Effects of Agile Methods on Website Quality for Electronic Commerce

by David F. Rico
AGENDA

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Conceptual Framework
Research Method
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Author

**DoD Contractor**  
with 24+ Years of Experience

- Large-scale NASA and DoD programs in U.S., Japan, and Europe
- Five books and 13 articles on management of information technology

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### Overview

| Motivation          | Study effects of using agile methods to produce e-commerce websites  
|                    | E-commerce has grown into a $2.4 trillion per year U.S. industry  
|                    | Poor website quality costs firms up to 90% of these revenues  
| Problem            | Agile methods are based on craft industry principles to speed design  
|                    | Traditional methods are based on scientific management principles  
|                    | Agile methods may not have the quality controls of traditional ones  
| Approach           | Developed conceptual model of agile methods and website quality  
|                    | Collected data from 250 individuals producing e-commerce websites  
|                    | Analyzed the relationships between agile methods and website quality  
| Findings           | 68% of our respondents were using principles of agile methods  
|                    | 80% of respondents attributed use of agile methods to various benefits  
|                    | 50% of the factors of agile methods were related to high website quality  
| Summary            | Developed a new framework for analyzing the effects of agile methods  
|                    | There is some evidence linking agile methods to better website quality  
|                    | More gains may be possible by better implementation of agile methods  |
# Key Terminology

| **E-Commerce** | Use of telephone, networks, or the Internet for monetary transactions  
|                | Automation of business transactions such as buying, selling, & delivery  
|                | Application of technology to help buyers and suppliers improve efficiency |
| **E-Commerce Website** | Collection of Web pages, images, videos, sound, or other digital assets  
|                          | Hosted on Web servers connected to the Internet, intranets, or devices  
|                          | Sharing information, maintaining relationships, or executing transactions |
| **Website Quality** | Customer’s view of a website’s overall excellence or superiority  
|                      | Attitude based on comparing expectations to perceived performance  
|                      | Efficient and effective shopping, purchasing, and delivery of products |
| **Traditional Method** | Product design process based on scientific management principles  
|                       | Sequential process of analysis, design, coding, and integration testing  
|                       | Formalized activities, reviews, documents, and a quality control regimen |
| **Agile Method** | New product development process based on craft industry principles  
|                  | Small teams inject customer feedback into frequent software releases  
|                  | Software is designed to evolve, grow, and change to satisfy user needs |
# Introduction

| **Internet**                  | Rapid convergence of PCs. Windows 95, and Netscape in 1995  
|                              | Internet technologies also enabled websites to be built very quickly  
|                              | Number of computers on the Internet increased 41 times to 13 million  |
| **E-Commerce**                | Internet became a medium for conducting business transactions  
|                              | Enabled the instant exchange of trillions of dollars on a global scale  
|                              | Websites became the basic tool for conducting electronic commerce  |
| **Growth**                    | Number of websites has increased 5,936 times to 136 million  
|                              | Number of Internet users has increased 78 times to 1.3 billion  
|                              | Number of Internet shoppers has increased 51 times to 147 million  |
| **Stakes**                    | U.S. e-commerce revenues have grown 96 times to $2.4 trillion  
|                              | 60% to 90% of Internet shoppers abandon poor quality websites  
|                              | Poor website quality results in losses of $204 billion to $1.2 trillion  |
| **Purpose**                   | Managers began using agile methods based on craft industry principles  
|                              | Experts in scientific management principles linked them to poor quality  
|                              | Purpose is to study the effects of agile methods on website quality  |
Internet Websites

136 Million Websites

- 5,936-fold increase in number of websites from 1995 to 2007
- Websites tripled annually from 1997 to 2000 (30% annual growth)
- Internet hosts doubled annually from 1995 to 2000 (30% annual growth)

1.25 Billion Internet Users

- 78-fold increase in number of Internet users from 1995 to 2007
- U.S. represents 19% of total international Internet users (235 million)
- No. America has the highest number of Internet users per capita (69%)

147 Million Internet Shoppers

- 51-fold increase in number of Internet shoppers from 1995 to 2007
- 147 million U.S. Internet shoppers conducted 633 million transactions
- Internet buyers trail Internet shoppers by an average rate of 60% to 90%

Internet Commerce

$2.4\text{ Trillion}
E-Commerce Revenues

- 96-fold increase in e-commerce revenues from 1995 to 2007
- Total U.S. e-commerce revenues reached $2.4 trillion in 2007
- Total U.S. e-retail revenues range from $93 billion to 136 billion

**U.S. E-Commerce Revenues (billions)**

- $189.0 (8%)
- $2,211.3 (92%)

**U.S. E-Retail Revenues (billions)**

- $3.1 (4%)
- $1.2 (1%)
- $0.8 (1%)
- $3.2 (4%)
- $10.0 (12%)
- $2.2 (3%)
- $2.1 (3%)
- $1.2 (1%)
- $19.8 (24%)
- $1.0 (1%)
- $12.3 (15%)
- $22.4 (26%)

- Apparel
- Books
- Food/Drug
- Hardware
- Health
- Jewelry
- Dept. Store
- Office Supplies
- Sporting Goods
- Toys/Hobbies
- Specialty

**Source.** U.S. Census Bureau (2007) and Internet Retailer (2007)
Internet Quality

$1.2$ Trillion
Lost to Poor
Website Quality

- 86-fold increase in lost e-commerce revenues from 1995 to 2007
- Lost sales due to poor quality range from $204$ billion to $1.2$ trillion
- Largest factors of poor quality are bad website design and performance

### Web Surfer Frustrations

<table>
<thead>
<tr>
<th>Reasons for Web Surfer Frustration</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Plug Ins Required</td>
<td>70%</td>
</tr>
<tr>
<td>7 No Interactivity</td>
<td>60%</td>
</tr>
<tr>
<td>6 Boring Content</td>
<td>50%</td>
</tr>
<tr>
<td>5 Confusing Home Page</td>
<td>40%</td>
</tr>
<tr>
<td>4 Too Many Clicks Required</td>
<td>30%</td>
</tr>
<tr>
<td>3 Couldn’t Find Information</td>
<td>20%</td>
</tr>
<tr>
<td>2 Slow Downloading</td>
<td>10%</td>
</tr>
<tr>
<td>1 Difficult Navigation</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Reasons for Abandoned E-Commerce Transactions

<table>
<thead>
<tr>
<th>Reasons for Website Abandonment</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Credit Cards Not Taken</td>
<td>40%</td>
</tr>
<tr>
<td>7 Returned Product</td>
<td>30%</td>
</tr>
<tr>
<td>6 Slow Product Delivery</td>
<td>20%</td>
</tr>
<tr>
<td>5 Needed Customer Service</td>
<td>10%</td>
</tr>
<tr>
<td>4 Website Crashed</td>
<td>0%</td>
</tr>
<tr>
<td>3 Product is Unavailable</td>
<td>0%</td>
</tr>
<tr>
<td>2 Website is Confusing</td>
<td>0%</td>
</tr>
<tr>
<td>1 Website is Slow</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Source.** Netsmart America (1999), Boston Consulting Group (2000), and MarketingSherpa (2007)
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| **Background** | Hundreds of traditional methods were created from 1968 to 1995  
|               | They were designed to address the software crisis of the 1960s  
|               | They evolved into multi-year, multi-million dollar life cycles |
| **Problem**   | New Internet technology enabled websites to be built in record-time  
|               | This gave rise to agile methods based on basic craft industry principles  
|               | Scholars complained that agile methods had insufficient quality controls |
| **Studies**   | Business schools began studying agile methods in the 1990s  
|               | Dozens of narrowly focused studies emerged from 1998 to 2006  
|               | The current period is dominated by attitudinal surveys of agile methods |
| **Deficiencies** | All of the major tenets had yet to emerge at the time of the early studies  
|                | Newer studies were narrowly focused on one or two minor techniques  
|                | None of these studies were based on a scholarly conceptual model |
| **Question**  | Do methods based on craft industry principles improve website quality?  
|               | Does the use of agile methods improve e-commerce website quality?  
|               | Do factors of agile methods improve e-commerce website quality? |
Evolution of Traditional Methods

- 100s of traditional methods emerged from 1968 to 1995
- Purpose was to solve the software productivity crisis of 1960s
- U.S. DoD led the development of traditional methods until mid-1990s

100s of Traditional Methods

- MIL-STD-1679
- DOD-STD-2167
- DOD-STD-2167A
- DOD-STD-7935A
- NSA-1703
- MIL-STD-498
- IEEE/EIA 12207
- ISO/IEC 12207

1970  MIL-STD-483  Configuration Management
1978  DOD-STD-480A  Configuration Control
1979  MIL-S-52779A  Quality
1983  MIL-STD-1815A  Ada83 Language Reference
1983  DOD-STD-7935  Documentation Standards
1983  DOD-STD-1679A  Software Development
1984  DOD-STD-1644B  Training Software Development
1985  MIL-STD-1521B  Technical Reviews and Audits
1985  DOD-STD-2167  Defense System Software
1988  DOD-STD-7935A  Documentation Standards
1988  DOD-STD-2167A  Defense System Software
1988  DOD-STD-2168  Defense System Software Quality
1992  MIL-STD-793  Configuration Management
1994  MIL-STD-498  Software Development
1996  IEEE/EIA 12207  Software Life Cycle Processes

What Traditional Methods Became

Multi-Year, Multi-Million Life Cycles

- Required millions of dollars in activities, documents, and reviews
- Intended for large systems like missiles, airplanes, and spacecraft
- Larger projects have greater requirements volatility and failure rates

Evolution of Agile Methods

Dozens of agile methods emerged from 1989 to 2003
• Purpose was to accelerate traditional methods from the 1990s
• Origins in systems theory and new product development from 1980s

<table>
<thead>
<tr>
<th>Systems Theory</th>
<th>New Product Development</th>
<th>Agile Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>(customer feedback and flexibility)</td>
<td>(iterative development and well-structured teams)</td>
<td>(iteration, feedback, teams, and flexibility)</td>
</tr>
<tr>
<td>• 1928 - Organismic biology (Bertalanffy)</td>
<td>• 1964 - Concept testing (Axelrod)</td>
<td>• 1999 - New development rhythm (Sulack)</td>
</tr>
<tr>
<td>• 1949 - Cybernetics (Wiener)</td>
<td>• 1968 - Systematic new product dev. (Credland)</td>
<td>• 1991 - Crystal methods (Cockburn)</td>
</tr>
<tr>
<td>• 1956 - Systems theory (Boulding)</td>
<td>• 1975 - Overlapping operations (Szczerbiński)</td>
<td>• 1993 - Scrum (Sutherland)</td>
</tr>
<tr>
<td>• 1958 - Industrial dynamics (Forrester)</td>
<td>• 1976 - Cross functional teams (Likert)</td>
<td>• 1993 - Dynamic systems development (UK)</td>
</tr>
<tr>
<td>• 1961 - Butterfly effect (Lorenz)</td>
<td>• 1976 - Customer active paradigm (Von Hippel)</td>
<td>• 1995 - Synch-n-stabilize (Cusumano)</td>
</tr>
<tr>
<td>• 1966 - Learning by doing (Levhari)</td>
<td>• 1983 - Integrated product development (Goulding)</td>
<td>• 1997 - Feature driven development (Palmer)</td>
</tr>
<tr>
<td>• 1975 - Chaos (Yorke)</td>
<td>• 1984 - User initiated innovation (Foxall)</td>
<td>• 1998 - Judo strategy (Cusumano)</td>
</tr>
<tr>
<td>• 1976 - Double loop learning (Argyris)</td>
<td>• 1986 - Lead user method (Von Hippel)</td>
<td>• 1998 - Internet time (MacCormack)</td>
</tr>
<tr>
<td>• 1982 - Adaptive organization (Anderson)</td>
<td>• 1986 - New product development game (Takeuchi)</td>
<td>• 1998 - Extreme programming (Anderson)</td>
</tr>
<tr>
<td>• 1990 - Learning organization (Senge)</td>
<td>• 1988 - Time-based competition (Bower)</td>
<td>• 1999 - Open source software (Raymond)</td>
</tr>
<tr>
<td>• 1992 - Edge of chaos (Lewin)</td>
<td>• 1989 - Simultaneous engineering (Dean)</td>
<td>• 2000 - Rational unified process (Kruchten)</td>
</tr>
<tr>
<td>• 1995 - Sense and response (Randall)</td>
<td>• 1990 - Concurrent engineering (Kusiak)</td>
<td>• 2000 - Adaptive software design (Highsmith)</td>
</tr>
<tr>
<td>• 1996 - Ecosystems (Moore)</td>
<td>• 1997 - Continuous innovation (Brown)</td>
<td>• 2001 - Agile manifesto (Beck)</td>
</tr>
<tr>
<td>• 1997 - Chaotic organizations (Hock)</td>
<td>• 1998 - Experimentation (Thomke)</td>
<td>• 2003 - Lean development (Poppendieck)</td>
</tr>
</tbody>
</table>
What Agile Methods Became

**Daily, Weekly, and Monthly Life Cycles**
- Involved few activities, little documentation, and a lot of coding
- Intended for small systems like Internet applications and websites
- Smaller projects have greater requirements stability and success rates

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**Source:** Agile Manifesto (2001) and Highsmith (2002)
### Traditional vs Agile Methods

#### Scientific Management vs. Craft Industry
- **Traditional** — Mass production, autocratic control, and defect reduction
- **Agile** — Custom products, egalitarian control, and customer satisfaction
- “Any color as long as it’s black” vs. “a car for every purse and purpose”

<table>
<thead>
<tr>
<th>Traditional Methods (scientific management principles)</th>
<th>Agile Methods (craft industry principles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Manufacturing oriented</td>
<td>- Job-shop oriented</td>
</tr>
<tr>
<td>- Mass production</td>
<td>- Mass customization</td>
</tr>
<tr>
<td>- Mass market</td>
<td>- Micro-market segmentation</td>
</tr>
<tr>
<td>- “As long as it’s black…”</td>
<td>- “Every purse and purpose…”</td>
</tr>
<tr>
<td>- Production lines</td>
<td>- Manufacturing cells</td>
</tr>
<tr>
<td>- Autocratic</td>
<td>- Egalitarian</td>
</tr>
<tr>
<td>- Centralized</td>
<td>- Decentralized</td>
</tr>
<tr>
<td>- Division of labor</td>
<td>- Empowerment</td>
</tr>
<tr>
<td>- Specialization</td>
<td>- Multi-disciplinary</td>
</tr>
<tr>
<td>- Individualism</td>
<td>- Collectivism</td>
</tr>
<tr>
<td>- Economies of scale</td>
<td>- Economies of scope</td>
</tr>
<tr>
<td>- Cost</td>
<td>- Value</td>
</tr>
<tr>
<td>- Efficiency</td>
<td>- Effectiveness</td>
</tr>
<tr>
<td>- Reliability</td>
<td>- Elegance</td>
</tr>
<tr>
<td>- Defect reduction</td>
<td>- Capability enhancement</td>
</tr>
<tr>
<td>- Quality control</td>
<td>- Customer satisfaction</td>
</tr>
</tbody>
</table>

**Crux** — Agile methods may be good for small websites, but may result in poor quality that costs trillions of dollars

**Source.** Pine (1992), Tushman and O’Reilly (1996), and Boehm and Turner (2004)
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# Literature Review

| Computer Industry | · Electronic computers emerged in the 1940s  
|                   | · Operating systems and Internet emerged in the 1960s  
|                   | · Software industry emerged in 1969 and grew to $394 billion in 2000s |
| Electronic Commerce | · ATM, EFT, NYSE, FAX, POS, and EDI emerged from 1964 to 1980  
|                    | · HTML and HTTP created by Tim Berners-Lee from 1980 to 1990  
|                    | · Pentium, Windows 95, and Netscape platform converges in 1995 |
| Software Methods  | · PM, life cycles, reviews, testing, QA, and CM emerge from 1966 to 1991  
|                    | · Structured, formal, OO, and reuse methods emerge from 1969 to 1992  
|                    | · Prototyping, JAD, RAD, and agile methods emerge from 1982 to 1999 |
| Agile Methods     | · New development rhythm, synch-n-stabilize emerge from 1989 to 1995  
|                   | · Crystal, Scrum, DSDM, FDD, and XP emerge from 1991 to 1998  
|                   | · Judo strategy and Internet time emerge from 1995 to 1998 |
| Software Quality  | · Software attribute models created by Logicon in 1968  
|                   | · Algorithmic models created by McDonnell Douglas in 1972  
|                   | · User satisfaction emerged in 1974 and website quality in 1997 |
17 Major Kinds of Software Methods

- Developed one of the first timelines and histories of software methods
- Identified 17 major classes of software methods emerging since 1961
- Our 75-page literature review will be published in its entirety in 2008

Source. Rico, Sayani, and Field (2008)
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<table>
<thead>
<tr>
<th><strong>Conceptual Framework</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agile Manifesto</strong></td>
</tr>
<tr>
<td>- Analyzed factors from 175 interdisciplinary books and studies</td>
</tr>
<tr>
<td>- Selected final subfactors from an analysis of nine major approaches</td>
</tr>
<tr>
<td>- Synch-n-stabilize, judo strategy, and Internet time were most influential</td>
</tr>
<tr>
<td><strong>Iterative Development</strong></td>
</tr>
<tr>
<td>- Process of making multiple smaller products until a problem is solved</td>
</tr>
<tr>
<td>- Time-boxed, operational, small, frequent, and numerous releases</td>
</tr>
<tr>
<td>- Process of rapid experimentation similar to Pasteur and Edison</td>
</tr>
<tr>
<td><strong>Customer Feedback</strong></td>
</tr>
<tr>
<td>- Process of soliciting market feedback on working software releases</td>
</tr>
<tr>
<td>- Feedback solicited, received, frequency, quality, and incorporated</td>
</tr>
<tr>
<td>- Process of beta testing similar to early market concept testing</td>
</tr>
<tr>
<td><strong>Well-Structured Teams</strong></td>
</tr>
<tr>
<td>- Small programming teams with semi-formal managerial structures</td>
</tr>
<tr>
<td>- Team leader, vision, strategy, goals, objectives, schedules, timelines</td>
</tr>
<tr>
<td>- Specialized teams with authority and resources to solve critical problem</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
</tr>
<tr>
<td>- Powerful, inexpensive, easy to use, and adaptable technology</td>
</tr>
<tr>
<td>- Small size, simple, modular, portable (JVM), and extensible design</td>
</tr>
<tr>
<td>- High productivity tools such as 4GLs, GUIMS, and program generators</td>
</tr>
</tbody>
</table>
Conceptual Model

Conceptual Model based on Agile Manifesto

- Creators of agile methods met in 2001 to outline their principles
- Outlined four broad values corresponding to our conceptual model
- Similar to NPD software methods from IBM, Microsoft, and Netscape

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## Research Method

| Research Design | Determine if the use of agile methods is related website quality  
|                 | Survey to rapidly and economically collect as much data as possible  
|                 | Small cross-sectional survey to measure current U.S. software methods |
| Research Instruments | Designed a 20-item agile methods instrument from conceptual model  
|                     | Adapted the 14-item eTailQ instrument from an analysis of 80 studies  
|                     | Performed cognitive interviews and pilot tests to evaluate instruments |
| Data Collection | Designed and posted a self-administered questionnaire on the Internet  
|                  | Announced the survey in a major U.S. online software magazine  
|                  | Collected data from 250 respondents in about two-weeks |
| Data Analysis | Seven-point Likert scale ranging from strongly disagree to strongly agree  
|                | The overall mean was 5.04 loosely corresponding to “somewhat agree”  
|                | We used SPSS for descriptive, correlational, and regression analysis |
| Threats to Validity | Respondents were self-selected and provided minor incentives  
|                    | Respondents were from a contemporary online software magazine  
|                    | Respondents were not necessarily webmasters or from Internet retailers |
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# Data Analysis

| Demographic Data | • Response rate for demographic data was very good  
|                 | • Software engineers (38%) from the information industry (21%)  
|                 | • 11-15 years of exp. (22%), 1-19 employees (17%), <$1M revenue (22%)  
| Agile Methods Data | • Respondents generally agreed with statements about agile methods  
|                  | • Iterative (70%), feedback (68%), teams (74%), and flexibility (61%)  
|                  | • Agile methods factors were related using regression analysis  
| Benefit Data | • Respondents generally agreed with statements about benefits  
|              | • Cost (74%), productivity (82%), quality (80%), and speed (81%)  
|              | • Benefit factors were related using regression analysis  
| Website Quality Data | • Respondents generally agreed with statements about website quality  
|                   | • Design (82%), privacy (67%), fulfillment (70%), and service (80%)  
|                   | • Website quality factors were related using regression analysis  
| Hypothesis Testing | • Agile methods were correlated to website quality in-general (0.10)  
|                   | • Iterative development (0.04) and customer feedback (0.10) correlated  
|                   | • Well-structured teams (0.05) and flexibility (0.03) “negatively” correlated  

Sensitivity Analysis

60% Subfactors Correlated to Website Quality

- Iterative, feedback, and team subfactors correlated to website quality
- Feedback quality and small team size not correlated to website quality
- Four out of five flexibility subfactors weren’t correlated to website quality

Source: Rico, Sayani, Stewart, and Field (2007) and Rico (2008)
Hypothesis Tests

Agile Methods Correlated to Website Quality

- Aggregated model of agile methods correlated to website quality
- Iterative development and customer feedback correlated to quality
- Well-structured teams and flexibility negatively correlated to quality

Source: Rico, Sayani, Stewart, and Field (2007) and Rico (2008)
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## Conclusion

### Findings
- 68% use agile methods, though 46% get poor quality customer feedback
- 80% reported positive benefits and 76% had good website quality
- 83% of respondents were from small to medium-sized firms

### Limitations
- Conceptual model of agile methods is new and needs more validation
- Limited number of respondents and data from 20 different industries
- Small-scale study with non-random participants and respondents

### Lessons
- Submitting stakeholder papers to conferences results in good feedback
- Doing a thorough industry analysis helps refine the research problem
- Using a simple research design ensures success of data collection

### Contributions
- Designed conceptual model and survey instruments for agile methods
- Collected original data beyond mere attitudes about agile methods
- Published three articles and literature review as a book chapter

### Future Studies
- Simplify research method to increase amount and quality of data
- Refine and improve conceptual model to address technology issues
- Focus on Internet retailing firms and combine with use of case studies