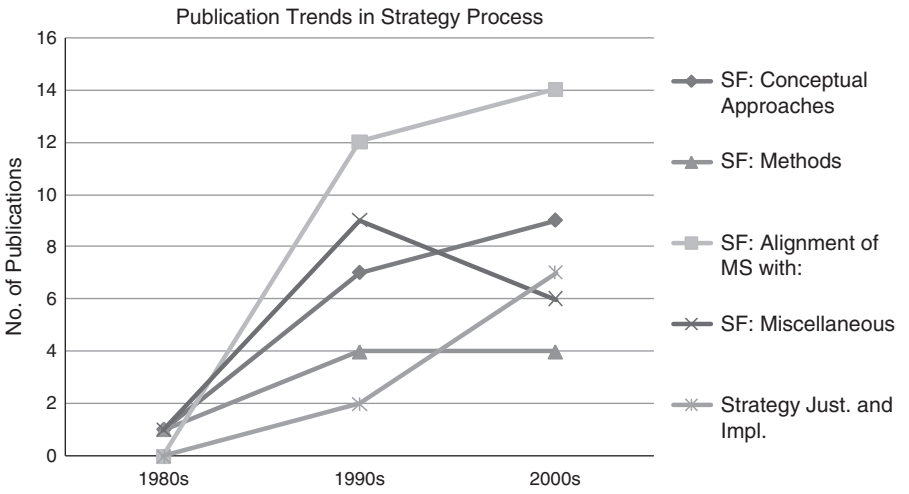

Figure 8.
Publication trends in strategy process

and frameworks on which to base the strategy formulation, methods used for formulating strategy, and alignment of MS with other organizational components. Within conceptual approaches for MS formulation, important topics studied to date include the mediating role of competitive priorities in the planning of MS (Wang and Cao, 2008), the type of organizations with respect to strategy planning (Papke-Shields *et al.*, 2006), complex adaptive systems as a theory to formulating MS (McCarthy, 2004), institutional and contingency perspectives on MS (Ketokivi and Schroeder, 2004), a process model for formulating MS (Platts, 1993; Kim and Arnold, 1996), an evolutionary model of MS (Adamides and Pomonis, 2009), and deeper structures in MS processes (Kiridena *et al.*, 2009). The approaches utilize economic perspective alone and are not taking into consideration social and environmental perspectives. Though the need of theory development in operations management (of which MS is a sub discipline) was emphasized during the early 1990s (Swamidass, 1991), this analysis shows that interest in explaining MS in the light of organizational behavior theories is growing.

Similarly, a number of methods have been utilized for formulating strategy that include quality function deployment (Barad and Gien, 2001; Crowe and Cheng, 1996), a method for traceability of action plans and MS content (Mills *et al.*, 1998), a fuzzy multi-criteria decision support method (Chiadamrong, 1999), and simulation-based models (Lee *et al.*, 2002).

The subtheme of alignment of MS with other organizational components constitutes 38 percent of the publications within strategy formulation. Overall research interest is growing with time (Figure 8, Table VII). This subtheme comprises alignment of MS with BS, other functional strategies, and the manufacturing task or the function itself (Adam and Swamidass, 1989). Salient topics researched to date within alignment of MS with BS include the misalignment of strategic and operational levels and manufacturing performance (Joshi *et al.*, 2003), the mediating role of MS in competitive strategy and performance (Ward and Duray, 2000), and the involvement of manufacturing managers in the making of BS (Anderson *et al.*, 1991).

Similarly, the alignment of MS with other functional strategies is a much researched area. The alignment of MS with the following functions has been investigated: cost accounting systems (Fry *et al.*, 1995; Tayles and Walley, 1997), human practices (Santos, 2000), IT applications (Kathuria and Igbaria, 1997), marketing (Hausman *et al.*, 2002; Berry *et al.*, 1999; Adamides and Voutsina, 2006), and design (Pilkington, 1999). The literature reveals that alignment of manufacturing with marketing and costing has received the most investigation.

Consistency among components of manufacturing function and their alignment with MS is another important area (Adam and Swamidass, 1989). Within the domain of alignment, it is the least investigated topic, although there do appear to be some publications in this area during 2000s. Some of the topics investigated to date include alignment of manufacturing managers with MS (Kathuria and Porth, 2003), alignment between strategic and operations levels in a manufacturing firm (Martinez-Olvera, 2010), and six decision areas within MS and designing of constructs for their empirical investigation (Rosenzweig *et al.*, 2003). This subtheme remains open for future research, especially with respect to investigating involvement of shop floor workers in MS development, and coherence among components of production system and their impact on MS formulation, to name a few.

Last but not the least, within the theme of SP, is the subtheme of strategy justification and implementation. Strategy justification involves aspects of quantifying

and decision making during strategy implementation. This subtheme constitutes 12 percent of the publications within the SP. Interest is growing with time and across Europe and other areas around the world. Important topics investigated to date include: a quantification framework for developing and implementing MS (Hallgren and Olhager, 2006b), generating action plans in relation to MS (Tan and Platts, 2004), and linking actions with performance (Ketokivi and Heikkila, 2003).

4.4 Advanced cross-tabulations

Table IX provides results of a cross tabulation of themes with type of research design. The table presents the extent to which a theme has been studied using different research designs. The results show that overall empirical studies constitute about 40 percent of the studies, the remaining being conceptual studies. There are a very limited number of studies that use mixed method (qualitative and quantitative methods) of research design. The gray shaded cells (in the percentage table) highlight research designs that have been utilized the least (after mixed method) for each theme, thus identifying research gaps from the methodological viewpoint.

5. Discussion on research findings and future research directions

One objective of this research is to make an analysis of the extent to which existing MS literature provides thematic coverage to the challenges (from economic, social, and environmental perspectives) posed to manufacturing organizations in the future. Another complementary objective is to identify trends and patterns of the evolution of thematic areas of study in MS literature with time and across geographical regions. A summary of the major research findings is provided in Table X.

The following discusses these research findings and provides broader research directions for meeting challenges posed to the manufacturing enterprise of the future.

5.1 Integrated view of MS

MS literature to date has mostly focussed on the economic perspective of manufacturing organizations. The importance of adopting societal and environmental practices in the context of operations management has been discussed in the past. For example, Angell and Klassen (1999) provide a research agenda for considering environmental issues in structural and infrastructural decisions. Kleindorfer *et al.* (2005) provide a review of research in sustainable operations management published within the *Production and Operations Management* journal and conclude that "we are just beginning to understand and map the territory for sustainable OM." Environmental sustainability is a fertile area for academic research; it has the potential to impact government policies, and identify new business models and manufacturing operations (Linton *et al.*, 2007). It has been argued that in the future the sustainability of manufacturing firms would depend upon the sustainability of their environment (Sarkis, 2001; Florida, 1996). Thus, the economic value generated by firms at high social and environmental costs would undermine the very existence of the firms in the future. Therefore, it is important for the manufacturing enterprise of the future to have an integrated development view in which the economic, societal, and environmental perspectives are intertwined. In the future, the economic, social, and environmental perspectives would need to be measured jointly in terms of the economic, social, and environmental value generated (Klassen and Whybark, 1999; Garetti and Taisch, 2012; Berlin *et al.*, 2013). Social and

Table IX.
Cross tabulation of major themes with type of research design

Major themes	Conceptual qualitative	Conceptual quantitative	Empirical qualitative	Empirical quantitative	Empirical mixed method	Total
MS components and paradigms	4	2	0	3	0	9
Manufacturing Capabilities	24	24	9	20	7	84
Competitive priorities	6	3	3	9	4	25
Typologies, taxonomies and Generic MSs	6	8	0	3	1	18
Manufacturing capabilities and goal	7	7	3	1	2	20
Others (RBV, tradeoffs, bus. perf., etc.)	5	6	3	7	0	21
Strategic choices	35	46	19	23	4	127
Structural choices	8	15	13	9	2	47
Infrastructural choices	27	31	6	14	2	80
Best practices	34	32	20	27	3	116
Agile, mass-cust., and Virtual Manuf.	4	4	3	7	0	18
AMT and Information Systems	8	1	2	7	1	19
CIM	4	1	2	2	0	9
FMS	5	11	2	1	0	19
JIT, lean and cellular manufacturing	4	11	3	5	1	24
WCM	3	0	2	2	0	7
Miscellaneous	6	4	6	3	1	20
Strategy process	23	18	16	20	0	77
Strategy formulation	20	16	14	18	0	68
Strategy justification and implementation	3	2	2	2	0	9
Supply chain management	3	8	0	2	0	13
Performance measurements	2	6	1	3	0	12
Transnational comparisons	1	8	1	9	1	20
Environment/green	6	2	2	1	1	12
Global	7	6	10	3	2	28
Literature review	7	1	0	0	0	8
Total	146	153	78	111	18	506

(*continued*)

Table IX.

Major themes	Conceptual qualitative (%)	Conceptual quantitative (%)	Empirical qualitative (%)	Empirical quantitative (%)	Empirical mixed method (%)	Total (%)
MS components and paradigms	44	22	0	33	0	100
Manufacturing capabilities	29	29	11	24	8	100
Competitive priorities	24	12	12	36	16	100
Typologies, taxonomies and generic MSs	33	44	0	17	6	100
Manufacturing capabilities and goal	35	35	15	5	10	100
Others (RBV, Tradeoffs, Bus. Perf., etc.)	24	29	14	33	0	100
Strategic choices	28	36	15	18	3	100
Structural choices	17	32	28	19	4	100
Infrastructural choices	34	39	8	18	3	100
Best practices	29	28	17	23	3	100
Agile, mass-cust., and virtual manuf.	22	22	17	39	0	100
AMT and information systems	42	5	11	37	5	100
CIM	44	11	22	22	0	100
FMS	26	58	11	5	0	100
JIT, lean and cellular manufacturing	17	46	13	21	4	100
WCM	43	0	29	29	0	100
Miscellaneous	30	20	30	15	5	100
Strategy process	30	23	21	26	0	100
Strategy formulation	29	24	21	26	0	100
Strategy justification and implementation	33	22	22	22	0	100
Supply chain management	23	62	0	15	0	100
Performance measurements	17	50	8	25	0	100
Transnational comparisons	5	40	5	45	5	100
Environment/Green	50	17	17	8	8	100
Global	25	21	36	11	7	100
Literature review	88	13	0	0	0	100
Total	29	30	15	22	4	100

Table X.
Summary of major research findings

Theme/subtheme	Summary of findings
Major themes	Majority of publications belong to the three themes of manufacturing capabilities (17%), strategic choices (25%), and best practices (23%) Emerging new themes include: supply-chain management, global manufacturing, and environment/green manufacturing Overall, NA has focussed more on the themes of manufacturing capabilities and strategic choices, while Europe has focussed more on best practices and strategy process. More recently, both NA and Europe are focussing on the themes of strategic choices and best practices the most Most literature focusses on economic perspective. Social and environmental perspectives have not been studied in MS literature to any significant extent
MS components and paradigms	Embodies mostly seminal papers Three paradigms of MS that include: competing through competitive priorities, competing through strategic choices and competing through best practices. These paradigms though have room to accommodate the social and environmental perspectives, have been studied only from the economic perspective
Manufacturing capabilities	
Competitive priorities	Mostly competitive priorities of cost, quality, flexibility and delivery have been investigated. Only rarely, "service" has been discussed as a source of competitive advantage Firms pursue multiple manufacturing priorities simultaneously Flexibility is the most researched competitive priority Service, innovation, and solution orientation have not been studied as competitive priorities
Typologies, taxonomies and generic MSs	Interest in this area is growing with time and across the geographical regions Configuration models play important role in developing, implementing, and changing MSs. Organizations can design generic MSs based on competitive capabilities or realized strengths
Manufacturing capabilities and goal	Research interest is declining with time and across the geographical regions Literature in this subtheme mostly informs how certain competitive priorities can be realized in a manufacturing firm There is growing evidence in literature of cumulative capabilities theory. Tradeoff theory seems to have become obsolete More recently, the role of knowledge and learning in manufacturing organizations is being explored under the umbrella of resource-based view
Others	Relationship of manufacturing capabilities with business performance

(*continued*)

Table X.

Theme/subtheme	Summary of findings
Strategic choices – structural choices	
Capacity choices	Stagnant publication trend since 1990s. Europe has focussed more on this subtheme compared to NA Capacity choices differ under MTS and MTO operational models Capacity choice is a function of perspectives of manufacturing and other organizational functions
Facility choices	The least studied area within structural choices. Only NAs studied this topic Different manufacturing objectives drive different plant characteristics Plant location decisions should consider the availability of human capital
Technology choices	Only NA and Europe have studied this subtheme Different levels of automations result into different levels of manufacturing performance Organizational, environmental and strategic context leads to technology practices. Manufacturing and marketing strategies drive process technology
Process span	Research interest is growing with time and across geographical regions Vertical integrated is one of the least studied topics in structural choices Outsourcing cause changes in development, engineering & production planning. Outsourcing decision should be driven by competitive priorities. There exist a number of enablers and barriers of outsourcing
Process focus	The most studied subtheme within structural choices. Research interest has declined during 2000s Criteria for making focus decision are provided especially based on competitive priorities of cost and quality, and environmental flexibility Major portion of literature discusses relationship between process focus and manufacturing capabilities and performance
Strategic choices – infrastructural choices	
Planning and control	Constitutes 61% publications within the infrastructural choices Both NA and Europe are showing growing interest in this subtheme Subtopics include: strategic planning & control, quality and productivity, production planning & control, accounting and cost control
Planning and control – strategic manufacturing planning	An emerging subtheme. All regions have shown interest Salient topics include: strategic analysis of manufacturing, strategic control approaches, strategic planning and business strategy

(*continued*)

Table X.

Theme/subtheme	Summary of findings
Planning and control – PPC	The most studied area within planning and control. Research interest is growing with time and across geographical regions Push and pull strategies need to be combined when pull strategy is inapplicable or product variety is high in a manufacturing environment The use of modularity depends on order-fulfillment strategy An approach for selecting production control philosophy is presented
Planning and control – productivity and quality	The least studied area within planning and control Salient topics include: strategies for optimizing total productivity of firms, plant focus results into productivity, productivity is reduced by poor management and organization, quality and productivity improve with knowledge workers and support services
Budget, accounting and cost control	Research interest is growing with time and across the geographical regions of Europe and others Salient topics include: adoption of modern accounting methods, effects of financial accounting on operations decisions, effect of push / pull strategies and flexible factory on financial performance
Organization	Research interest is declining with time and across the geographical regions Salient topics include: impact of best practices on organization, organizational culture and MS, communication and coordination mechanisms, institutional changes and teamwork
Human-resource management	Research interest is stagnant with time and across the geographical regions During 1990s, the research mainly focussed on workforce allocation, their organization, motivation, and compensation policies During 2000s, the research focussed on worker knowledge and worker requirements for best practices
Sourcing	The least researched subtheme within infrastructural choices Research interest is declining with time and across the geographical regions Salient topics include: strategic sourcing, criteria for selecting vendors, suppliers and quality, etc.
Product and/or process development	An emerging theme within infrastructural choices Research interest is growing with time and across the geographical regions Salient topics include: a framework for process development, product development cycle time, order penetration point and value chain, strategic planning of products

(*continued*)

Table X.

Theme/subtheme	Summary of findings
Manufacturing best practices	
Agility, mass customization, and virtual manufacturing	The most researched best practice during 2000s and across the geographical regions Mass customization, teamwork and virtual organization are enablers of agility Salient topics include: taxonomy of agile manufacturers, network innovation agility, manufacturing routines and capabilities for agility, agile practices and organizational outcomes, measure of virtuality, tradeoffs, financial performance and mass customization, and customization process
AMT and information systems	Another highly researched best practice. Research interest is declining with time and across Europe and NA Salient topics include: decision support tools assessing investment in AMT, AMT implementation, decentralization and AMT, ERP competence construct, information systems and agility, and e-business strategy
FMS	Another highly researched best practice with declining research interest in Europe and Other parts around the world Salient topics include: MS and manufacturing system design, reconfigurable manufacturing systems, organic model of production system, flexibility of production system, and worker resistance to FMS
CIM	Research interest is declining with time and across the geographical regions Salient topics include: architectures and tools of enterprise engineering, implementation of CIM, and CIM and product and process development
JIT/lean/cellular manufacturing	The most researched group of best practices with growing research interest JIT includes quality implementation, waste reduction, and continuous improvement. Other salient topics include: inventory control and JIT, indicators of lean production, leagile manufacturing, methods for forming cells, and human issues in cells
Others	
Supply-chain management	Research interest is growing with time and across the geographical regions Salient topics include: integration of physical and information flows in supply-chain, inter-organizational information systems, supply-chain design with innovation and cost focus, and postponement and speculation strategies
Performance measurement	Research interest is growing with time and across the geographical regions Salient topics include: MS and performance measurement, time-based performance measurement, performance measurement and continuous improvement

(*continued*)

Table X.

Theme/subtheme	Summary of findings
Trans-national comparisons	Research interest is growing with time. NA has studied this theme the least MS practices in various countries, for example: pursuit of excellence and focussing on quality and delivery in Spain; quality, high innovation rate, faster product development and continuous improvement as competitive priorities in India; customer focus, quality, and technology focus as competitive priorities in Australian and European firms; process control as a fundamental strategy in Japan; worker motivation and process quality in Sweden; low price and aesthetic designs in Denmark; product quality and low cost in US (electronics industry)
Environment/green manufacturing	Research interest started during 1990s and region wise NA and Others have shown interest Salient topics include: environmental uncertainty, sustainable manufacturing organization and environment, environment technology portfolio, innovation and environmentally conscious MSs, capabilities for green manufacturing, and green productivity
Global manufacturing	Constitutes 6% of publications in MS literature. NA is showing declining research interest while Europe and Others are showing growing interest This is an emerging subtheme and includes the following topics: global structural choices, global infrastructural choices, global MSs & global SCM
Global manufacturing – infrastructural choices	Salient topics within global infrastructural choices include: tradeoffs between manufacturing and logistics costs, inter-firm collaboration, and international sourcing
Global manufacturing – structural choices	Salient topics within global structural choices include: production allocation, production sharing, integrated analysis of capacity, technology and location, and technology development
Global manufacturing – global MSs	Constitutes about one-half of publications within the theme of global manufacturing. Research interest is growing since 1990s Salient topics within global MSs include: framework for international manufacturing networks, barriers and determinants of to international operations, global MSs in various countries, and typology of international plants
Global manufacturing – global SCM	Salient topics include: coordination of global production operations, designing global supply-chains
Strategy process	
Strategy formulation	Constitutes 82% publications within strategy process. Research interest is stagnant in NA while declining in Europe and Other parts around the world Three topics are emerging: conceptual approach and frameworks, methods for strategy formulation, and alignment of MS with other organizational components

(*continued*)

Theme/subtheme	Summary of findings
Strategy formulation – conceptual approaches and frameworks	Salient topics include: the role of competitive priorities in MS planning, organization types and strategy planning, complex adaptive systems and evolutionary approach for MS formulation, institutional and contingency perspectives on MS, process model for MS formulation, deeper structures in MS processes
Strategy formulation – methods	Salient topics include: QFD and strategy formulation, method for tracability of action plans and MS content, fuzzy multi-criteria decision making method, and simulation-based models
Alignment	Constitutes 41% of publications within MS formulation. Research interest is growing with time and in NA Includes three subthemes: alignment of MS with BS, alignment of MS with other functional units, and alignment of MS with manufacturing task
Alignment of MS with BS	Salient topics include: misalignment and manufacturing performance, involvement of manufacturing managers in making BS
Alignment of MS with other functions	Highly studied area within the subtheme of alignment. Research interest is growing with time Marketing and costing are the most researched functions. Human practices, IT, design and other organizational functions are the least studied ones
Alignment of MS with manufacturing task	The least studied topic within alignment. Research started during 2000s. Only NA and Others have shown interest Salient topics include: alignment of manufacturing managers with MS, and alignment between strategic and operational levels
Strategy Justification and implementation	Constitutes 12% publications within the strategy process. Research interest is growing with time and across the geographical areas of Europe and Others Salient topics include: quantification framework for developing and implementing MS, action plans in relation to MS, and linking actions with performance

Table X.

environmental consciousness at the business level would need to penetrate into the functional level, including manufacturing.

We envisage that the manufacturing enterprise of the future will need to develop and employ new concepts, methods and techniques at strategic, tactical, and operational levels for realizing BPs, strategies, products, and services that consider economic, societal, and environmental issues in an integrated manner. Studies that focus on apprising business executives of the inevitability of social and environmental issues in the future should be conducted:

Research Opportunity 1. Develop an integrated view of MS that explicates the interplay among economic, social, and environmental perspectives, and focusses on joint value generation and corresponding measures.

5.2 MCs

Within the capability paradigm, the configuration approaches (taxonomies, typologies, and generic MSs), and MCs and goal subthemes are growing. With continuing offshoring of manufacturing facilities to low-cost countries, MCs and standards of living are improving, and the low-cost advantage in the developing countries is diminishing (Renschler and Lawrence, 2012). Consequently, the competitive priorities of cost, quality, delivery, and flexibility are becoming insufficient to attract customers in the developed countries. Firms in the developed countries are trying to test new business models, including innovation, servitization, and solution orientation as also proposed by some research articles and industry reports (Manyika *et al.*, 2012; TiM, 2011; Kowalkowski *et al.*, 2011; Baines *et al.*, 2009; Hanisch, 2008; Kuivanen, 2008; Lightfoot *et al.*, 2013). Future research needs to substantiate whether these models can bring about competitive advantage in the long run and, if so, how they can be realized in a networked manufacturing enterprise.

Configuration models (typologies, taxonomies, and generic MSs) provide a set of competitive criteria or realized capabilities that organizations pursue in order to gain a competitive advantage. In recent times, the growing evidence in MS literature of cumulative capabilities, as compared to tradeoff theory, demonstrates that organizations are pursuing multiple capabilities at the same time (Amoako-Gyampah and Meredith, 2007; Rosenzweig and Roth, 2004; GroBler and Grubner, 2006). This makes sense because of the growing set of challenges a manufacturing firm has to face in an era of globalization marked with changing customer needs, diverse and volatile markets, uncertainty, and higher competition. However, Schroeder *et al.* (2011) do not find universal support for the cumulative theory and raise the need of a contingency approach to explain its applicability.

The development of cumulative capabilities would be facilitated by an understanding of the origins of these capabilities. The resource-based view, learning, and knowledge can be explored to help in understanding cumulative as well as dynamic capabilities (Paiva *et al.*, 2012; Caniato *et al.*, 2013; Cordes and Hülsmann, 2013). Previously, literature treated employees as bundles of skills who could do certain jobs assigned to them. Thus, employee allocation and utilization issues were important in the past. The resource-based view broadens the definition of resource and includes organizational (and employee) information and knowledge in its premise. This is important, because in the information age and with global networks of manufacturing, information and knowledge will prove vital resources for organizations. Within a resource-based view, the resource capabilities are considered dynamic and evolve to sustain in a dynamic environment.

Further research in the resource-based view will help to develop the dynamic capabilities in manufacturing enterprise of the future:

Research Opportunity 2. Extend the scope of competitive priorities to include new business models (potentially including innovation, servitization, and solution orientation) and test their validity in the long run. At the same time, there is a need of investigating the origins, types, and role of (cumulative and) dynamic capabilities in realizing competitive priorities in the context of production systems.

5.3 BPs

The interest in BPs has grown with time. A notion of bundles of practices (Voss, 2005) is emerging that indicates that a set of manufacturing practices, instead of individual practices, leads to manufacturing and business performance owing to the complexity of operations faced today. A higher level of interest in cumulative capabilities calls for the need to implement BPs because these would help developing multiple capabilities simultaneously. A high level of interest in agility, shown in the last decade, validates this argument, as agility is said to be composed of mass customization, virtual organization, and teamwork (Gunasekaran and Yusuf, 2002). Agility is the capability of an organization to successfully respond to the needs of customers both in predictable and unpredictable situations, and promises quick responsiveness. As virtual manufacturing promises remote operation of geographically distributed manufacturing equipment and systems, it will require some level of CIM infrastructure as a priori. It can be said that with growing interest in virtual manufacturing, the interest in CIM is not declining but its nature is changing. Thus, continued research in agility promises to realize responsive networks of manufacturing organizations in the uncertain global environment. CIM can support interoperation of geographically distributed firms in a network as well as material, information, resource, control, and decision flows among them. Lean manufacturing is another significant BP that includes JIT, quality management, waste reduction, and continuous improvement, and it also has a role to play in the future (Meybodi, 2013; Panizzolo *et al.*, 2012).

BPs can play a significant role in achieving the objectives of the manufacturing enterprise of the future. From a sustainability viewpoint, a socially and environmentally sustainable manufacturing paradigm can be envisioned. It is arguable that in a socially conscious paradigm, levels of sustainability can be conceptualized ranging from an appropriate mix of automation and humans in a firm, to producing products and services that are good for the society, to social good as one of the pillars of the BS of the organization. Likewise, frameworks are needed for developing an environmentally sustainable manufacturing enterprise:

Research Opportunity 3 (A). The relationships of BPs with new business models (e.g. innovation, servitization, and solution orientation) need to be explored. At the same time, a continued interest in responsiveness, adaptability, and customization requires continued research in the BPs such as agility and JIT/Lean.

Research Opportunity 3 (B). BPs for a socially and environmentally sustainable manufacturing enterprise of the future need to be investigated.

5.4 SCs

In relation to structural decisions, there is a growing research interest in outsourcing. There is a need of developing analytical models that determine the overall economics of and facilitate the outsourcing decisions. At the same time, the competitive role outsourcing can play needs to be substantiated by linking outsourcing with the traditional competitive priorities in general and servitization, innovation, and solution orientation in particular. We envisage that outsourcing can act as a tool to reap many of the objectives posed in a socially or environmentally conscious manufacturing enterprise of the future (Rossi, 2013). For example, rationalization of production, innovation, and service operations between the developing and developed countries through the mechanism of outsourcing can help alleviate some of the issues pertaining to the balancing of automation and human work, as well as responsible deployment of technology.

Within ICs, strategic manufacturing planning helps achieving strategic decisions coherently and in a timely manner. A growth of interest in PPC as well as accounting and costing may be attributed to the rise in complexity that organizations face today (Ivert and Jonsson, 2010; Vrabic and Butala, 2012). Similarly, a growth of research interest in human resources management may be attributed to a diversity of skills and worker knowledge requirements (Stratman *et al.*, 2004; Gavetti, 2005; Tseng *et al.*, 2012) that are important to meet the challenges of the future manufacturing enterprise. Research topics in the future may include HR and manufacturing BPs, developing human-resource capabilities and knowledge, the influence of technologies on human capital, human choices in distributed organizations, and human choices in relation to the competitive priorities of innovation, servitization, and solution orientation. Another emerging area of interest in the MS literature is the design and engineering of products and services (Lu and Botha, 2006; Jun *et al.*, 2005). Design and engineering can be considered as a bridge between BS and production operations. Designing environmentally and socially conscious products, services, and processes would depend predominantly upon this function. Hence, its importance is multiplied in the wake of a socio-environmentally conscious manufacturing enterprise:

Research Opportunity 4 (A). There is a need of investigating the role outsourcing can play with regard to competitive priorities of innovation, servitization, and solution orientation and the impact it has on manufacturing and business performance (economic, social, and environmental).

Research Opportunity 4 (B). The complexity of business operations caused by the diversity and uncertainty of environment raises the need of planning and control of operations, developing human capabilities and knowledge, and designing environmentally and socially conscious products and services.

5.5 SCM

Supply chains present an important topic of study as they focus on the inter-operations of multiple firms. Comparing topics studied in the past with the future challenges, a number of topics become evident as important to be studied in the future. These topics include dynamic supply chains, agile and responsive supply chains, supply chains designed to compete through innovation, servitization and solution orientation,

supply chain contracts, inter-firm communication and coordination, and network management:

Research Opportunity 5. There is a need of developing supply chains that cater to the needs of complexity and uncertainty of environments and focus on realizing the competitive priorities of adaptability, responsiveness, innovation, servitization, and solution orientation.

5.6 Transnational comparisons

There is a growing trend in MS literature of a transnational comparison of manufacturing practices. The MS literature is growing with practices adopted in countries such as the USA, China, India, Spain, Australia, and Hungary and the impact these practices have on manufacturing performance. With globalization, there is a growing need to empirically test the existing models of relationships among business performance, MS, manufacturing performance, and action programs in developing country scenarios in order to ascertain the extent to which these models are applicable and to develop new models if need arises. At the same time, manufacturing practices from within other developed countries also need to be captured for comparison purposes. Moreover, the proposed empirical research on MS and performance measurement may also exploit the opportunity of developing as a priori new measures linking economic, social, and environmental factors:

Research Opportunity 6. Manufacturing practices of firms in the developed and the developing economies need to be captured in order to broaden the knowledge base of MS and its impact on business and manufacturing performance and to help firms to learn from each other.

5.7 Global manufacturing

Global manufacturing is a growing area of interest both for practitioners and researchers. Though some international manufacturing network design frameworks have been proposed by authors such as Miltenburg (2009) and Shi (2003), they have not yet been widely validated. Global manufacturing is an emergent theme, and topics have been segregated into the subthemes of global MCs, global SCs, and global BPs. Significant research opportunities exist in all facets of the global infrastructural and SLCs. From the global MC viewpoint, topics such as global competitive priorities, global manufacturing taxonomies, generic global MSs, and identification and development of global MCs need to be investigated:

Research Opportunity 7. Global manufacturing needs to be studied through the lenses of manufacturing paradigms: MCs, SCs, and BPs, as well as from the economic, social, and environmental perspectives. The existing frameworks of global/international manufacturing need to be tested on a wider scale to come up with a unified body of knowledge.

5.8 SP

SP constitutes a significant portion of studies in MS and research interest is growing. MS formulation has been studied significantly more than strategy implementation. Generally, there are relatively few studies focussing on joint methods that span the formulation and implementation processes. It is argued that combined methods and

techniques covering both stages of SP will make the MS process consistent, robust, and more effective. The strategy making process is heavily skewed toward the economic perspective and does not take into consideration social and environmental perspectives. New approaches and frameworks are being deployed to conceive and formulate MS in the light of evolutionary approaches, organizational behavior theories such as institutional and contingency theories, and process models. There is a need to develop theories specific to operations discipline that could explain the very nature of MS (Ketokivi and Schroeder, 2004; Schroeder *et al.*, 2002; Katsikopoulos and Gigerenzer, 2013).

With regard to alignment of MS with BS, much of the empirical research focusses on exploring the influence of organizational factors (tenure, age, and level of education of manufacturing managers) on the relationship between MS and BS. However, very limited research has focussed on devising methods and techniques for supporting the alignment process. Another idea in literature is to align MS with the business environment. This relationship needs the mediation of BS (Ward and Duray, 2000). It can be argued that in a static environment, this relationship may work smoothly. However, the role and nature of alignment in an uncertain and volatile environment need to be researched.

Regarding alignment of MS with other functional strategies, the interface between MS and marketing has been studied extensively. Historically, marketing and manufacturing function objectives are considered in conflict with each other and a number of studies have focussed on harmonizing this relationship and proposing methodologies to achieve this. Relatively fewer studies focus on aligning MS with accounting and finance strategies. The least studied areas are alignment of MS with human resources, engineering and design, and information systems. In global and socially conscious manufacturing organizations of the future, the importance of alignment becomes self-evident.

It has been only recently that researchers realized the need of studying internal consistency within manufacturing choices and their alignment with MS. Alignment between strategic and operational levels is considered to be a function of organizational factors such as tenure, age, and level of education of a manufacturing manager (Kathuria and Porth, 2003). Arguably, the impact of other organizational factors such as control policies employed, education of workers, and work organization may also be studied in future research. This is a fertile theme for future research as it would investigate the consistency among structural and ICs, capabilities, and practices and their alignment with MS. With respect to strategy implementation, there is a need to investigating the underlying processes and factors that tie into its success:

Research Opportunity 8 (A). There is a need of devising analytical methods and processes that address strategy formulation and strategy implementation in a coherent fashion. This would help to realize consistent, robust, and more effective MSs and better manufacturing performance.

Research Opportunity 8 (B). Alignment of MS with business environment as well as HR, engineering and design, and information systems functions need to be studied. Additionally, consistency among various components of manufacturing function at the operational level and their alignment with MS needs to be studied.

5.9 MS and research design methods

From the methodological viewpoint, more empirical research needs to be conducted for advancing theory in the MS discipline. Table IX indicates research gaps from the methodological viewpoint within each major and subtheme. MS should develop theories of its own and empirical research can be utilized to achieve this objective:

Research Opportunity 9. There is a need of advancing theory development in MS for which purpose empirical research methods can be deployed.

6. Conclusions and limitations of the current research

The objective of this paper is: to conduct a thematic analysis of the burgeoning body of MS literature, to assess the extent to which these themes address the challenges posed to manufacturing enterprise of the future, and to understand how these themes are changing with time and by geographical regions, and what research design and methodologies are related to these themes.

A set of 506 articles published in top-ranked, refereed international journals in the discipline of operations management formed the basis of this analysis. This paper extends the thematic framework proposed by Dangayach and Deshmukh (2001a) by identifying new themes and subthemes of study in the MS literature and linking these themes and subthemes to research designs, time and geographic regions. Such a broad and deep review of thematic areas has not been conducted in this field. This paper will help develop better understanding of MS literature. In particular, it separates mature themes from under researched topics, which can assist researchers in future research. We also discuss challenges posed to manufacturing enterprise of the future and how MS literature is equipped to respond to such challenges. While doing so, the paper focusses on a sufficient set of challenges and requirements for manufacturing enterprise of the future as highlighted by researchers and practitioners in recent years, which remains one of the limitations of this paper.

We found that MS literature covers eleven major thematic areas, namely: MS components and paradigms, MCs, SCs, BPs, the SP, SCM, performance measurement, transnational comparisons, global manufacturing, environmental/green manufacturing, and literature reviews. However, a significant portion, almost 80 percent, of the research studies in the MS discipline have focussed on the four major themes of MCs, SCs, BPs, and SP. The research in two areas – MCs and SCs – has been in decline, while the research in BPs and SP is growing. NAs have focussed more on the theme of SCs, whereas Europeans and Others have focussed more on BPs. Emerging new themes include: SCM, global manufacturing, and environmental/green manufacturing.

In the MS literature the competitive priorities of cost, quality, flexibility, and delivery have been investigated. Firms pursue multiple manufacturing priorities simultaneously. Flexibility is the most researched competitive priority. Service, innovation, and solution orientation have not been studied as competitive priorities. There is growing evidence in the literature of the cumulative capabilities theory. SCs are divided into two major subthemes – SLCs and ICs. SLCs are further sub-divided into capacity, facility, technology, process focus, and process span. Process focus is the most studied subtheme while process span is becoming increasingly popular. ICs comprise planning and control, budget, accounting and cost

control, organization, human-resource management, sourcing and PPD. JIT/lean/cellular manufacturing is a highly researched group of BPs with growing research interest while research interest in other areas such as agility/mass customization/virtual manufacturing, AMT and Information systems, FMS and CIM is mostly declining. Strategy formulation is a main subtheme under the SP but interest in it is declining. Alignment of MS with BS, manufacturing tasks, and other functions is becoming popular.

In terms of research design, 40 percent of the studies overall are empirical while 60 percent are conceptual. Thus, more empirical research is needed for advancing theory in the MS discipline. Empirical research can facilitate testing of MS theories. Also, there are very limited numbers of studies that use both qualitative and quantitative research methods within the same study.

Challenges to manufacturing enterprises in the future were divided into three categories – economic, social, and environmental. The economic aspect is related to customers, competitors, and new geographical markets. The social dimension is concerned with the well-being of people, while the environmental aspect examines the impact of a firm's activities on the environment. Relevant capabilities that can assist in dealing with these challenged are also specified in the paper. For instance, economic challenges can be met with agile/adaptive capabilities, mass customization, and responsiveness. Organizations can deal with economic challenges by focussing on solutions rather than products, human knowledge, innovation, servitization, managing network of organizations and partnerships, and dynamic capabilities. Social challenges can be met by caring for employees, considering the implications of technology on society, and adhering to socially conscious regulations. The ability to produce environmentally friendly products and services and considering the environmental implication of new technology would assist firms in meeting environmental challenges.

We identified a number of research opportunities in the backdrop of thematic analysis as well as economic, social, and environmental challenges, such as:

- There is a need to develop a cohesive view of MS that integrates economic, social, and environmental perspectives. By and large the MS literature has focussed on the economic dimension while the social and environmental dimensions are severely under researched.
- For manufacturing firms in the future, the applicability and sustainability of new business models – such as innovation, servitization, and solution orientation – need to be tested. The role of outsourcing in the context of new business models should also be explored.
- The relationship of BPs with new business models needs further examination. Nonetheless, agility and JIT/Lean require continuous research to aid responsiveness, adaptability, and customization.
- Supply chains should cater to the complexity and uncertainty of environments while focussing on the competitive priorities of adaptability, responsiveness, innovation, servitization, and solution orientation.
- A comparison of manufacturing practices of firms in the developed and developing countries can broaden the knowledge base of MS and provide learning opportunities.
- Manufacturing paradigms – MCs, SCs, and BPs, as well economic, social, and environmental perspectives – can be incorporated in the study of global manufacturing to develop a unified body of knowledge.

- Analytical methods and processes should be formulated to address strategy formulation and strategy implementation in a coherent fashion.
- An alignment of MS with the business environment as well as HR, engineering and design, and information systems functions needs further exploration. Similarly, the alignment of MS with various components of manufacturing functions at the operational level should also be investigated.

This paper contributes to knowledge in MS in at least four ways. First, it identifies mature and emerging themes and subthemes of study in the body of MS literature. Moreover, it identifies patterns of publications within each theme/subtheme by time and across geographical regions of NA, Europe, and other parts around the world. This informs about the focus of research in the past and gives cues as to where the focus should be in the future. The contribution made by this paper, compared to earlier literature reviews in MS, is described in Table III. Second, this paper documents key findings of salient papers within each theme/subtheme. For future research studies this is considered to be a significant contribution as it illustrates the main topics emphasized in the past and the topics that remain to be researched in the future. The key findings from the extant MS literature are documented and presented in Table VIII. The third contribution of this paper is an identification of research opportunities for future research work. These research opportunities are identified as a result of careful analyses of the body of research in each thematic area of the MS literature and comparing key findings from the extant literature with challenges posed to manufacturing enterprise of the future. The coverage provided by the extant literature in relation to challenges in the future is highlighted in Table VIII (the farthest right column). Fourth, this paper identifies patterns in the use of research designs within each theme/subtheme. While designing future research studies, researchers can consider methodological contribution to a theme/subtheme.

This research work is based on the articles appearing in the 34 refereed journals listed in Vastag and Montabon (2002), Vokurka (1996), Olson (2005), Dangayach and Deshmukh (2001a). This broader coverage of journals in production and operations management discipline provides more authenticity to the trends identified in the paper it may undermine the strengths of the findings by giving equal weights to various tier journals. However, the sample selected in this study largely (82 percent) constitutes papers that appear in tier one or two journals. Another limitation is the fact that journal publishers change their standards and operating policies over time. Although the authors tried not to depend on the ranking of one author or one time, there may still be some inherent variations in the standards of journals since Olson (2005).

Glossary

BPs	best practices
ICs	infrastructure choices
MCs	manufacturing capabilities
MSs	manufacturing strategies
NA	North America
PPD	product and/or process development
SCs	strategic choices
SLCs	structural choices
SP	strategic process

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