ABSTRACT

Agile research spans a variety of disciplines including manufacturing, engineering, software development, supply chain management, marketing, and project management. The purpose of this paper is to provide a multidisciplinary review of agile literature. The vast amount of research identifying agile drivers and strategies (enablers) underscores the importance of agility. This review articulates the principle drivers of agility and the strategies in the various disciplines. It is found that the drivers and strategies pursued to achieve agility are common across the disciplines. Furthermore, it is found that there exists little, if any, research that verifies the efficacy of these agile strategies.

KEYWORDS: Agile, Lean, Agile Manufacturing, Agile Software Development, Agile Project Management

INTRODUCTION

The “paradigm” of agility was first described in 1991 by a group of researchers at Lehigh University’s Iacocca Institute. Their efforts led to the published report 21st Century Manufacturing Enterprise Strategy: An Industry-Led View (Nagel and Dove, 1991). This report provided an early working definition of agile largely being the ability to meet quickly changing marketplace needs.

The Iacocca Institute report encouraged several authors to promote agile as a new, evolving paradigm. Over the past thirty years, various discipline-specific manuscripts have promoted agility has as an important emerging business paradigm. Using Kuhn’s (1970) model of paradigmatic change, Burgess (1994) suggests that extended periods of time pass between these paradigmatic changes. He draws connections between agile manufacturing and previous production paradigms of craft, mass, and lean enablers of these earlier paradigms.

Goldman, Nagel and Preiss (1995) recognized in their pioneering work resulting from the 1991 report published by the Iacocca Institute that incremental improvement of the currently existing mass-production system was no longer able to provide American manufacturing with a competitive dominance. Numerous authors since, including Kidd (1994), Goldman, Nagel and Preiss (1995), Fliedner and Vokurka (1997), Gunasekaran (1998), Yusuf et al. (1999), Sharp et al. (1999), as well as others all largely agree that the principle motivator of agile development has been marketplace turbulence attributable to drivers including rapidly changing customer demands, competitive challenges, and technological development, as well as cultural and social
change. A summary of the principle drivers for agile development noted in the literature are shown in Table 1.

<table>
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<th>Table 1: Commonly Noted Agile Development Drivers</th>
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<tr>
<td>1. Marketplace requests for mass customization</td>
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<td>2. Supply chain stakeholders’ perceived value of information enrichment</td>
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<td>3. The ability for technology to provide real time information (operationally to the factory floor, internally across transformative functions, and externally across supply chains)</td>
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<td>4. The ability for technology to enhance innovation, product design and development</td>
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<td>5. Competitor driven responses (e.g., capabilities such as quality, flexibility, fast response times, and lower costs)</td>
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<td>6. Social and cultural change</td>
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<td>7. Team based investments (skills, welfare, decentralized authority)</td>
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One interesting observation of this body of agile literature is its multidisciplinary nature. From an evolutionary point of view, authors initially examined agility from a manufacturing perspective. This was followed by contributions examining agility from an engineering perspective, software development, supply chain management, marketing, and most recently agile concepts for project management have been promoted. Taken as a whole, over this three decade time frame, this body of work has synthesized common drivers and strategies for achieving agility across these various areas. The multidisciplinary nature of this body of literature clearly represents a key criterion for judging the merits of agility. The purpose of this paper is to provide a multidisciplinary review of the agile literature, to document the common drivers and strategies for the pursuit of agility, and to recognize the conclusions that may be drawn from this common body of literature.

**AGILE MANUFACTURING**

Nagel and Dove (1991) may have been the first to offer an explanation of agility from an operations or manufacturing perspective. These authors participated in the Lehigh University’s Iacocca Institute study. They note that agility requires integrating flexible technologies of production with the skill base of a knowledgeable work force and with flexible management structures that stimulate cooperative initiatives within and between firms. The authors further note that the agile manufacturing enterprise is capable of designing, developing and producing new products quickly, assimilating field experience and technological innovation easily into existing products. An important aspect of these authors’ definition of agility is the inclusion of flexibility, product (e.g., product mix or specification changes), process (e.g., machine changeover or scheduling), or volume (e.g., varying output levels) flexibility, in order to respond quickly to marketplace changes.

In an early exploration, Kidd (1994) suggests agility should be considered from a systematic viewpoint as competencies provided by partnering enterprises, each having some core capabilities (e.g., diverse technologies) enabling rapid adaptation. Kidd suggests the emphasis is on leveraging the skills and knowledge of people in the organizations.
Goldman, Nagel, and Preiss (1995) defined agility as the capability of operating profitably in a competitive environment of continually, and unpredictably, changing customer opportunities. These authors elaborate extensively upon this definition and expand upon the earliest definition of agility by noting that the key difference between agility and flexibility is the ability to respond quickly to unanticipated marketplace changes. In their elaboration, these authors also note that the journey to agility is never completed due to an ever changing marketplace.

Kumar and Motwani (1995) offer an agility index, which is derived from 21 influencing factors. Similar to Kidd (1994), two of their influencing factors commonly cited in subsequent literature include information technologies and organizational or human resource factors.

Fliedner and Vokurka (1997) defined agility as the ability to successfully market low-cost, high-quality products with short lead times and in varying volumes that provide enhanced customer value through customization capabilities. The authors note this ability must be able to respond to changes in market demands regardless of the source. Namely, agile firms manage change as a matter of routine.

In approximately 1998, the body of agile manufacturing literature began to focus on the difference between agility and lean. Gunasekaran (1998) asserts four dimensions define the agile manufacturing enterprise: (1) value-based pricing strategies that enrich the customer, (2) co-operation that enhances competitiveness, (3) organizational mastery of change and uncertainty, and (4) investments that leverage the impact of people and information. Gunasekaran also asserts that agile and lean are not synonymous. However, he only provides an example of supplier relationship differences between the two. The contribution of this manuscript lies with its identification of agile enablers and the conceptual model illustrating these enabling strategies.

Sharp et al. (1999) address this difference and identify some other authors that have as well. They note that agile firms must be lean, flexible, and have the ability to respond quickly to changing situations. These authors also add that despite having these abilities, agile firms will not likely possess all of the necessary resources and will increasingly need to rely upon supply chain partners. These authors promote a theoretical model, built upon the drivers of Table 1, consisting of ten key agile enablers: (1) core competencies, (2) virtual enterprises, (3) rapid prototyping, (4) concurrent engineering, (5) multi-skilled workforce, (6) continuous improvement commitment, (7) team work, (8) change and risk management, (9) information technology, and (10) employee empowerment. These enablers are similar to the work of Yusuf et al. (1999).

Also in approximately 1998, the body of agile manufacturing literature began to focus on the difference between agility and flexibility. Vokurka and Fliedner (1998) attempt to differentiate agility from flexibility noting that flexible changes are responses to known situations where the procedures are already in place to manage the change. These authors suggest that agility extends the capability of flexibility by requiring the ability to respond to unpredictable changes in market or customer demands.

Sharifi and Zhang (1999) state that agile manufacturing has sometimes been confused with flexibility and lean manufacturing. These authors note agile manufacturing goes “beyond” the latter two “thought schools of manufacturing management.” These authors suggest that agility is comprised of two main factors: (1) responding to change, either anticipated or unexpected and, (2) exploiting changes as opportunities. The authors conducted a large survey of: (1) electrical and electronics, (2) aerospace and (3) vehicle parts manufacturing. Their findings varied by industry, however they found: (1) environmental disturbances are a key driver, (2) a customer
focus was consistently important across all three industries, (3) information systems/technology are a major differentiator of agile systems compared to traditional systems, (4) organization and personnel are keys to success, (5) customization capabilities is an emerging differentiator, and (6) virtual organizations, mass-customization, and internet capabilities were not as important as expected.

Similar to some authors noted above, Yusuf et al., (1999) identify various drivers of agility and provide a comprehensive definition based upon the literature at that time. These authors extend the necessary core competencies as noted by Kidd (1994) and the collective insights of the agile body of literature to identify ten decision domains comprised of 32 attributes of agile organizations that should be explored in future research. The ten decision domains identified leading agility, include: (1) integration of enterprise information capabilities, (2) intraorganizational and interorganizational supply chain competencies, (3) the team building nature of empowering employees, (4) technology, (5) quality, (6) receptiveness to change, (7) effective partnerships, (8) market focus, (9) employee investments, and (10) employee welfare.

Zhang and Sharifi (2007) proposed a framework for agile implementation comprised of seven agile capabilities. Utilizing a taxonomical approach based upon cluster analysis, three distinct types of agile strategies, “quick, responsive, and proactive players” were identified in various United Kingdom manufacturing sectors. Factor analysis and canonical discriminant analysis were used to investigate the differences among the underlying dimensions of these three groupings. The “quick” participants were characterized as possessing a significant customer focus. The “responsive” participants were characterized as emphasizing responsiveness to change and a flexible, reactive approach to dealing with change. The “proactive” participants emphasized a proactive and partnering approach to environmental threats and opportunities.

The most comprehensive definition given the multidisciplinary nature of agile literature was provided by Conboy (2009). Conboy defined agility in the context of information system development as the “continual readiness’ … ‘to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, simplicity), through its collective components and relationships with its environment.” Conboy constructed his definition from agile manufacturing, engineering, software development, and marketing literature. The various definitions proposed over the years are all easily rationalized to all business disciplines.

However, to date, there exists little, if any, research that verifies the efficacy of these agile manufacturing strategies. The vast amount of research identifying agile drivers, concepts, and strategies (enablers) underscores the implied importance of agility. However there is little if any empirical evidence documenting the value of these agile strategies. As noted by Zhang and Sharifi (2007) and reiterated here, most of the research is speculative rather than evidence based.

AGILE ENGINEERING

Historical engineering approaches for the design and development of new products have been highly structured, linear processes. Using an overly simplistic explanation, the process initiates with product conceptualization, feasibility assessment, establishing design requirements, creation of a preliminary design, creation of detailed design specifications, production planning and tool design, and finally production itself. Initial design requirements and the creation of detailed specifications may be identified jointly by the customer, marketing, and engineering. Once detailed requirements have been determined, various contributions from within the
engineering function are made, possibly including concept engineering and prototyping, product engineering, as well as manufacturing engineering, all prior to production.

Various strategies within the engineering function are being promoted in order to remain agile. One such strategy is reliance upon Quality Function Deployment (QFD) which has been shown useful for collecting customer requirements (customer attributes) and translating these into detailed specifications (engineering characteristics) in order to clearly articulate stakeholders’ wants, needs, and preferences (Chan and Wu, 2002). Furthermore, the use of QFD has been shown to greatly enhance functional collaboration (e.g., marketing and engineering) through a variety of facilitated workshop techniques or interviews.

MacCormack et al. (2001) as well as Grieves (2006) identify and discuss additional agile engineering strategies. Some of the more significant strategies identified include: reliance upon experienced, cross-functional teams; heavy emphasis upon technology and the management of product data, information, and knowledge over a product’s life; and the ability to share product data intraorganizationally and interorganizationally. MacCormack et al. (2001) argue that tight integration between an emerging design and the resulting application context is critical. These authors note that early test versions must contain the essential specifications providing a baseline for customers to provide timely feedback. The architectural design is important in terms of its ability to accept late design changes. These authors found the generational experience of team members to be critical as it led to fewer resources being needed to complete projects and higher quality levels for more complex products. However, the authors note that this experience may not be beneficial in environments characterized by rapidly changing customer requirements.

Grieves (2006) emphasized important product characteristics and the information associated with products. This author notes that possibly as much as 80 percent of the cost structure of a product is defined while establishing engineering design requirements. He suggests that a business strategy that enables collaborative creation, management, dissemination, and use of product definition information across the extended enterprise (supply chain) is critical. Therefore, enterprise-wide and supply chain information technology systems are critical determinants of agile strategies.

**AGILE SOFTWARE DEVELOPMENT**

Historical software development methods have emphasized the creation of detailed plans consisting of specified processes and products. The Systems Development Life Cycle (SDLC) method, sometimes called plan-based or Waterfall Model, was one of the original software development methodologies. Planning and execution within SDLC is typically characterized as a linear and sequential process. It is a five-phased model that goes through requirements gathering (planning), analysis, design, implementation, and maintenance with each phase being completed before the next phase commences. This Waterfall approach may be depicted graphically as shown in Figure 1.
This process begins by determining the functionality required in the software (requirements gathering). During this phase the customer is involved to convey necessary functionality and requirements. Once the necessary functionality and requirements have been determined, solution analysis begins. Solutions lead to a design or blueprint for the construction phase. Implementation is the actual construction of the system with the software being deployed at phase end. The customer is often not involved with analysis, design, or implementation phases. The support phase provides the necessary maintenance over the useful life of the system as the software would be upgraded or enhanced. The customer is often reintroduced during this latter phase for user acceptance testing purposes. This has been the primary means of software development for several decades. It has served to offer stable project requirements over the project life to facilitate project goal attainment.

Enhanced computing capabilities and the growth and continuing development of corporate information systems have led to more complex and interdependent systems over this span of time. Furthermore, significant up-front planning efforts suggest that the environment remains static. In a changing environment, the early assumptions or requirements and consequential specifications may not hold throughout the project. By its very nature, the phased approach of the SDLC is resistant to changing requirements.

Agile software development recognizes that custom designed and built systems lead to high costs and long installation lead times due to increasingly changing or even volatile environments. Since the early to mid-1990’s, agile principles have been integrated into software development efforts. The Chrysler Comprehensive Compensation Project (C3 Project) in 1996 is often cited as the seminal eXtreme Programming Project fully utilizing the tools and techniques of agile software development throughout the project lifecycle (C3 Team, 1998). In 2001 these techniques were formally codified into what has become known as the twelve principles behind the Agile Manifesto. The central ideas include: (1) individuals and interactions may be more important than processes and tools, (2) the development of working software in a timely manner may be more important than comprehensive documentation, (3) customer collaboration is critical to success, and (4) quick responses to change trump following a detailed plan identified at the project outset.

Ramesh et al. (2010) note common drivers for its development, including requirements that tend to evolve very quickly and become obsolete prior to project completion, time-to-market
pressures, as well as rapid changes in competitive threats, stakeholder preferences, and software technology.

Consequently, families of agile methods, which seek to address high costs and long installation times, have emerged over the past two decades (Agile Alliance, 2001; Boehm and Turner, 2003). A few of the more popular methods comprising this family include: Scrum, Extreme Programming (XP), Agile Modeling, Rational Unified Process (RUP), Crystal Clear, Dynamic Systems Development Method (DSDM), Lean Development, and Rapid Product Development (RPD). These methods utilize various strategies to reduce costs and hasten delivery times, including: short iterations and Test Driven Development (TDD); frequent releases based upon highest priority or most critical features; simpler designs; peer reviews and collective code ownership; as well as various communication tools such as prototyping, piloting applications, onsite customer participation, review meetings, and acceptance testing, all of which provide fast feedback. Various researchers, including Augustine et al. (2005), Ramesh, et al. (2010) provide detailed discussions complete with citations of these alternative strategies.

Similarly, Poppendieck and Poppendieck (2007) and Poppendieck and Cusumano (2012) compare their beliefs that lean practices are applicable to the design, development, deployment, and validation of software projects. These authors have gained acclaim for emphasizing waste elimination, bureaucracy reduction, and enhanced learning with short cycles, frequent builds, and fast iterations with frequent feedback pulling changes into products. These authors promote seven principles of lean software development, similar to agile strategies of other functional areas, including: (1) optimizing the whole (systems perspective), (2) eliminate waste (e.g., unnecessary code and functionality, using smaller teams with less staff), (3) building quality in (considering that earlier testing and later specification identification can reduce waste), (4) learn constantly, (5) deliver fast, (6) engage everyone, and (7) continuous improvement. However, to date, there exists little, if any, research that verifies the efficacy of these agile software development strategies. The vast amount of research identifying agile drivers, concepts, and strategies (enablers) underscores the implied importance of agility. However there is little if any empirical evidence documenting the value of these agile strategies. As noted by MacCormack (2001), few studies have empirically confirmed the benefits of agile methods. MacCormack suggests the following software development strategies provide positive results: share an early, low-functionality version with customers for feedback (“microproject”) followed with an iterative approach to adding functionality, all the while using an experienced development team and a product architecture that offers flexibility. However, these research findings did not directly compare the iterative approach with a traditional waterfall method. Rather, results achieved were compared to historical project results. At a later date, Erickson et al. (2005) notes that most of the research is speculative rather than evidence based.

AGILE SUPPLY CHAIN MANAGEMENT

Naylor et al. (1999) suggest that lean and agile are different paradigms developed in the manufacturing sector but should not be viewed separately within a supply chain. Rather, these paradigms should be combined to form a total supply chain strategy utilizing market knowledge and positioning of inventory to establish a “decoupling point.” Supply chain inventory serves as a decoupling point, or as a point of postponement at which a product may be differentiated. The decoupling point is used to buffer upstream lean manufacturing, which benefits from potential waste elimination afforded by a stable, level schedule, from the downstream satisfaction of fluctuating demands in a volatile marketplace, thus providing agility. The authors refer to this
concept as “leagility.” The view of these authors is supported by consideration of a personal computer supply chain case study.

Mason-Jones et al. (2000) extend the “leagile” concept by suggesting that businesses must first identify and fully understand marketplace requirements, including product variety demands and the extent of demand variability. This understanding promotes the supply chain’s information enrichment capability. The authors argue that this knowledge must be used in conjunction with the “decoupling point" to achieve leagility.

Christopher (2000) subsequently attempts to distinguish between lean, which he suggests is best restricted to waste elimination in factories within high volume, low variation environments, and agility, which refers to the ability to respond rapidly to volatility in demand, either from volume or variety. He notes several strategies that promote agility, including: capturing of real time customer demand and its exchange among supply chain partners to drive planning responses, (2) the use of a decoupling point, prior to which inventory is held in a delayed configuration, (3) leveraging supplier relations with fewer, trusted strategic partners that permit the collaborative exchange of sensitive information.

The literature noted above as well as others offer a clear consensus of various strategies that promote supply chain agility. Included among these are: (1) information technology and information exchanges, both intra- and interorganizationally which enable the capture of real time demand which promotes a fast response capability to marketplace volatility, (2) the use of a decoupling point, prior to which inventory is held in a delayed configuration, (3) investing and leveraging supply chain partner capabilities in order to promote the integration of business processes throughout the chain.

AGILE MARKETING MANAGEMENT

The central idea promoted within the marketing literature devoted to agility is best described by Goldman, Nagel, and Preiss (1995) when these authors noted that “agile competitors precipitate change, creating new markets and new customers out of their understanding of the directions in which new markets and customer requirements are evolving” (p. 43). Sharifi and Zhang (1999) suggest that agile is a means to provide the “opportunistic actions in capturing new markets and responding to new customer requirements” which is necessary for success given the drivers in Table 1 (p. 1).

Developed principally as a marketing concept to facilitate customer needs assessment, product development, and quality management, as noted earlier, QFD can be viewed as a significant agile methodology. QFD has been shown useful for collecting customer requirements (customer attributes) and translating these into detailed specifications (engineering characteristics) in order to clearly articulate stakeholders’ wants, needs, and preferences. QFD has the ability to significantly reduce product time-to-market (Chan and Wu, 2002). Furthermore, the use of QFD has been shown to greatly enhance functional collaboration through a variety of facilitated workshop techniques or interviews. QFD has been successfully applied within various function areas, including marketing, engineering, and even software development (Haag et al., 1996). As noted by Chan and Wu (2002), “there is no definite boundary for QFD’s potential fields of applications.”

Poolton et al. (2006) examined agile manufacturing principles for the creation and development of proactive, strategic marketing plans in small and medium-sized enterprises in the United Kingdom. These authors promote a three step, proactive agility framework. First, a bottom-up
focus on identifying tactical improvement opportunities within the operating environment is promoted. Second, is the identification of responses to address the vulnerabilities identified as an outcome of the first step. These authors contend this creates a robustness of the operating system. Third, once robustness has been achieved, the authors encourage a campaign to better anticipate and even further stimulate marketplace demands. The authors point is that stimulating marketplace demands while production systems have weaknesses could lead to the loss of customers. Addressing operational weaknesses can present opportunities to grow one’s business. The authors suggest that “marketing agility” enables companies to reconfigure their marketing efforts on short notice.

AGILE PROJECT MANAGEMENT

Traditional project planning promotes a hierarchical planning approach including clearly defined, well-documented and planned project specifications, budgets, and schedules. Traditional project management planning promotes a five-phase approach consisting of initiating, planning, executing, monitoring and control, and closing. Although time consuming, this hierarchical decomposition approach to planning facilitates subsequent execution. Decomposition is similar in concept to the SDLC method of software development. Decomposition is a hierarchical and sequential division of work, possibly into stages. As each stage is completed, there is typically an assessment performed. This break down process enhances communication, estimating accuracy, monitoring and control, as well as stakeholder understanding and motivation.

Over the past thirty years numerous strategies have been developed to promote the faster accomplishment of project objectives. One of these time-saving strategies is fast tracking. Fast tracking is the deliberate overlapping of sequential tasks so successor tasks may commence sooner rather than later. Within the realm of project management, agile is a recent term being used to refer to a more advanced set of strategies to achieve a faster response to quick changing environmental conditions. As noted in the project management literature, agile project management emphasizes:

1. A team approach with frequent interpersonal interaction and communications and greater stakeholder involvement and communications to facilitate a rapid approval process for new specification adoption as well as process and product change orders,
2. Simultaneous or parallel task execution emulating the effects of fast tracking, and
3. Decomposition of specifications of deliverables into stages.

To date, agile project management (APM) relates largely to the management and control of software projects. Agile project management principles may be applicable to projects of any type. Fernandez and Fernandez (2008) note that the emphasis on people and the desire to remain flexible and adaptive is critically important in light of project uncertainty and complexity. These authors identify that attempts have been made to widen the scope of APM to projects with different characteristics, for example construction projects. These authors state that research suggests that “considerable potential exists for gains to be made from the adoption of APM in the predesign and design phases of construction.” The reason given is that the iterative and incremental development approach of agile methods “can facilitate creative solutions, particularly to complex and uncertain requirements.”

Most of the research proceeds to contrast traditional project management versus APM. Fernandez and Fernandez (2008) note three important differences: (1) traditional projects are clearly articulated with well-documented and planned project specifications, budgets, and schedules whereas APM discovers complete project requirements iteratively; (2) traditional
projects manage and control with the budget, schedule, and project scope, whereas APM focuses more on deliverables and value offerings with budgets and timelines being secondary; (3) traditional projects distribute work to teams and specialists by matching well-defined requirements with capabilities whereas APM requires co-location of team and staff members to promote faster responses to change order requests and to produce incremental accomplishment.

Highsmith (2004) promotes a five-phased approach for APM, consisting of: (1) envisioning, (2) speculating, (3) exploring, (4) adapting, and (5) closing. The underlying concept of these five phases for projects with complex and possibly uncertain requirements is for team members to explore different avenues to achieve outcomes, test and adapt the more acceptable solutions in an ongoing iterative manner, until project requirements are achieved. Highsmith notes this to be a less-structured environment relying upon greater flexibility, informal communications, and evolving requirements.

As others have suggested, Leybourne (2009) notes the shift towards APM has been driven by increased environmental turbulence and the shortcomings in traditional project-based approaches. Leybourne promotes further evolution of APM based upon organizational improvisation literature and its importance relative to compressed project timetables. He identifies and defines seven key constructs: (1) creativity, (2) intuition, (3) bricolage, (4) adaption, (5) compression, (6) innovation, and (7) learning. Leybourne discusses similarities of improvisation strategies with APM strategies and overlaps of these constructs with the APM literature. He suggests that more experienced project managers who are able to adapt their style based upon these constructs or the components of APM may be better positioned to resolve ambiguities and shorten delivery times.

CONCLUSIONS

The research literature offers three important conclusions. First, regardless of the functional discipline, there is widespread agreement in the research literature that agility refers to the ability of a firm to rapidly respond to volatile, unpredictable marketplace demands. Whether the agile paradigm is truly different from the lean paradigm has yet to be proven. There seems to be a consensus in the literature that agile represents a significant paradigmatic change and that agile and lean are different.

Second, there is also widespread agreement within the multidisciplinary agile research suggesting a common body of strategies for achieving agility. Five of these strategies most often cited are:

1. Organizational mastery of uncertainty and swift responses are essential given rapid marketplace change. The ability to innovate given marketplace volatility and uncertainty is essential.
2. Invest and empower one’s team (possibly small and inclusive of all stakeholders) in order to leverage their ensuing capabilities. Agility requires speed to react to changing market conditions and the ability to deliver value to the customer. Investing in one’s team better positions the enterprise to achieve rapid response and value delivery proposition.
3. A systems viewpoint and reliance upon cooperation that enhances competitiveness. This includes both intraorganizational as well as interorganizational cooperation. Reliance upon a shared vision and the integration of whole business processes across a supply chain, including virtual organizations, partnerships, or other forms of cooperation are essential.
4. Intraorganizational and interorganizational information technology and exchanges. Moore’s law, Butter’s Law, and Nielsen’s Law all suggest that technology and the ability to capture real time information and rapidly share vast amounts of information in a virtual manner across a supply chain offers value. The timely exchange of this information is essential.

5. The incremental development of product offerings given swiftly changing marketplace demands. It is critical to constantly assess customer demands and to have the ability to rapidly alter current product configurations.

Third, the focus of this multidisciplinary body of agile research literature is on: (1) defining agility, (2) identifying the drivers for agility, (3) discussing agile concepts, and (4) identifying the strategies (enablers) for achieving agility. To date, there exists little, if any, research that verifies the efficacy of agile strategies. The vast amount of research identifying agile drivers, concepts, and strategies (enablers) underscores the implied importance of agility. However there is little if any empirical evidence documenting the value of these agile strategies. As noted by Zhang and Sharifi (2007) and reiterated here, most of the research promoting agility is speculative rather than evidence based.

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