Technologies in support of mass customization strategy:
Exploring the linkages between e-commerce and knowledge management

Marilyn M. Helms a,*, Mohammad Ahmadi b,1, Wen Jang Kenny Jih c,2, Lawrence P. Ettkin b,3

a Dalton State College, 213 N. College Drive, Dalton, GA 20730, United States
b University of Tennessee at Chattanooga, 615 McCallie Avenue, Chattanooga, TN 37403, United States
c Department of Computer Information Systems, Jennings A. Jones College of Business, Middle Tennessee State University, 1301 East Main Street, Murfreesboro, TN 37132-0001, United States

Available online 5 November 2007

Abstract

This paper explores two major interdisciplinary techniques facilitating mass customization strategies—e-commerce and knowledge management. The linkages between the two serve to validate the strategic shift toward mass customization. Internet-enabled e-commerce provides capabilities for firms to reach global buyers and suppliers and is increasingly recognized as a way to support the gathering of knowledge, specifically customer preferences. Knowledge management provides frameworks needed to manage intellectual capital as a valuable organizational resource for supporting customized preferences. Knowledge management makes mass customization a more viable strategy for manufacturers as they work to meet changing customer needs and desires. This article posits the linkage between e-commerce and knowledge management can support firms as they gather customer preferences and evaluate the data to advance mass customization. A profile for firms to assess their readiness for mass customization, specifically considering available knowledge management and e-commerce linkages, is provided along with areas for future research.

Published by Elsevier B.V.

Keywords: Knowledge management; Electronic commerce; Information technology; Mass customization

1. Introduction

Although the term “mass customization” was identified by Davis [1] in his book, Future Perfect, when he referred to the term as an oxymoron of mass production and customized goods [2], the concept emerged for the first time in the book Future Shock [3]. Later the term shifted toward a new business strategy and not just an evolution of mass production [4]. Mass customization relies on component standardization, modularization, or form postponement [5,6]. Other linking technologies like e-mail and the Internet allow firms to rapidly and more effectively communicate with consumers in a co-design process to learn exactly is wanted in services and product features.

Today’s customers are demanding quality, style, and uniqueness over homogeneous products. The purpose of this paper is to explore the information technology (IT) components to meet these unique and changing consumer desires to support a mass customization strategy. Specifically, two emerging and supporting technologies – e-commerce and knowledge management – are considered. The role of e-commerce is vital to capturing information resulting from customer feedback and electronic interactions. Knowledge management or on-going learning from customers and stakeholders is necessary to continually develop and refine product and service offerings for customization.

E-commerce provides the linkage to capture external information. Knowledge systems combine this information with internal organizational expertise transforming the information into knowledge to improve product options. The aim is to integrate these different but appropriate areas of information and communication technology as enabling tools to advance mass customization as a more viable organizational strategy. Based on a review of the current mass customization, e-commerce, and knowledge management literature, questions for top management to consider as they explore organizational
readiness for mass customization are developed and are presented for discussion and strategic planning purposes.

2. Mass customization

While a company’s marketing department may offer individualized or customized products, the offering typically means similar variations of the same mass produced items are available-like colors, features, materials or other options. If mass customization is the best way to delivery the desired uniqueness to customers, then customer involvement during the design process (including the utilization of web-based product development methodologies) provide the capability for this necessary involvement and serves to differentiate customization from mere product and service variety, defined as just additional, new offerings to the marketplace (see [7] for a discussion of the unique differences between variety and customization).

While a few products have been mass customized, many more products remain possibilities. A customized car might involve a paint option, a variety of wheels or tires, or seat styles. Computers too can be customized as various software and hardware can be easily added. Baseball gloves, for example, come in only standard sizes and it is often hard to find an exact fit. Though mass customization, a customer can select the correct length of fingers, correct pockets, correct wrist size, and even the glove color they desire.

While manufacturers struggled in the past to meet the wants and needs of their customers without sacrificing the efficiencies and profits gained through mass production, developments in information technology have increased the viability of a mass customization strategy. Most computer-aided-design (CAD) and computer assisted manufacturing (CAM) equipment used in apparel pattern making enable mass customization through the automatic alteration of patterns for individual body measurements. An essential key to the use of these enabling technologies is the ability of CAD systems to integrate measurement information and make changes to patterns, as necessary, without permanently changing the original garment pattern.

Interactive product websites too have advanced so customers can view the final prototype of their mass customized product on-line (i.e., running shoes at www.nike.com; teddy bears at www.vermonteddybear.com; custom chinos at www.landsend.com; or custom shirts at www.customizedgirl.com). Services too offer mass customization (e.g., cafeteria human resources benefits, selected cable television or satellite ratio station packages) or around a standard product (e.g., in-home service policies, extended warranties).

3. Mass customization strategy

Researchers have examined important features and success factors of mass customization (see, for example [8–12]). Silveira et al. [13] and McCutcheon et al. [14] extended the concept of mass customization as a viable organizational strategy. Ahlstrom and Westbrook [8] agree most articles on mass customization are concerned with the strategic impact of the concept. Yet most of the articles with a strategic theme do not address specific implementation issues.

Several studies explored the fuzzy characteristics of customer needs elicitation and the difficulty of capturing the necessary information to aid customization. Blecker et al. [15] examine what they called “recommender systems” within e-commerce for the mass customized environment and focused their research on gathering the implicit characteristics of customers needs. E-commerce systems use these recommender systems to search for products or services corresponding to customer-specific preferences or requirements. Blecker et al. [16] agree an information system based on an electronic market is the suitable approach for steering mass customization. Chen et al. [17] recognized too the “fuzzy” aspects of customer language and developed a corresponding fuzzy-logic model for product customization. The authors agree with the increasing popularity of the Internet, it is possible for consumers to be involved in the design of products that reflect their personalities and the medium can be used to facilitate this consumer input in the product design phase.

4. Electronic commerce and mass customization

E-commerce uses computer networks and the Internet to buy and sell products, services and transmit information. Researchers have analyzed e-commerce business models from many perspectives and frameworks [18–20] and agree when used properly, the Internet can become the technological foundation of an innovative strategy.

E-commerce includes business-to-consumer (B-to-C), business-to-business (B-to-B), and internal business interactions via an Intranet [19–22]. Data exchange between manufacturers and their suppliers (B-to-B) can be handled efficiently and in a timely manner using e-commerce techniques but often must be paired with agent technology that allow the computerized data systems of all supply chain partners to accurately communicate together to transmit timely data. Further study of agent-based coordinate by Sugumaran et al. [23] found systems collaboration and coordination among first. To interface the various participants working together, multi-agent systems are needed. Business to consumer (B-to-C) e-commerce supports mass customization by selling product and service options, on-line.

Business-to-business e-commerce interactions are handled by electronic data exchange which, through agent technologies, standardizes the information and orders between companies, permitting direct communication between numerous and varied business application systems. Customers need a way to describe exactly what they want to purchase and this task can be supported by interactive, integrated e-commerce configuration tools and systems (see [24,25]). If an order forces an engineering change, software for engineering data management allows quick design changes and can be integrated with systems responsible for production control and planning. The integration of suppliers as well as the coordination of cross-organizational production processes is critical success factors for mass customization (see [26]).

How the Internet is incorporated in the value-creating business strategy, rather than the mere presence on the Internet
enhances a company’s advantage [27,18,28–33]. The Internet provides companies a convenient, affordable communication infrastructure that is not limited by time and distance. The Internet has continued to be the center of companies’ technological and business infrastructure and Schneider [34] reports annual sales volumes of major e-commerce sectors, such as B2C and B2B, continue to increase.

The business to consumer e-commerce is supported by business-to-business e-commerce as the manufacturer becomes a customer of their suppliers for parts and assemblies. The same is true for the supplier to supplier segment. This leads to a networked production process covering multiple companies and plants supplying raw materials to manufacturing then distributing or directly delivering them to the customer. Mass customization as a competitive strategy requires these two e-commerce channels be simultaneously engaged.

E-commerce communication reduces transaction costs on both supply and demand sides. For suppliers, a key feature of Internet-based commerce is taking order online. A well-designed business model that leverages Internet features can lessen companies’ dependence on intermediaries, dealing with the customers directly. From the demand side perspective, customers can conduct activities through the entire resource acquisition cycle from information seeking to service request from their computer.

E-commerce is a means of enabling organizational changes to support mass customization, allowing companies to be more flexible, efficient, and responsive. E-commerce is revolutionizing operations management because it reduces costs so effectively. E-commerce increases economic efficiencies by matching buyers and sellers. The e-commerce collaboration in production and product design is not only cheaper but also quicker with better results.

Often e-tailers provide better customer service than traditional retailers by personalizing sites, creating opportunities for customization and treating customers as individuals instead of merely market segments. Firms create loyalty by employing a wide range of processes enabling companies to identify and understand the unique desires of customers. The Internet functions automatically and effortlessly to collect customer information for further analysis and implementation. Since information is the foundation for establishing customer relationships, the e-tailer collects additional information about the customer either actively or passively. Emotionally the Internet interacts with the customer over time to establish a personal, more intimate relationship.

Companies employ many analysts and researchers, invest large budgets and carry out extensive research programs to analyze and collect customer data. Generally they collect basic personal information provided on registration, purchasing habits, and click streams or site navigation patterns. By combining this information, the e-tailers create a detailed profile of every customer. Amazon.com, for example, uses click stream analysis for their personalized book suggestions.

Brokerage firms such as Charles Schwab (www.schwab.com) have implemented customizable e-mail “alert” systems to notify investors of events specific to securities of interest. Clients configure alerts based on multiple criteria including breaking news or price fluctuations. Additionally, such Web-enabled mass customization allows firms to target marketing efforts to specific investor groups. E*Trade (www.etrade.com) tracks the trading activity of each client, enabling tailored promotional offerings and exclusive Web site features for active traders, providing ways for clients and firms to conduct business online without human assistance. Similarly CDNow.com informs customers a long-awaited DVD has been released. Travelocity.com and expedia.com advise customers when a particular travel destination or price becomes available.

Developments in Web 2.0, the second-generation of Internet-based services, which includes wiki and blogs, are receiving much attention for their use as a collaboration tool [35]. This collection of Web-based services facilitates user participation in content contribution, promote collaboration and in-depth online conversations, and encourage social networking. From an integration point of view, Web 2.0 services are beneficial for both suppliers and consumers by allowing product and service suppliers to gather consumer requirements and preferences both more accurately and more efficiently. Deployed properly, these services also provide a convenient communication channel for companies to obtain additional and richer customer feedback on new offerings. These benefits are especially obvious for customers seeking one-of-a-kind products. With proper design, Web 2.0 and knowledge management frameworks can combine to promote mass customization.

User-centered Web 2.0 services also provide a platform for participation in content development since buyers and sellers are actively involved in value creation. The benefit from linking a group of entities is growing at an exponential rate. Companies successfully harnessing shared power are making the Internet an interactive mass media and are capturing an increasing share of customer attention or they use this powerful feature of the Internet as a technology business strategy implementation. The most publicized examples include www.google.com, www.MySpace.com, www.youtube.com, www.amazon.com and other well-participated wiki sites including www.wikipedia.com. Customers actively participate out of trust for the peer group as well as the platform manager who serves as the information broker, linking large numbers of users and contributors.

Such e-commerce facilitates the acquisition of knowledge which captures the actual customer Internet interactions into databases. This data is merely information and must be analyzed before it can become useful knowledge for the organization. Knowledge management is the result of the application of database mining tools that allows individual profiles to be compiled, reviewed, and analyzed for new market opportunities for current and potential customers. The following section profiles the role of knowledge management for mass customization.

5. Knowledge management and mass customization

Like e-commerce, knowledge management is valuable to mass customization by providing frameworks and infrastructure for knowledge creation, knowledge distribution, and
knowledge-based innovation regarding customers. From a pragmatic standpoint, knowledge management can be viewed as a business process where which valuable knowledge is identified, collected, created, organized, stored, distributed, and eventually applied to problems or accomplish goals [36,37].

In today’s business environment, characterized by fierce competition and constant change, intellectual capital or knowledge is recognized as an important organizational resource for creating strategic value [38–41]. Management of insights and knowledge is facilitated by systems that gather, analyze, and disseminate this information. Knowledge management has captured attention because it views intellectual capital as manageable and suggests frameworks to help companies effectively utilize this valuable resource. Fahey et al. [42] agree organizations need to focus on the knowledge gained via e-business to enhance customer relationship management, supply chain management and product development.

In the knowledge economy, proprietary intelligence associated with design, production, and delivery of innovative products or services is recognized as a key source of sustainable competitive advantage. Although the strategic value of knowledge is clear, most companies have not mastered the art of managing knowledge. In fact, the very capability to manage an organizational knowledge base is considered a strategic competence [40,41,43–46].

Researchers view knowledge management as an extension of traditional data and information management (or e-commerce) and suggest a holistic approach of knowledge management as a generic task permeating a knowledge worker’s management functions [43,47–49]. Rather than treating knowledge management as a new duty separate from existing work practices, an integrated approach is taken to embed knowledge management tasks in the business processes.

While providing intelligent decision support, the knowledge base component of the business processes allow user flexibility to adopt, adapt or override system recommendation. The integration of the knowledge base increases the difficulty of replication by competitors and thereby constitutes a source of sustainable competitive advantage. In the implementation of a knowledge management solution in a bank, Samiotis et al. [50] found support for knowledge-management in e-banking roles. Bose and Sugumaran [51] found knowledge management technology applied in customer relationship management, particularly in creating, structuring, disseminating, and applying knowledge. Rowley [52] agrees customer knowledge is an important e-business opportunity and knowing customers in the digital economy depends on knowledge management.

Depending on the nature of business, an organization can choose to place more emphasis on human capital or technological capabilities when implementing knowledge management. The experience of Partners HealthCare provides an example for the technological approach [53]. A problem common to physicians is the quantity of information as there are almost 10,000 different diseases and syndromes, 3000 medications, 1100 lab tests, and over 400,000 articles added yearly to biomedical literature. Errors resulting from updates and the complexity are many and costly. A report from the Institute of Medicine indicated more than a million injuries and as many as 98,000 yearly deaths are attributable to medical errors. To combat this problem, Partners created an order entry system to double-check physicians’ prescriptions against a database of patient history, a database of drugs, and a medical expert system. Physicians’ knowledge and judgment are still important and can override system recommendation, but the system and other knowledge management systems have significantly reduced wasted resources and enhanced customer service quality. By embedding knowledge delivery process in the customer service process, Partners HealthCare has demonstrated that flexible and efficient knowledge systems can be easily implemented.

6. Leveraging information into knowledge: synergies for mass customization strategic success

Information and communication technologies make it possible to both leverage and integrate approaches more quickly, helping organizations respond to customer wants [54]. Knowledge management implementation is facilitated by organizations’ capabilities in implementing e-commerce applications. Likewise, implementation of e-commerce applications can benefit from experience acquired from knowledge management practices. A reinforcing effect results from the shared characteristics of e-commerce and knowledge management. These effects includes:

6.1. Internet utilization

Both e-commerce and knowledge management rely on the Internet and the related technologies (such as the WWW, search engines, shopping activity tracking programs, and software agents). For e-commerce, not only are the online storefront operations relying on the browser-based user interface, but the back-office systems must also be integrated through Internet-based communication protocols to create attractive customer value (guaranteed fulfillment, consistent quality, and competitive price) all while keeping operational costs within acceptable ranges. Similarly, knowledge management projects involve using the Internet to link knowledge buyers, knowledge sellers, and knowledge brokers in a knowledge market [44]. Thus the Internet is providing a convenient and affordable infrastructure for enterprise knowledge management activities and this infrastructure is necessary for mass customization.

Using Web 2.0 services, customers and product/service providers are viewed as equal parts of the team. They share opinions, perceptions, preferences, and comments throughout the product life cycle. Deployed properly, Web 2.0 services hold potential for supporting mass customization because they serve to capture a large volume of customer feedback, both positive and negative, in a real-time environment. Used effectively by organizations, this data on their products and services and those of the competition can be included in the strategic planning and new product and service development process. With feedback on customer preferences in hand, companies know which product and service components or variables are appropriate for customized offerings. Customiza-
tion is not limited only to the order placement and processing stages, but includes planning, design, manufacturing, and after-sale services. Communication ensures maximum accommodation of customers’ needs and desires [34] and since customers control the content, the more they participate, the more deeply their participation becomes [55]. To please customers, firms must maintain a rich repository of customer profiles. These profiles allow firms to understand customers’ preference and experiences in using their products. Such comprehensive user profile results from meaningful interactions [53].

Grenci and Watts [56] agree providers will be differentiated by their ability to employ powerful Web-based interfaces to support a strategy that develops customer-controlled customization processes. Thus the need for e-commerce and supporting knowledge management systems must be in place for mass customization success. Dietrick et al. [57] support information systems as needed to manage product and process complexity in mass customization and call for context-specific IT services as a prerequisite for successful mass customization.

Facing a massive amount of information, customers’ attention will be drawn to websites offering innovative, unique values. Knowledge management supports e-commerce by enabling a company to put its entire organizational knowledge base behind major business processes including new product development, customer service, and supply chain management. The infrastructure constructed for e-commerce applications also provides valuable mechanisms for the implementation of knowledge management.

6.2. Intangible assets emphasis

While such tangible resources as capital, distribution channels, technology, and warehousing facilities are necessary for successful operations, intangible assets (customer trust, brand image, value and innovation capabilities) are even more important for a successful e-commerce business. The capability of organizational members to be actively engaged in knowledge acquisition, knowledge updating, and knowledge exchange is an essential condition of implementing mass customization initiatives and innovation. The rich knowledge information and knowledge content, according to Wolfinbarger and Gilly [58], represents an important motivating factor by providing online shoppers with freedom, control, and enjoyment. These intangibles are difficult to quantify but are important to users.

Chu et al. [59] found software enhancements including the ability to configure 3D parts in a regular web browser, conduct an on-line evaluation of a car’s interior using a digital human model, and even Internet-based design review systems that allow designers and others involved to change a prototype without access to CAD systems are changing collaboration for mass customization.

6.3. Integration requirement

Both e-commerce and knowledge management must be tightly integrated with major business processes. The experience accumulated via e-commerce indicates both internal and external processes must be streamlined and seamless. Knowledge management emphasizes the importance of integration with major business processes, such as new product development, customer service, and quality assurance and important for mass customization. Grover and Davenport [44] agree the ultimate success of knowledge management programs result in the complete integration of knowledge management into other business processes.

Knowledge management plays a vital role in mass customization. Mass customization involves providing customers with the products that “meet needs of individual customer with regard to certain product features [60].” Critical to mass customization is customers and vendors collaborating on products design via a user-friendly interface. Effective co-design requires companies possessing rich customer and product knowledge throughout the customer relationship management process, from the first contact of inquiry to product design and delivery to after-sale support. Traditional measures such as market survey and focus group may not be enough to collecting knowledge about customer needs. Even customer-completed forms and more automatic techniques such as cookies and software agents only capture an insignificant surface level of customer information preferences and browsing patterns. More engaging measures such as company blogs and resource-based wikis require more commitment, but, if done properly, can uncover valuable design information resulting from a deeper level and more fruitful customer relationships. Blogs posted by Microsoft engineers, for example, have been recognized being instrumental in transforming customer image and thereby enhancing its customer relation [61]. The millions of users of Google’s beta versions of its products have provided a great wealth of testing data and knowledge for product improvement and enhancements, a case of product co-design seamlessly embedded in the customer interaction process. These developments demonstrate the benefit provided by knowledge management.

Decision support and knowledge management processes often remain interdependent activities in many organizations, experts agree the true goal of knowledge management is to establish a unified, integrated global framework [62,63]. Although technology is not a replacement for knowledge, the gap between knowledge management and e-commerce must be bridged. Various hierarchies have been proposed where knowledge precedes the data-to-information process [64].

Warkentin et al. [65] studied e-knowledge networks and found them key in inter-organizational collaborative e-businesses, linking knowledge management and e-commerce. Developments in information technology, the Internet, enterprise resources planning systems, and knowledge management all necessitate the application of these technologies for business survival [66].

6.4. Innovation-minded

An organizational culture encouraging and stimulating individual and institutional innovation is necessary for e-commerce, knowledge management, and mass customization. Innovative products or processes are the most direct outcomes of
successful knowledge management efforts [67]. Many unique business models in e-commerce are new and unproven and the nature of Internet businesses makes it hard to keep an innovation proprietary for long. However, products crafted via mass customization are often the most unique or innovative options.

Alvesson [68] found key knowledge intensive firms are ones using e-commerce in their business model and include IT, management consulting, advertising, and life sciences. Alvesson calls for “de-layering” of the knowledge intensive organizations of today that rely on informal networks of employees but agrees, even with its weaknesses, knowledge management is a core competency. Without knowledge, innovative new products and services are difficult to develop and are often ineffective.

6.5. Lack of performance indicators

There is little doubt technological innovations centered on the Internet have made it easier for businesses to reach the global market overnight and have allowed customers the option to customize products; however, what is less certain is how these new capabilities should be incorporated into business practice. Researchers have suggested performance of knowledge management efforts should be measured in terms of their outcomes rather than knowledge itself [48]. Because outcome measures require a multiple year time frame, justifying investments in knowledge management programs remains challenging.

A well-designed knowledge management infrastructure makes it easier to share knowledge during problem solving. It reduces operating cost, improves staff productivity, and increases the knowledge base and expertise sharing [51]. Spiegler [69] feels the idea of technology is to represent the means and knowledge to the end and supports the process many include explicit and implicit methods for generating knowledge, often by using technology (e-commerce). Thus, knowledge management does not exist alone. It is context specific and must address a specific application, like mass customization. Focusing knowledge management to the customer serves to link knowledge management and e-commerce. The integration of these two broad fields aids companies within the e-commerce environment. While knowledge management is intangible, it is, nonetheless, vital. E-commerce in the broad sense includes multiple forms of electronic business including customer relationship management, supply chain management, and physical distribution management. Knowledge management gives e-commerce depth and the knowledge is focused on the task and is no longer unorganized or superficial, but uses information technology and a user interface. E-commerce is extremely competitive and stimulates thinking and requires the use of knowledge management.

6.6. Strategy significance

A well-formulated business strategy provides focus and direction for resources utilization and business operations. Researchers suggest the Internet is a complementary component of business strategy in delivering unique customer options and value [43,70,71]. Strategic thinking is also critical for successful management of organizational knowledge for mass customization. Strategic formulation provides the context for knowledge management by revealing external threats and opportunities and identifying organizational strengths and weaknesses. Such findings will help an organization specify its knowledge requirements, which in turn become the basis for subsequent knowledge management activities [70,71].

The potential synergy between knowledge management and e-commerce has been noted in both the information systems and the marketing literature in process impact, community and content, and system architecture. The process impact point of view stresses the increasing demand for in-depth knowledge in implementations of e-business processes and views knowledge management’s role in change management. Fahey et al. [42] suggest knowledge management is valuable in evaluating the what, how and why aspects of e-business operations.

6.7. Network economies

Both e-commerce applications and knowledge management implementations are governed by network economies. A knowledge-sharing network functions best when backed by enough active members contributing to the knowledge base and applying the knowledge acquired [33,45,72]. Song and Shepperd [73] found web use clustering, web page clustering and access path recognition useful for mass customization and personalization and are important issues for e-commerce.

Knowledge as a strategic asset must be managed [74]. Since business models are changing to include technology, it stands to reason the links between technology and knowledge must change. For example, the value-added content in website design has been recognized as an important factor influencing online shoppers’ perception and their shopping behavior [75,76]. True value-added content of a website can only be produced and sustained through a viable knowledge management program. Huosong et al. [77] agree an understanding of how the design of a knowledge management system affects both its use and definition is still limited, but Malhotra [78] confirms knowledge creation is relevant to e-business and e-commerce but notes, knowledge management technologies do not always deliver the right information to the right person at the right time. Also they cannot store human intelligence or experience and the knowledge management technologies cannot distribute human intelligence.

7. Assessment for mass customization

With an understanding of the e-commerce and knowledge management synergies for mass customization strategic success, how can an organization assess their readiness for implementing the strategy?

Implementing mass customization is challenging. When implemented successfully, organizations following mass customization eliminate the lack of sales forecasting accuracy as customized products are now build-to-order. This drives down finished goods inventory levels but increases scheduling and supply-chain performance pressures since customers demand quick delivery. But before committing their companies to a mass-customization strategy, top management must carefully
analyze the technology, demand and costs and benefits. Top management, IT, IS, manufacturing and marketing together should carefully review the questions together and accurately profile what gaps exist in their organization before the benefits of mass customization can be fully and profitably realized.

Hart [79] in his study of the conceptual underpinnings of mass customization agrees that organizational readiness requires a tough and honest assessment of an organization’s attitudes, culture, and resources. He agrees the job top management is to discover the degree of fit between the business opportunities inherent in mass customization and the organization’s ability to capitalize on the opportunity. Other researchers agree firms must determine when they should offer customized products [80] and effective integration of IT systems is crucial for implementation [81]. While several studies have examined customers’ readiness for mass customization (see, for example [82]), no assessments have been available to facilitate this determination of organizational readiness.

In an attempt to correct this deficiency, the assessment for top management, presented in Appendix A is based on the key variables from the literature including customer support, manufacturing and supply chain readiness, and the IT components of e-commerce and knowledge management that are prerequisites for choosing a mass customization strategy. The strategic planning, knowledge management and e-commerce questions are drawn from the previous literature review and include the key variables of both knowledge management and e-commerce necessary for mass customization. Practitioners can use the results of the assessment to rate their current readiness for mass customization and can use gap analysis tools to determine areas that must be addressed to more easily implement a mass customization strategy.

Is mass customization the best way to deliver variety to consumers? Mass customization requires unique operational capabilities combined with both knowledge management and e-commerce. Several elements must work well individually and together to ensure that mass customization is a viable business strategy. Current technologies support large-scale customization only for a few product attributes. For mass customization to deliver real value, customers too must have sharply differing preferences for certain attributes. This signals opportunities for manufacturing industries including apparel and fashion (see [83]), sports equipment and building accessories and opportunities for services including investment management and travel (see [84]). Managers should seek opportunities to add value through variety but before committing their companies to a mass-customization strategy, they carefully analyze the technology, demand, costs, and benefits. Questions 1–4 of the assessment address if customers would prefer customization. Obviously if the market is not yet demanding of customized offerings, management should not adopt the strategy but periodically assess current and/or potential customers and markets to see if preferences have changed.

Questions 5–14 address standard internal operations and production variables for mass customization. Those capabilities are: elicitation (a mechanism to interact with the customer and obtain specific information); process flexibility (production technology that fabricates the product according to the information); and logistics (subsequent processing stages and distribution that are able to maintain the identity of each item and deliver the right one to the right customer). Not all companies will master these capabilities.

The next aim of the survey is to explore the integration of different application areas of information communication technology between e-commerce and knowledge management. E-commerce is a necessary prerequisite to gather the data to support mass customization. The co-requisite of knowledge management enables organizational changes by interpreting the data into a viable production strategy to effectively lower production costs and increase revenue from the offering of customized products. Questions 15–29 of the assessment address information technology as supporting the mass customization strategy. These questions were based on the literature review of factors necessary for e-commerce and knowledge-management effectiveness (see also [85–87]). Questions 15–21 address business-to-business e-commerce activities while questions 22–26 focus on the business-to-consumer aspects of e-commerce. Finally questions 27–29 focus on the intra-organizational aspects of e-commerce activities. The final questions assess knowledge management readiness. Questions 30 and 31 focus on knowledge management strategies and questions 32–35 consider knowledge management objectives. Knowledge management critical success factors are the focus of Questions 36–39.

The managerial implications of the assessment are numerous. The assessment is a first step in discussing the viability of a mass customization strategy and can be used to bring key organizational leaders together to discuss strengths and weaknesses in the internal production and information technology areas. By gathering the market data from customers, the firm can decide if pursuing mass customization is warranted. By assessing the open-ended questions, future budgeting, procurement, and training can be aligned with the IT needs. The message is clear – variables for successful mass customization are known and managers must consider them and their true costs before choosing the strategy. The weaknesses discovered in the assessment can guide future short- and intermediate-term activities.

8. Areas for future research

Two major interdisciplinary developments are playing an important role in guiding mass customization. The first is the view of Internet technology as an integral component of business strategy in general. When linked with business processes, an Internet-based information infrastructure facilitates successful implementations of such major supporting business initiatives as customer relationship management, intra-firm process streamlining, and inter-firm supply chain integration. The second development is widespread recognition of the value of intellectual capital as a major source of sustainable competitive advantage. To avoid basing competitive strategy on a low-cost, price discounting strategy, companies must actively engage in acquiring and updating their knowledge base. Competitive advantage from effective
product or service differentiation is sustainable because intellectual assets embodied in the total business system are difficult to duplicate [88].

These two developments of knowledge management and e-commerce supplement each other as well as mass customization. Knowledge management provides the mechanism for firms to keep up with innovative activities. As information flows smoothly on the Internet, companies have found it increasingly difficult to enjoy the lasting benefit of new inventions. The only way to stay ahead of competition in the knowledge-based economy is to continue to innovate. Internet technologies have become readily available and affordable, thus the only differentiation lies in a firm’s capability to use Internet technologies. On the other hand, the integration of major business processes required by e-commerce often provides a wealth of data and information that fuels knowledge management leading to the discovery of new mass customized products. The existing literature is abundant regarding the reinforcing effects of e-commerce and knowledge management [89].

Areas for future research in mass customization are many and varied. Quantitative studies measuring and documenting the reinforcement effects of knowledge management and e-commerce for mass customization are needed. In addition qualitative case studies of firms implementing mass customization are needed to illustrate and document the time, frame, costs, and challenges. Cases from a variety of firms and industries can better clarify the process.

Using the survey in Appendix A to gather data from manufacturers considering mass customization is needed from a broad cross section of firms and industries to develop methods and rubrics for assessing readiness from mass customization and to validate the survey instrument. Examples of organizations using the survey are needed. Validating the variables is also needed to ensure a reliable assessment. Further refinements of the assessment should also be studies. Finally, teaching cases for business studies must be developed for IT and production operations management students and to address the dearth of educational materials on mass customization.

### Appendix A. Assessing mass customization readiness

**Customer preferences**

1. What percent of our customers now opt for customization (either from us or a competitor)?
   - Is this percentage
     - Increasing  By approximately what percent? __% (per year)
     - Decreasing  By approximately what percent? __% (per year)

2. Which customers segments are demanding more customization?
   - a. All customers
   - b. More sophisticated users
   - c. More high-end customers
   - d. Longer term users
   - e. Larger customer segments
   - f. Internet savvy users
   - g. Other (please specify) __________________________

3. How much more are customers willing to pay for customized products? __ percent

4. What factors are driving mass customization for our products and industry? (Consider – technology, growing popularity of customization, competition, consumer demands, etc.).

**Internal variables**

5. Do product and/or packing options currently exist that allow our products to be customized? If no, could they be configured to add variety for the customer?

6. What customization options are possible?
   - (Consider, for example, fabric, flavor, personalization, monogramming, flavor, packaging, size, color, number, material, features, texture, etc.)

7. What aspects of mass customization are **attractive** for our firm?
   - a. Build or make to order
   - b. Lower per-unit costs
   - c. Inventory reduction
   - d. Target new customers
   - e. Fewer or no product returns
   - f. Not dependent on sales forecasting
   - g. Higher gross profit margins
   - h. No middle distributors
8. Which of the following make mass customization difficult for our company?
   a. Lack of integrated supply channels
   b. Lack of standardized business process
   c. Lack of well-trained service representatives
   d. Need for full database integration
   e. Sheer complexity of the manufacturing and distribution system
   f. Complex bills of materials
   g. Difficult routings
   h. Pricing difficulties

9. Which time-based manufacturing activities are in place in our organization?
   a. Quality improvement efforts
   b. Supplier certification
   c. Pull production
   d. Preventive or productive maintenance
   e. Supply chain management
   f. Shop floor employee involvement in problem solving
   g. Cellular or group manufacturing of similar products or processes
   h. Setups that allow for quick change over between product runs
   i. Sole sourcing
   j. Concurrent engineering to speed the design-to-production stage
   k. Delivery time reduction
   l. Streamlined ordering, EDI, or automated re-supply of raw materials
   m. Customer collaboration
   n. Teams, employee empowerment, or broad job descriptions
   o. CAD/CAM

10. How do we rate our current manufacturing flexibility for mass customization?
    a. Significantly greater than we need
    b. Exactly where we need to be
    c. Significantly less than we need

11. Approximately what percent of our raw material sourcing is international?
    _____ 0-25%  _____26-50%  _____51-75%  _____75-100%

12. How much of our production takes place in the United States?
    _____ 0-25%  _____26-50%  _____51-75%  _____75-100%

13. What is our average manufacturing cycle time?
    ________________________________

14. What is our average delivery time (from product completion to final customer)?
    ________________________________
The following questions concern the various electronic commerce and knowledge management relationships in your organization.

Business-to-business e-commerce activities (B2B):

15. To what extent do we use the Internet to gather information from customers for creating product and service specifications?
   a. Not at all
   b. Somewhat
   c. Extensively

16. To what extent do we currently use an Intranet to link to suppliers, distributors and other internal and/or external chain partners?
   a. Not at all
   b. Somewhat
   c. Extensively

17. How do we rate our current, computer technology for mass customization?
   a. Significantly greater than we need
   b. Exactly where we need to be
   c. Significantly less than we need

*Please assess the following questions as True or False*

18. Our financial transactions with upstream and downstream business partners are all conducted on WWW and/or EDI.

19. We exchange information, knowledge, and experience with business partners on WWW and/or EDI.

20. We use WWW and/or EDI to communicate and collaborate with our business partners.

21. We use computer networks, including the Internet, to integrate with business partners our work flows.

Business-to-consumer e-commerce activities (B2C):

22. We provide company and products/services information on our website.

23. We conduct product and service transactions online.

24. We provide online search capability for customers’ information inquiry.

25. We offer online customer service and inquiry capabilities.

26. We advertise and promote our products and service online.
Intra-organizational e-commerce activities (intranet):

27. We encourage knowledge and experience sharing among employees using computer networks.

28. We provide networking capabilities for employees to communicate with one another and to engage in group discussions.

29. We attempt to integrate our workflows using Internet technologies.

Knowledge management strategy:

30. The relative emphasis on the two knowledge management strategies of your company is:
   System-driven: _____ %  Personally oriented: _____ %
   (The two numbers should total 100 %.)

31. The relative emphasis on the following two knowledge management strategies of our company is:
   Top-down strategy: _____ %  Bottom-up strategy: _____ %
   (The two numbers should total 100 %.)

Knowledge management Objectives:

32. Our objective for knowledge management implementation is to create electronic databases, digital knowledge bases, document bases, and other digital media so they are can be conveniently accessed by our employees.

33. Our objective for knowledge management implementation is creating valuable knowledge repositories in electronic forms.

34. Our objective for knowledge management implementation is to strengthen our innovation

35. Our objective for knowledge management implementation is to uncover knowledge owned by our employee so it can be utilized more.

Knowledge management critical sucess factors:

36. Our knowledge management initiatives are aligned with our overall business strategy.

37. Knowledge management is viewed as a long term organizational effort rather than just a short-term and one-time endeavor.

38. A flexible organization structure is employed to promote knowledge management efforts, such as an inter-departmental knowledge management team.

39. We have a clear definition for knowledge to distinguish it from data and information.

References


Marilyn Helms is the Sesquicentennial Chair and professor of management at Dalton State College in Dalton, Georgia. She holds a doctorate degree from the University of Memphis. She has published extensively on the topics of strategy, quality, and international management. In addition, she writes a monthly column on management issues for the Dalton Daily Citizen newspaper. She was awarded the Fulbright Teaching and Research Award and taught at the University of Coinbraga in Portugal. She has extensive international teaching experience. She was the recipient of the 2007 Regents’ Teaching Excellence Award for University System of Georgia Two-Year and State Colleges as well as a recipient of the 2006 Dalton State College Foundation Teaching Excellence Award. Her recent research interests include e-commerce, customer service management, and student satisfaction with online and hybrid courses.

Mohammad Ahmadi is Guerry professor of Management Science and Statistics at the University of Tennessee at Chattanooga. He received his PhD in Management Science from the University of North Texas. His numerous articles in areas of statistics and management science have been published by journals including The International Journal of Educational Management, Faculties, The Journal of Career Planning & Employment, The Journal of Computer Information, The Journal of Business and Society and Journal of Education for Business. His worksbooks “Statistics for Business and Economics” (ninth edition) and “Essentials of Statistics for Business and Economics” (fourth edition), which accompany Anderson, Sweeney, and Williams’ textbooks, are published by South-Western Publishing Company. He is a member of DSI and has regularly been a reviewer for the DSI journal and has presented papers at DSI meetings.

Wen-Jang (Kenny) Jih is a professor of computer information systems of the Jennings A. Jones College of Business at the Middle Tennessee State University. He obtained his doctorate degree in business computer information systems from the University of North Texas in 1985. He also holds a Mcom degree in Information Systems, National Chen-Chi University, Taiwan, 1977 and a BS, Physics, National Central University, Taiwan, 1974. His recent research interests include e-commerce, m-commerce, knowledge management, customer relationship management, and innovative instructional methods in information systems.

Lawrence P. Ettkin is the Marvin E. White Professor of Business and Head of the Departments of Management and Marketing & Entrepreneurship at the University of Tennessee at Chattanooga. He has a PhD from the University of Nebraska in Production Management. Ettkin has worked with firms throughout North America developing successful Manufacturing Resource Planning (MRP II), Maintenance Resource Management (MRM), Total Quality Management (TQM), Just-In-Time (JIT) systems, Lean Manufacturing and Project Management Systems. He is past president of the Tri-State Chapter of the American Production and Inventory Control Society (APICS), and served on region staff for 10 years. Dr. Ettkin is Certified at the Fellow Level in Production and Inventory Management (CPIM) by APICS. He is certified as an APICS qualified instructor for all modules of the CPIM review courses. He has presented papers at international and national conferences such as APICS, the Academy of Management and Decision Sciences Institute. In addition, he has published numerous articles in professional journals including: Advances in Competitive Research, Business Horizons, Business Process Management Journal, European Business Review, Quality Assurance in Education, SAM Advance Management Journal, TARGET and TQM Magazine.