Organizational Change Perspectives on Software Process Improvement

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Organizational Change Perspectives on Software Process Improvement

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Organizational Change Perspectives on Software Process Improvement

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Abstract

Many software organizations have engaged in Software Process Improvement (SPI) and experienced the challenges related to managing such complex organizational change efforts. As a result, there is an increasing body of research investigating change management in SPI. To provide an overview of what we know and don't know about SPI as organizational change, this paper addresses the following question: What are the dominant perspectives on SPI as organizational change in the literature and how is this knowledge presented and published? All journals on the AIS ranking list were screened to identify relevant articles and Gareth Morgan's organizational metaphors (1996) were used to analyze this literature considering the following dimensions of each article: organizational perspective (metaphor), knowledge orientation (normative versus descriptive), theoretical emphasis (high versus low), main audience (practitioner versus academic), geographical origin (Scandinavia, the Americas, Europe, or the Asia-Pacific), and publication level (high versus low ranked journal).

The review demonstrates that the literature on SPI as organizational change is firmly grounded in both theory and practice, and Scandinavia and the Americas are the main contributors to this research. The distribution of articles across Morgan's metaphors is uneven and reveals knowledge gaps that present new avenues for research. The current literature offers important insights into organizational change in SPI from machine, organism, and brain perspectives. Practitioners may use these articles as a guide to SPI insights relevant to their improvement initiatives. In contrast, the impact of culture, dominance, psychic prison, flux and transformation, and politics in SPI have only received scant attention. We argue that these perspectives offer important insights into the challenges involved in managing change in SPI. Researchers are therefore advised to engage in new SPI research based on one or more of these perspectives. Overall, the paper provides a roadmap to help identify insights and specific articles related to SPI as organizational change.

Keywords: Software Process Improvement, Organizational Change, Organizational Metaphors, Images of Organization, Literature Review

1. Introduction

Software Process Improvement (SPI) covers a wide variety of approaches and practices aimed at improving quality and reliability, employee and customer satisfaction, and return on investment in

software development. SPI dates back to the founding of the Software Engineering Institute at Carnegie Mellon University in 1984 and the publishing of Watts Humphrey's book "Managing the Software Process" (1989). Since then the industrial and scientific interest in SPI has been persistently strong as reflected in nearly 400 contributions in the journals on the Association of Information Systems' (AIS) journal ranking list (http://www.isworld.org/csaunders/rankings.htm). This extensive body of knowledge has previously been reviewed (Aaen et al., 2001; Jakobsen et al., 2003; Hansen et al., 2004), but never with a focus on SPI as organizational change.

As the organizational change processes involved in SPI are rather complex and success in SPI heavily depends on how change is perceived and managed (Kautz et al., 2001; Frederiksen & Rose, 2003; Iversen et al., 2004; Kautz & Nielsen, 2004; Hardgrave & Armstrong, 2005; Mathiassen et al., 2005), this paper reviews the insights offered on this subject in the literature. Such insights may inform software managers in their practical efforts and guide researchers in their continued investigation of SPI practices. Through a systematic process, we identified 46 scientific articles on SPI that deal with organizational change. To analyze the different perspectives that are present within this body of knowledge, we adopted metaphorical thinking as suggested by Gareth Morgan. In his seminal work "Images of Organization", he emphasizes that "all theories of organization and management are based on implicit images or metaphors that lead us to see, understand, and manage organizations in distinctive yet partial ways" (Morgan, 1996: 4). Following this logic, metaphorical thinking can help us understand in what directions our current knowledge on SPI guide change management perceptions and practices, and in what new directions we need to search to arrive at a more comprehensive understanding of change management in SPI.

With Morgan's metaphors as the overarching lens, we identified each article's knowledge orientation (normative versus descriptive), emphasis on theory (high versus low), main audience (practitioner versus academic), geographical origin (location of researchers), and publication level (high versus low ranking journal). Hence, we used metaphorical thinking in combination with other key characteristics to address the following research question: What are the dominant perspectives on SPI as organizational change in the literature and how is this knowledge presented and published? By addressing this question, the paper adds to the literature applying organizational perspectives to help us understand the complexities and variations involved in software engineering and management (e.g. Hirschheim & Klein, 1989; Iivari, 1991; Kendall & Kendall, 1993; Ngwenyama & Nielsen, 2003).

Our analyses has led to a comprehensive overview of the literature revealing both strengths and weaknesses. Firstly, some perspectives on organizations are well explored; others are researched more sporadically; and still others are not researched at all despite their arguable relevance for SPI practices. Secondly, a major part of the research is descriptive in nature, and most articles have a high emphasis on theory. Thirdly, most articles are written for an academic audience, but there is also a considerable representation of practitioner oriented contributions. Interesting differences and similarities exist between academic articles published in high ranked journals versus those published in lower ranked journals. Finally, the analyses reveals that the major part of research on SPI as organizational change originate in Scandinavia and the Americas, while only minor parts originate in the rest of Europe and the Asia-Pacific.

Our analyses and detailed findings are presented and discussed as follows. First, we present the theoretical background for the review. Second, we describe the method through which we identified and analyzed the literature. Third, we characterize the 46 identified articles on SPI and describe

how they represent different perspectives on organizational change. Fourth, we discuss the findings and point out implications for both research and practice.

2. Theoretical Framing

SPI covers a great variety of approaches to improving software engineering practices. Definitions of SPI abound. For example, SPI "is an applied academic field rooted in the software engineering and information systems disciplines. It deals with the professional management of software firms, and the improvement of their practice, displaying a managerial focus rather than dealing directly with the techniques that are used to write software" (Hansen et al., 2004: 457).[i] Initially, SPI has had an affinity with software engineering, but the field has been broadened to encompass information systems development and management of software firms more broadly. In this paper, we adopt this broader view and in line with contemporary research we consider knowledge on organizational change as key to successfully manage SPI initiatives (Kautz et al., 2001; Frederiksen & Rose, 2003; Iversen et al., 2004; Kautz & Nielsen, 2004; Hardgrave & Armstrong, 2005; Mathiassen et al., 2005).

As noted earlier, a wealth of articles has been published on SPI, and a number of authors have reviewed the literature from different angles and for different purposes. First, Jakobsen et al. conducted a literature study to uncover factors influencing SPI readiness (2003). Second, Hansen et al. reviewed and categorized the literature into three different types of contributions, namely prescriptive, descriptive, and reflective contributions (2004). "Prescriptive contributions are primarily concerned with informing SPI practitioners how they can carry out software process improvement initiatives. Descriptive contributions are primarily concerned with describing those initiatives. Reflective contributions are primarily concerned with setting the other contributions in a theoretical context, or developing theory" (Hansen et al., 2004: 458). Third, Aaen et al. provided an in-depth examination of the SPI literature and identified the fundamental ideas underlying SPI approaches and practices, i.e. ideas related to management of (M), approach to (A), and perspective on (P) SPI. This set of ideas comprises a "MAP" that can be used to evaluate strengths and weaknesses of SPI initiatives (Aaen et al., 2001; Pourkomeylian, 2001). This paper presents a literature review that complements these contributions by analyzing the SPI literature from an organization change perspective using Morgan's "Images of Organization" (1996) as the analytical framework.

Morgan describes eight images or metaphors of organizations that represent distinct and different ways to perceive and manage organizational life, see Table 1. Taken together these lenses express the richness of organizational theory and they can inform new research by supporting alternative thinking and by leading to more comprehensive insights into organizational practices. Morgan's metaphors invite us to apply a wide and varied range of perspectives on situations as they play out in organizations an this leads to richer perceptions and a wider set of options for managerial intervention. Each metaphor is a powerful conceptual tool that allows important insights to emerge, but that also has limitations, because it produces one-sided knowledge by favoring some interpretations while neglecting others. Below is a description of each of Morgan's eight metaphors.

Table 1. Morgan's Metaphors

Metaphor	*Key Characteristics*
Machine	• Organizations as machines of interlocking parts • Rules and regulations in bureaucratic organizations • Routinization, efficiency, reliability, and predictability
Organism	• Organizations as living systems • Environmental adaptation • Different species of organizations
Brain	• Organizations as learning systems • Information processing in decision-making and communication • Knowledge management and capacity for learning
Culture	• Organizations as cultures • Social interaction and shared meaning in organizational behavior • Values, ideas, beliefs, norms, and rituals
Political System	• Organizations as stages for political gaming • Conflicting interests and the use of power to resolve conflicts • political dimensions of structures, technologies, and strategies
Psychic Prison	• Organizations as mental prisons • Trapped by conscious and unconscious thoughts, ideas, and beliefs • Habitual thinking and rigid thought patterns
Flux and transformation	• Organizations as self-producing systems • Forces shaping organizations in a permanent state of movement • Logics of change shaping social life
Instrument of domination	• Organizations as a state of slavery • Hidden agendas and exploitative actions through the use of power • Class-based tensions and oppression

Organizations as machines involves thinking about organizations as a machine made up of interlocking parts with each part playing a clearly defined role in the functioning of the whole. In the thoughts of Max Weber, the machine metaphor underpins the development of bureaucratic organizations through rules and regulations. This form of management can at times prove highly effective and productive, but at other times it can have unfortunate results. Routinization, efficiency, reliability, and predictability are desirable characteristics of organizations when viewed through this mechanistic lens. Mechanistic management is an ingrained part of the conventional theorizing about organizations (Morgan, 1996: Chapter 2).

Organizations as organisms involves thinking about organizations as living systems, focusing on organizational needs and environmental relations. It is in this view feasible to identify different species of organizations that are suited for some environments but not for others. The organism metaphor helps us understand how organizations are born, grow, develop, decline, and die, and how they can adapt to changing environments, e.g. new social, technological, or political circumstances (Morgan, 1996: Chapter 3).

Organizations as brains involves thinking about organizations as learning systems that serve to control and coordinate activities of autonomous subsystems. This metaphor draws attention to information processing, learning, knowledge management, and intelligence. When looking at organizations as information processing brains, the focus is on communication and decision making. When thinking of organizations as learning systems, focus centers on capacities for learning as exemplified by single-loop learning versus double-loop learning.[ii] The brain metaphor implies a holistic systems view with a high degree of connectivity between the different parts - each with a high degree of task specialization that contributes to certain general functions. Control and

hierarchy are undesirable organizing principles when organizations are considered as learning systems (Morgan, 1996: Chapter 4).

Organizations as cultures involves thinking about organizations in terms of the values, ideas, beliefs, norms, rituals, and other patterns of shared meaning that guide organizational life. This metaphor brings attention to the different ways people behave and the reasons for their behaving in certain ways. Culture develops through processes of social interaction and is not imposed. Successfully managing organizations requires dealing with cultures and subcultures within the organization. Power can be exerted to influence corporate culture, but it is not necessarily the formal sources of power that impact corporate cultures the most. Opinion leaders, for example, are perceived to be powerful actors that contribute to the shaping of corporate cultures (Morgan, 1996: Chapter 5).

Organizations as political systems involves thinking about organizations as stages for political gaming. The focus is on interests, conflicting interests, and the use of power to resolve conflicts. All organizational activity and functioning is interest based which means that, for example, structures, technologies, and strategies have a political dimension. Private and organizational interests cause people to act politically, and these acts have a disintegrative effect on an organization by pulling it in different directions. The political system metaphor is ideally suited for likening organizations to systems of government by drawing attention to the many factors that shape politics in organizational life (Morgan, 1996: Chapter 6).

Organizations as psychic prisons involves thinking about organizations as psychic phenomena. People unconsciously become trapped by their own thoughts, ideas, and beliefs thereby creating mental prisons that enslave them by making it difficult, if not impossible, to escape habitual thinking and rigid thought patterns. The psychic prison metaphor invites examinations of organizational life to see if, and in what ways, organizations become trapped by conscious and unconscious processes of their own devise (Morgan, 1996: Chapter 7).

Organizations as flux and transformation focuses on the logics of change that shape social life. The metaphor is expressed in different ways grounded in the belief that the universe is in a permanent state of movement. One view emphasizes organizations as self-producing systems that create and recreate themselves in their own image. A second view depicts organizations as complex and chaotic entities shared through different forms of agency. A third view portrays organizations as the result of circular flows of positive and negative feedback. And, a fourth view focuses on organizations as a result of dialectical processes in which every phenomenon generates its opposite. The flux and transformation metaphor is particularly useful in understanding and managing change and in appreciating the many forces within society that shape organizations (Morgan, 1996: Chapter 8).

Organizations as instruments of domination brings attention to how organizations achieve their ends through the use of power. The underlying idea is that organizations as a reflection of society replicate the class-based tensions between capitalists and the proletariat or between the 'have and have-nots'. One group uses its power to exploit the other group and to keep it in a contemporary state of slavery. The instrument of domination metaphor is useful in helping us understand organizations from the perspective of exploitation and oppression. Hidden agendas make for different interpretations of action, so actions that appear rational from one perspective can prove exploitative from a different viewpoint (Morgan, 1996: Chapter 9).

3. Review Methodology

A literature review should be complete and focus on concepts (Webster & Watson, 2002). Two of the key issues are therefore how to identify the relevant literature and how to structure the analysis of the included literature.

3.1 Selection of Literature

At the outset it was decided to focus on SPI articles that explicitly deal with some aspect of organizational change. Consequently, articles that explore other albeit also interesting SPI topics, e.g. metrics (e.g. Gopal, 2005) or return on investment (e.g. Ebert, 1999), were excluded. This decision was grounded in our interest in understanding what we as a research community know and don't know about SPI as organizational change. In addition, we decided to limit the search to the 125 journals on the AIS journal ranking list because it merges eight individual ranking lists covering both software engineering and information systems journals (Rainer & Miller, 2005; Lowry et al., 2004; Katerattanakul et al., 2003; Peffers & Tang, 2003; Mylonopoulos & Theoharakis, 2001; Whitman et al., 1999; Hardgrave & Walstrom, 1997; Walstrom et al., 1995).

To systematically search through the journals and identify relevant articles for this review, we applied certain methods and search criteria. We used a combination of 'meta-search' engines provided by a host of databases (Blackwell Synergy, Business Source Premier, Directory of Open Access Journals, JSTOR, Kluwer/SpringerLink, Emerald, Oxford Journals (Oxford University Press), Elsevier, Wiley InterScience, and SourceOECD) and the search facilities provided by each journal.[iii] This approach was devised to overcome the problem of articles being indexed differently across databases. The initial pool of potentially interesting articles was produced by searching for the terms "SPI" or "Software Process Improvement" in either the title, the abstract, the keywords, or the body text of the article. 26 of the 125 journals on the AIS list contained articles that satisfied the search criteria, and the process led to 371 potentially interesting articles that had some relation to SPI.

Next, we identified from this pool relevant articles that deal with organizational change in SPI. Whereas the initial selection of potential articles was done automatically, the screening of articles that followed was interpretive in nature. We identified a number of keywords to support this process of selecting and deselecting articles from the larger pool. For each article, we looked for "change", "change management", "organizational change", "organizational development", "process change" or synonymous concepts to appear in the title, abstract, keywords or introduction. Furthermore, this assessment was done independently by each of the authors to determine which of the articles to include in the literature review. In cases of disagreement the content of the article in question was scrutinized to reach a decision. In the end, 46 of the 371 articles (12%) were determined to meet the criteria of addressing SPI with an organizational change focus. These 46 articles were published between 1994 and 2006.

3.2 Analyses of Literature

In addition to analyzing the identified articles through the lens of Morgan's organizational metaphors, we identified other concepts and distinctions that could help us characterize how the existing body of knowledge on SPI as organizational change is presented and published. A

summary of the resulting concepts and codes that were used to analyze each of the 46 articles is provided in Table 2.

Table 2. Codes applied to characterize articles

Concept	Definition of Code
Organizational perspective	Metaphor: Machine; Organism; Brain; Culture; Political System; Psychic Prison; Flux and Transformation; Instrument of Domination; Multi-perspective (for definitions see Table 1 and 3)
Knowledge orientation	Normative: Offers prescriptions, recommendations, normative guidelines, and generic strategies to support SPI practices Descriptive: Offers insights from 'the trenches' that foster greater understanding of SPI practices
Theoretical emphasis	High: Theory plays an important role as foundation, analytical framework, or contribution Low: Lack of substantial elements of theory as foundation, analytical framework, or contribution
Main audience	Practitioner: The journal's mission and content is mainly targeting a practitioner audience Academic: The journal's mission and content is mainly targeting an academic audience
Geographical origin	Scandinavia: The primary authors were located and the investigations were conducted in Scandinavia Europe: The primary authors were located and the investigations were conducted in the rest of Europe Americas: The primary authors were located and the investigations were conducted in the Americas Asia-Pacific: The primary authors were located and the investigations were conducted in Asia-Pacific
Publication level	Highly ranked: the top ⅓ of the identified academic articles according to the AIS ranking list of journals Low ranked: the bottom ⅔ of the identified academic articles according to the AIS ranking list of journals

*: More than one perspective.

First, the articles were coded according to the underlying organizational metaphor. To that end, we conducted content analysis (Miles & Huberman, 1994; Beath & Orlikowski, 1994; Lyytinen et al., 1998) of each chapter in "Images of Organization" to identify keywords and issues that would help identify each article's primary underlying perspective. This effort advanced our understanding of each metaphor and led to the brief summaries presented above. To further support the analysis, we used the software tools ATLAS.ti (http://www.atlasti.com) and Leximancer (http://www.leximancer.com) to produce word counts and to extrapolate core concepts from each of the chapters in "Images of Organization" (Morgan, 1996), and we identified lists of themes that we would expect to find in the SPI literature based on each of Morgan's eight metaphors. An overview of these keywords and themes is provided in Table 3. Each article was then read independently by the three authors and a primary metaphor was ascribed based on qualitative content analysis (Miles & Huberman, 1994; Beath & Orlikowski, 1994; Lyytinen et al., 1998). After this individual coding, results were compared and in case of disagreement the article's underlying organizational perspective was discussed and differences of opinion were reconciled. Some articles fit more than one metaphor. An example is the article by Frederiksen & Rose (2003) that has elements pointing towards the brain, political system, culture, and psychic prison metaphors. The elements that deal with the search and use of knowledge in the organization being investigated fit the brain metaphor. The emphasis on rules, norms, and values within the organization relates to the culture metaphor.

The unveiled interests and power struggles suggest the political system metaphor. However, the psychic prison metaphor dominates the article, because the recurrent theme is the psychological entrapment of employees into certain perceptions of software development and software metrics. In this case, people were kept prisoners by existing mental schemes and thought patterns, and the new metrics program accomplished little in terms of change, but instead reinforced the current state of affairs. In the end, three articles were coded as multi-perspective because they rely on explicit combinations of two or more metaphors. The article by Kautz et al. (2001) is a case in point. It deals with the multiple roles of change agents in SPI. Based on the framework by Burrell & Morgan (1979), four change agent roles are identified. The technical expert shares many characteristics with the machine metaphor. The facilitating participant fits the culture metaphor. Not surprisingly, the political agent stems from the political system metaphor. Finally, the individual therapist and the psychic prison metaphor are closely related.

Table 3. Keywords and themes based on content analysis of (Morgan, 1996)

Metaphor	*Keywords*	*Themes*
Machine	- work/worker(s) - principle(s) - control - mechanistic/machine(s) - classical - production	- Factors that influence SPI - Routinization, reliability, efficiency and predictability of production - Controllable variables - Normative models and generic/universal strategies for SPI - SPI under conditions of stability and static organizational characteristics
Organism	- environment(s) - system(s) - relations - species - structure(s) - nature - needs - open - organism(s)	- Organizational needs; balance of needs - Adaptation to internal and external surroundings/environment - Development, growth, survival and evolution of organizations - Environmental changes (e.g. social, technological, and political environmental factors) - Organizational context - Organizational relations
Brain	- learning - information - brain(s) - system(s) - intelligence - holographic	- Knowledge; knowledge management - Organizational learning, working iteratively, learning through iteration - Information processing in organizations - Groups with specialized knowledge (knowledge centers) - Knowledge of process areas as key to success in SPI
Culture	- cultural/culture(s) - values - people - life - reality - social	- Rules, norms, ideas, beliefs, motivation, values, and rituals in groups - SPI acceptance - Job/employee satisfaction and work environment - Intraorganizational behavior and climate
Political system	- power - control - political/politics - interests - work	- Interests and conflicts between different (interest) groups - Power relations - Patterns of influence

	- influence - relations - conflict(s)	
Psychic prison	- unconscious - life - change - control - reality - group(s) - human(s) - understanding	- Freezing/locking of organization by existing patterns - Organizational members unconsciously trapped by their own minds, thoughts, ideas, and beliefs
Flux and transformation	- change(s) - system(s) - environment(s) - pattern(s) - context - chaos	- Logics of change shaping social life - Constant dynamic movement within and beyond the organization - Uncontrollable or chaotic organizational change
Instrument of domination	- domination - labor - work/workers - power - interests - control	- Focus on exploitative and negative aspects of corporate life - Organizations that use employees, host communities, and the world economy to obtain goals by use of power and domination - Forced SPI initiative

Second, we coded the primary knowledge orientation of each paper into being normative versus descriptive, see Table 2. Normative articles focus on prescriptions, recommendations, normative guidelines, and generic strategies for SPI practitioners. An example of such an article is Iversen et al. (2004) offering five strategies, specific techniques, and an overall process to manage risks in SPI teams. Descriptive articles on the hand present insights from 'the trenches' that foster a greater understanding of SPI. An example of this type of article is the case study by Keeni (2000) offering experience data on how successful changes in quality processes occurred over a 10-year period in an organization. Descriptive articles also include theoretical analyses of relevant SPI topics, including the analysis of the SW-CMM and People CMM models by Ngwenyama & Nielsen (2003). Articles may, of course, contain both descriptive and prescriptive elements, so we determined for each paper the primary knowledge orientation, i.e. whether the articles set out to provide recommendations for practitioners and researchers or to promote an understanding of certain aspects of SPI.

Third, we coded the emphasis on theory into high versus low, see Table 2. Very few articles are devoid of theoretical background information, theorizing, or theoretical backing for the analyses that are performed or the empirical findings that are presented. However, for an article to be labeled high on theoretical emphasis, theory must play an important role in relation to the argument of the article in terms of (1) input (foundation), (2) analyses (framework), or (3) output (contribution). Articles that were coded as being low on theoretical emphasis lacked substantial elements of theory in this sense. Articles of this type typically focus on experiences, events, or lessons from a particular organizational context (e.g. Börjesson & Mathiassen, 2004).

Fourth, we coded the main audience for each article into practitioner versus academic, see Table 2. This was done by closely examining the mission, content, and target audience of each journal. The journal homepages were instrumental in this process. Articles published in a particular journal would then be coded according to that journal's main audience. Articles published in, for example,

MISQ were hence considered academic, while *IEEE Software* articles were considered practitioner oriented.[iv]

Fifth, we coded the geographical origin of the article based on where the primary authors were located and the investigations were conducted, see Table 2. The codes were, in this case, developed based on the actual distribution of geographical origin of the identified 46 articles. As it turned out, that led to classifying the articles into four distinct regions: Scandinavia, the Americas, the rest of Europe, and the Asia-Pacific.

Finally, we coded the publication level of the articles into high versus low, see Table 2. This coding only applied to articles in academic journals. The journals containing the top ⅓ of the academic articles were labeled high ranking whereas the journals containing the lower ⅔ were labeled low ranking. While this partitioning could have been done in a number of ways, its purpose was solely to allow for analyses of general patterns and trends of articles published in highly ranked journals versus those published in lower ranked journals. This issue might not be of importance to SPI practitioners, but it is important in relation to understanding how research on SPI as organizational change receive academic recognition and support promotion and tenure decisions.

4. Characterizing the Literature

In this section we present the results from our analysis of the characteristics of the 46 articles in accordance with the analytical framework (see Table 2).

While SPI as a field of practice dates back to the end of the 1980s, it was not until 8-10 years later that research on issues related to SPI as organizational change was first published in journals. The bulk of the articles in the sample appear in journals from 1997 and onward which indicates a time lag from the advent of SPI projects in real-world organizations until researchers reported their insights in the literature in terms of the challenges related to organizational change. Only 16 of the 125 journals on the AIS journal ranking list contain articles that focus on organizational change aspects of SPI, and only 8 of these 16 journals feature more than 1 article.[v] Concerning the articles' geographic distribution, 39% (18) of the articles are Scandinavian in origin, 37% (17) are from the Americas, 13% (6) are from the Asia-Pacific, and 11% (5) are from the rest of Europe.

The most prevalent perspectives on organizations in the literature are the organism, machine, and brain metaphors. In fact, these perspectives cover 67% (31) of the 46 articles. The metaphors viewing organizations through the lens of political systems, psychic prisons, cultures, flux and transformation, and instruments of domination are either absent (instrument of domination) or non-dominant (see Figure 1).[vi]

Figure 1. Distribution of articles across metaphors

Legend:
- Political Systems
- Brains
- Organisms
- Multi-perspective
- Machines
- Psychic Prisons
- Cultures
- Flux & Transformation
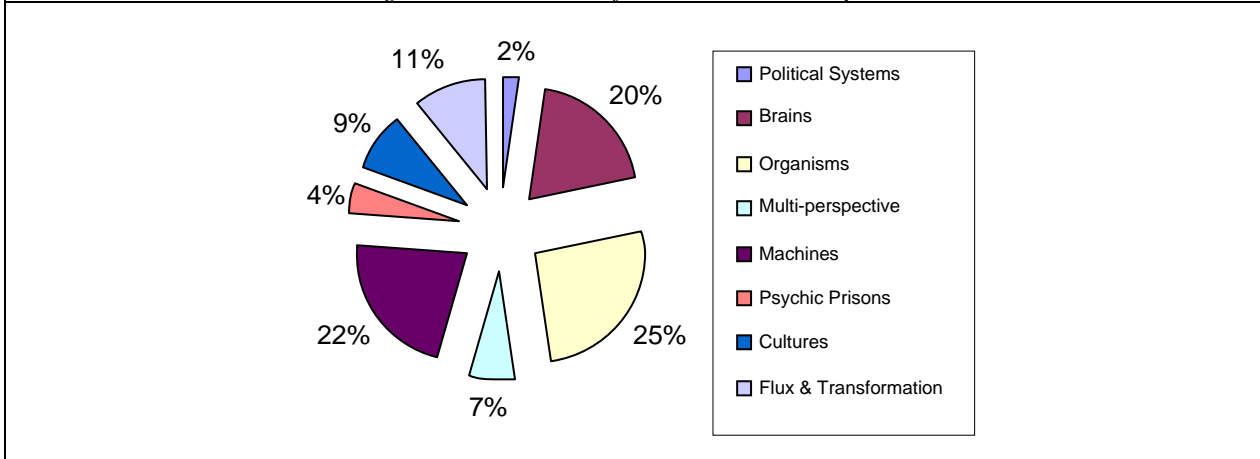
The research on SPI as organizational change is deeply rooted in both theory and practice. Thus, 65% (30) of the 46 articles are characterized as very theoretical in nature, while only 35% (16) are characterized as less theoretical. Moreover, 76% (35) of the articles are characterized as mainly descriptive in nature, while only 24% (11) are characterized as mainly prescriptive in nature.

Considering the distribution pattern across journal types, there is a healthy balance between academic and practitioner articles. 65% (30) of the articles are published in academic journals, while 35% (16) are published in practitioner journals. There is a similar distribution of descriptive (¾) versus prescriptive (¼) articles in both academic and practitioner journals. Also, the theoretical emphasis of articles in academic journals is noteworthy with 93% (28) categorized as very theoretical and only 7% (2) as less theoretical. The theoretical emphasis is considerably smaller in practitioner journals with only 13% (2) of the articles categorized as very theoretical and 87% (14) categorized as less theoretical. Finally, we found a considerable representation of different metaphors in both academic and practitioner journals. Figure 2 reveals that the brain and organism metaphors account for approximately the same share of articles in both academic and practitioner journals (20% (6) and 27% (8) versus 19% (3) and 25% (4)). The most notable difference is the fact that whereas 31% (5) of the articles in practitioner journals fit the perspective on organizations as flux and transformation (a metaphor that is absent in the academic journals), an almost equal share (27% (8)) of the academic articles adopt the machine metaphor.

Figure 2. Distribution of metaphors in academic and practitioner journals
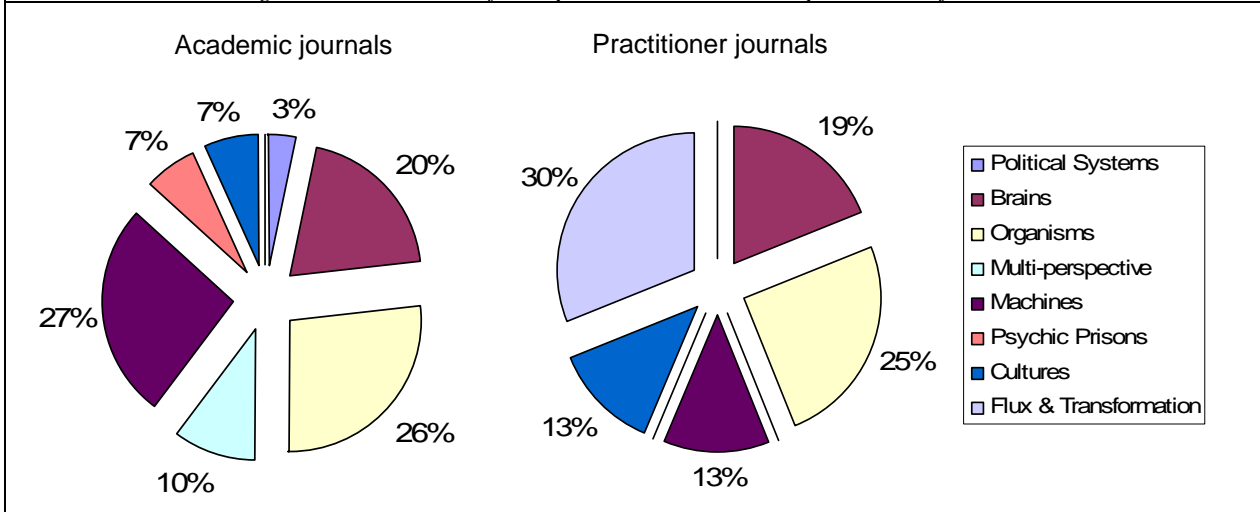
Focusing on academic articles published in high ranking versus low ranking journals, a number of observations deserve mentioning (see Figure 3). For articles published in high ranking journals, the brain and organism metaphors are dominant (both 33% (3)), and several of the eight metaphors are absent (machine, political system, psychic prison, flux and transformation, and instrument of domination). While there are only a limited number of metaphors and noticeably no articles espousing the machine metaphor in high ranking journals, articles in lower ranking journals are more versatile in terms of the number of metaphors found, and as many as 37% (8) of these articles are based on the machine metaphor.

Figure 3. Distribution of metaphors in high and low ranking academic journals
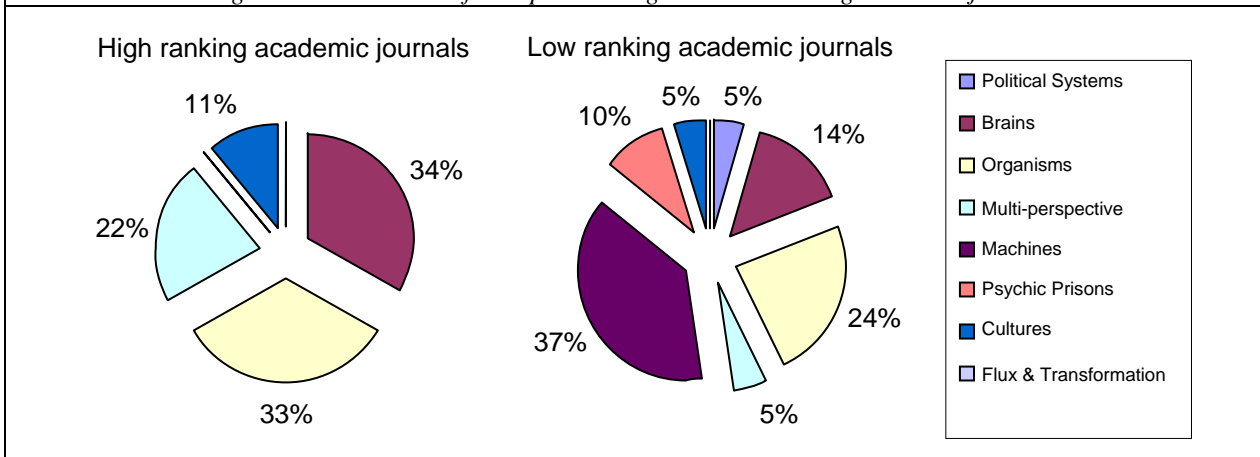
Focusing on the geographical origin of the articles, the major portion of articles published in academic journals are from Scandinavia (50% (15)), while the major part of articles published in practitioner journals are from the Americas (68% (11)) (see Figure 4). Also, the major part of the articles with high theoretical emphasis are Scandinavian (57% (17)), while the major part of the less theoretical articles are from the Americas (81% (13)) (see Figure 5). Finally, as illustrated in Figure 6, articles from the rest of the world exhibit less variation in the underlying metaphors than articles from Scandinavia and the Americas. In fact, 73% (8) of these articles are based on the organization as machine metaphor.

Figure 4. Geographical distribution of articles in academic and practitioner journals
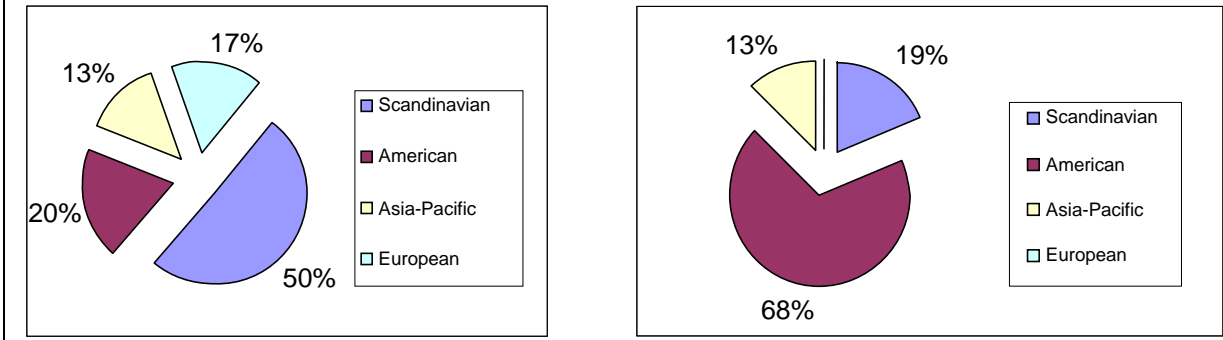
17%
13%
20%
50%

Scandinavian
American
Asia-Pacific
European

13%
19%
68%

Scandinavian
American
Asia-Pacific
European

Figure 5. Geographical distribution of very theoretical and less theoretical articles

17%
13%
13%
57%

Scandinavian
American
Asia-Pacific
European

6%
13%
81%

Scandinavian
American
Asia-Pacific
European
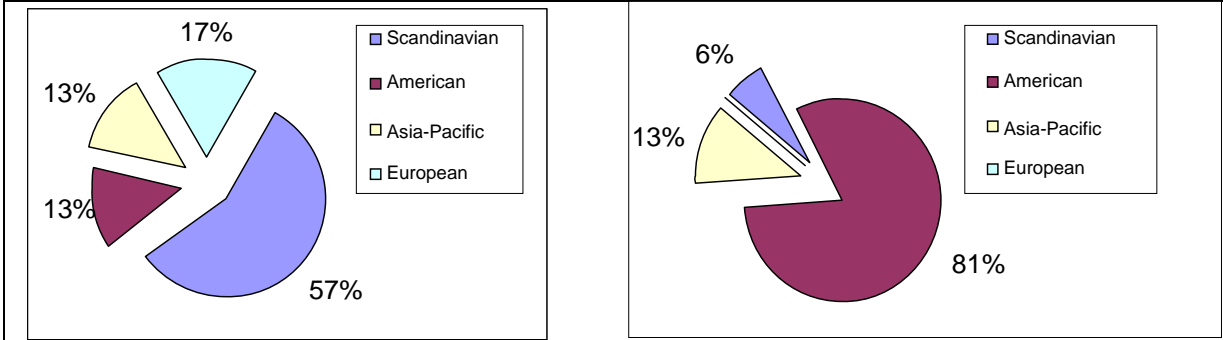
Figure 6. Distribution of articles across metaphors based on geographic origin

Scandinavian

6% 6% 6%
6%
17%
27%
32%

American

18% 18%
12%
6%
34%
12%

Rest of the world

9% 9%
9%
73%

Political Systems
Brains
Organisms
Multi-perspective
Machines
Psychic Prisons
Cultures
Flux & Transformation
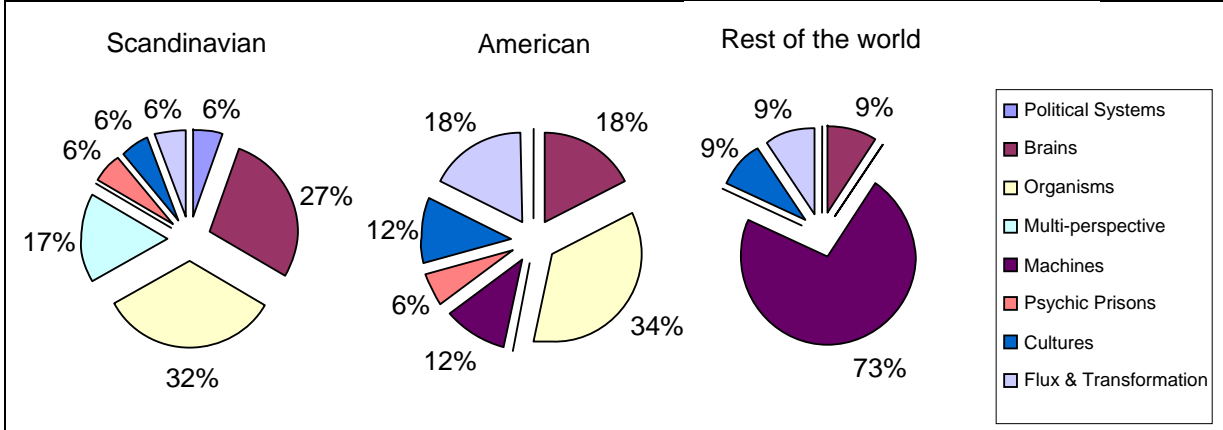
5. Summarizing the Literature

In this section we present a summary of the insights provided by the literature on SPI as organizational change. Table 4 provides an overview of these contributions according to the metaphors espoused by each article.

Table 4. Organizational perspectives on SPI

Metaphor	Contributions	References
Machine	• Universal motivators, de-motivators, and factors affecting SPI initiatives • Generic SPI models and assessment methods	Niazi, Wilson & Zowghi (2005) Niazi, Wilson & Zowghi (2005) Baddoo & Hall (2003) Rainer & Hall (2003) Baddoo & Hall (2002) Rainer & Hall (2002) Wilson, Hall & Baddoo (2001) Van Loon (2000) Pitterman (2000) Saiedian & Carr (1997)
Organism	• Environmental conditions for SPI – both internal and external to organizations • Species of organizations with different needs coping with SPI	Gresse von Wangenheim, Weber, Hauck & Trentin (2006) Börjesson & Mathiassen (2005) Green, Hevner & Collins (2005) Guerrero & Eterovic (2004) Iversen, Mathiassen & Nielsen (2004) Dybå (2003) Aaen, Arent, Mathiassen & Ngwenyama (2001) Pourkomeylian (2001) Ward, Fayad & Laitinen (2001) Kautz (1999) Wiegers (1999) Wohlwend & Rosenbaum (1994)
Brain	• Knowledge creation (research), management, and dissemination in SPI • Organizational knowledge and individuals' knowledge and education as success factors in SPI • Assessments and measurements as vehicles for collecting and distributing key knowledge in SPI	Cater-Steel, Toleman & Rout (2006) Iversen & Ngwenyama (2006) Slaughter & Kirsch (2006) Börjesson & Mathiassen (2004) Conradi & Dybå (2001) Baskerville & Pries-Heje (1999) Iversen, Nielsen & Nørbjerg (1999) Fayad & Laitinen (1997) Pressman (1996)
Culture	• Impact of national cultures on SPI • Cultural inconsistencies in maturity models • Importance of job motivation and satisfaction in SPI	Phongpaibul & Boehm (2005) Ngwenyama & Nielsen (2003) Boehm (2000) Yamamura (1999)
Political system	• Politics and interests in SPI as means to uncover and remove obstacles	Nielsen & Nørbjerg (2001)
Psychic prison	• Existing practices reinforced through SPI • Countering resistance through models that take adoption issues into account	Umarji & Seaman (2005) Frederiksen & Rose (2003)
Flux and transformation	• Longitudinal process perspective on SPI • Use of tactics and monitoring to achieve lasting change through SPI • Unfreezing existing behavior and focusing on continuous improvement and change in SPI	Hardgrave & Armstrong (2005) Mathiassen, Ngwenyama & Aaen (2005) Keeni (2000) Herbsleb, Zubrow, Goldenson, Hayes & Paulk (1997) Hollenbach, Young, Pflugrad & Smith (1997)
Multi-perspective	• Multiple perspectives on SPI in	Kautz & Nielsen (2004) Iversen & Mathiassen (2003)

	organizations • Different SPI agent roles and the prospects for change	Kautz, Hansen & Thaysen (2001)

The organization as machine metaphor has drawn researchers' attention towards universal motivators, critical success factors, barriers, and other factors that impact SPI initiatives. Motivators and de-motivators, including process ownership, available resources, resistance to change, and commercial pressure, have been found to differ across different staff groups involved in SPI (Baddoo & Hall, 2003). A number of other factors have also been found to affect SPI initiatives in general, i.e. executive support, experienced staff, metrics, software procedures, reviews, inspections, mentoring, training, and the use of process experts (Rainer & Hall, 2003; Rainer & Hall, 2002; Van Loon, 2000; Pitterman, 2000). In addition, these articles offer generic models and methods for SPI, including SPI implementation strategies (Baddoo & Hall, 2002), an SPI implementation framework (Niazi et al., 2005), a self-evaluation framework for assessing readiness for SPI and for identifying weaknesses that may hamper SPI efforts (Wilson et al., 2001), as well as a method for personal software process improvement (Saiedian & Carr, 1997).

The organization as organism metaphor has directed researchers' attention to the internal and external environments and their effects on SPI initiatives. A number of environmental factors (process related training, developers' involvement, maintaining momentum, group focus, champions, frequency of assessments, and SPI process visibility) have been identified as influencing SPI efforts (Guerrero & Eterovic, 2004). This part of the SPI literature has also identified different types or species of organizations (e.g. small and large organizations) with different needs that must be attended to through tailored approaches to SPI. Processes must reflect the needs and goals of the organization and continue to develop as the organization evolves (Kautz, 1999). Also, a key to success in SPI is the ability not only to demonstrate a positive effect on quality and productivity, but also to provide benefits for developers and project managers alike (Green et al., 2005). When doing SPI, it is necessary to think in terms of improving the whole organization, because an organization is only as strong as its weakest link. For this purpose, an all-encompassing approach to SPI that includes issues of assessment, training, measurement, technology, consulting, and communication may prove useful (Wohlwend & Rosenbaum, 1994). Even though some people may consider SPI primarily applicable to large and stable organizations, small organizations can implement SPI in a beneficial and cost-efficient manner as well. However, this requires taking into account specific business goals, business models, business characteristics, resource limitations, context dependency, and small organizations' relative strengths in relation to employee participation and opportunities for exploring new knowledge (Gresse von Wangenheim et al., 2006; Ward et al., 2001; Dybå, 2003). Keeping this in mind, SPI can be used even in organizations characterized by cutting-edge technologies, fast-track projects, rapid development, and constant business pressure, though these organizations are typically quite unstable (Wiegers, 1999). Small organizations are considered relatively agile, but normative methods and maturity models like the CMMs impose structure. This creates a potential for conflict. Meanwhile, agile principles can have a positive impact on SPI initiatives when applied to the improvement process itself (Börjesson & Mathiassen, 2005). In pursuing these ideas further, an effort has been made to combine the CMM with the Personal Software Process (PSP) to minimize the number of process areas[vii] and to ensure a better fit with small and agile organizations (Saiedian & Carr, 1997). Lastly, to support the evaluation of fit between SPI initiatives and the organizational context in which they unfold, a framework[viii] has been developed that incorporates characteristic features of SPI initiatives, the benefits and risks related to such initiatives, and the possible approaches that can be

adopted to SPI (Aaen et al., 2001). This framework has been used to assess and guide SPI practices in a large pharmaceutical firm (Pourkomeylian, 2001).

The organization as brain metaphor has led researchers to focus on the role of knowledge in SPI. People in organizations must have adequate knowledge about the process areas in question to ensure acceptance of SPI initiatives (Pressman, 1996). If the knowledge needed to perform SPI initiatives does not exist within the organizations, it is necessary to draw upon the expertise of external consultants and assessors (Cater-Steel et al., 2006). Therefore, a strategy for educating people should be an integral part of any SPI project, including having a plan, assigning personal education budgets, providing meaningful incentives, and insisting on people being able to demonstrate their competencies (Iversen & Ngwenyama, 2006). Assessments and measurements are considered important means by which valuable knowledge about the organization and the SPI initiative is acquired (Fayad & Laitinen, 1997). In this light, a method for eliciting problems in software organizations that fosters mutual understanding as a prerequisite for establishing consensus on what needs to be improved has been presented (Iversen et al., 1999). For similar reasons, process engineers and practitioners should be involved in all SPI phases to ensure learning as a prerequisite for success (Börjesson & Mathiassen, 2004). The question of how organizations may increase their chance of success has also been investigated from a knowledge transfer perspective (Slaughter & Kirsch, 2006), suggesting that it is important to strike a balance between a disciplined (or rational) and a creative (or experimental) way of working (Conradi & Dybå, 2001). Finally, it has been found that small organizations and organizations in unstable environments may benefit from focusing on improving their knowledge management capability instead of focusing on traditional process areas that permeate maturity models like the CMM (Baskerville & Pries-Heje, 1999).

The organization as culture metaphor has drawn researchers' attention to the impact of employee satisfaction and motivation on success in SPI (Yamamura, 1999). People that are well trained, have the right skills, and in other ways fit their job profiles are motivated – also in relation to SPI. Management can promote employee satisfaction on a project level through careful planning, a disciplined development environment, growth opportunities, interesting assignments, and mentoring. Also, management focus on process improvements helps clarify expectations of employees and contributes to their job satisfaction. Organizations that work as an integrated unit with a common set of norms, beliefs, ideas, and values are in a more favorable position to do SPI compared to organizations that are more heterogeneous internally (Boehm, 2000). In terms of national cultures, it has been found that to improve software processes in Thailand, researchers and practitioners must understand the cultural differences and tailor western style processes to Thai software development practices (Phongpaibul & Boehm, 2005). However, cultural tensions exist not only on the level of national cultures. Cultural inconsistencies have also been identified within some of the maturity models (People CMM and SW-CMM) themselves (Ngwenyama & Nielsen, 2003).

The organization as political system metaphor draws researchers' attention to power and interests in order to understand the reasons behind seemingly irrational behavior in SPI change processes. Appraisals and strategies based on maturity models are means to evaluate and transform software engineering capabilities based on rational, means-end behavior perspectives. The political system metaphor provides an alternative lens that may help managers uncover, understand, and possibly remove organizational obstacles to SPI that the rationalistic approaches fail to recognize. SPI potentially shifts the balance of power in organizations which in some instances may account for

resistance to change. Planning and successfully executing SPI initiatives therefore require us to acknowledge the different interests at stake in SPI (Nielsen & Nørbjerg, 2001).

The organization as psychic prison metaphor helps researchers focus on how and why SPI initiatives sometimes reinforce existing practices rather than lead to new and improved ones. New software technologies are sometimes chosen and implemented in a way that is consistent with the social construction of current software operations thereby reinforcing rather than altering existing practices. Consequently, existing patterns of thought and values are easily reproduced both in the selection of the technology and in shaping the social practices involved in using new technologies (Frederiksen & Rose, 2003). Constructs in models like TAM and TPB are suggested as means that may help managers understand and counter resistance to SPI and more effectively assimilate process improvements into a software engineering culture (Umarji & Seaman, 2005).

The organization as flux and transformation metaphor draws researcher's attention to the capacity for change over time in SPI initiatives (Keeni, 2000). In this perspective, it is important to focus on change in relation to processes, structures, people, and management to obtain lasting effects of SPI. Appropriate tactics must be adopted to manage SPI change, including creating a vision, managing commitments, planning the initiative, staying agile, and monitoring improvements (Mathiassen et al., 2005; Hollenbach et al., 1997; Herbsleb et al., 1997). Emphasis must also be placed on continuous improvements and unfreezing current behavior to effect change (Hardgrave & Armstrong, 2005).

Adoption of multi-perspective approaches empowers researchers to investigate the complexities involved in SPI initiatives and to understand the different and sometimes contradictory forces that shape such efforts. One multi-perspective framework is suggested for planning and reflecting upon SPI initiatives through three complementary perspectives on organizational innovation (the individualist, the structuralist, and the interactive process perspectives) (Kautz & Nielsen, 2004). Another framework presents the SPI change agent in four different roles each with accompanying methods and techniques that accommodate different situations (Kautz et al., 2001). In a similar vein, it is suggested that a combination of an engineering and a cultivation perspective provides managers with a comprehensive understanding of SPI initiatives and more likely lead them towards success (Iversen & Mathiassen, 2003).

6. Discussion

The goal of this literature review has been to analyze what we currently know and don't know about SPI as organizational change. We identified 46 articles published within this area in journals appearing on the AIS journal ranking list and we analyzed the articles guided by the conceptual framework summarized in Table 2 in order to answer the following research question: What are the dominant perspectives on SPI as organizational change in the literature and how is this knowledge presented and published? Even though we adopted a rigorous approach, this literature study has two important limitations. First, articles were selected only from journals on the AIS journal ranking list. We have not covered articles published in other journals or research reported in books, at conference, and in other outlets not covered by the AIS list. The reason for relying on the AIS list is, however, that it is inclusive based on a merger of eight other lists of software engineering and informations systems research (Rainer & Miller, 2005; Lowry et al., 2004; Katerattanakul et al., 2003; Peffers & Tang, 2003; Mylonopoulos & Theoharakis, 2001; Whitman et al., 1999; Hardgrave & Walstrom, 1997; Walstrom et al., 1995). Second, our analyses of the identified articles are

limited by our use of Morgan's eight metaphors as alternative perspectives on organizations and organizational change (see Table 1). Related research has employed different sets of metaphors as bases for analyses, though not in relation to SPI (e.g. Elkind, 1998; Aupperle, 1996; Kendall & Kendall, 1993; Keys, 1991). Also, Morgan's use of metaphorical thinking has been debated. McCourt (1997) argues, for example, that metaphoric thinking as practiced by Morgan is located within the organizational development school and differentiates itself from more constructivist approaches. Hence, while Morgan's framework helped us provide a rich portfolio of perspectives on organizations, there are alternative frameworks available and these would have provided different insights into the SPI literature on organizational change.

Despite these limitations, the analyses have led to a number of interesting findings. While there is a delay of 8-10 years from the initiation of SPI initiatives in the 1980s until researchers started investigating these practices from an organizational change perspective, the 46 identified articles constitute a small but significant portion (12%) of the 371 SPI articles identified. Hence, there is today a comprehensive body of knowledge on SPI as organizational change and this literature appear well balanced in a number of ways. First, 65% (30) of the articles were characterized as very theoretical in nature, reflecting that most researchers within this field use and develop information systems theory to drive their investigations. It is also reassuring that all except 2 of the papers that were characterized as less theoretical were published in practitioner journals. Second, as many as 76% (35) of the articles were characterized as being mainly descriptive in nature, suggesting that there is a major emphasis in the literature on presenting insights from the trenches to foster a better understanding of SPI as organizational change. All except 7 of the articles that were characterized as mainly normative were published in practitioner journals. Third, 65% (30) of the articles were published in academic journals. However, there is a considerable representation of articles (35% (16)) in practitioner journals indicating a strong commitment to publish results in a form useful for practice.

At the same time, there are a number of characteristics of the identified articles that raise questions. First, it is interesting to consider the geographical distribution of the articles with as many as 39% (18) originating in Scandinavia, 37% (17) originating in the Americas, and only 24% (11) originating in the rest of the world. SPI was initiated in the U.S., and U.S. institutions like the Department of Defence and the Software Engineering Institute continue to play major roles in promoting SPI as a way to move the software industry forward. Thus, it is not surprising that a major part of the literature originates in the Americas. It is, however, striking that 37% (17) of the articles originate in Scandinavia. One explanation may be that the long-standing tradition for industry-related software research in this part of the world has led to a number of research initiatives to critically investigate the applicability of SPI to software practices. While it is understandable that the interest in SPI as organizational change is still limited in the Asia-Pacific (13% (6)) because the software industry has started to grow rather recently in that part of the world, it is less clear why only 11% (5) of the articles originate in the rest of Europe. SPI research has been heavily sponsored by the EU and there have been strong European initiatives to build alternative SPI models, e.g. Bootstrap (Kuvaja & Bicego, 1994). Taking this into account, one would expect more contributions from the rest of Europe helping us understand the complex change issues related to SPI. Finally, it is also interesting that 2 of the papers that were characterized as less theoretical in nature were published in academic journals (Saiedian & Carr, 1997; Wohlwend & Rosenbaum, 1994) and one of these articles was published in a high ranking academic journal (Wohlwend & Rosenbaum, 1994). One would expect especially high ranking academic journals to require

theoretical emphasis. A possible explanation is that this article was published in *IEEE Transactions on Software Engineering* – a prestigious engineering journal with strong ties to practice.

While the findings provide interesting insights into how research on SPI as organizational change is presented and published, the main emphasis in our analyses has been on understanding the dominant perspectives on SPI as organizational change and to get an overview of what we currently know and don't know about these complex change processes in software firms. We found a rather broad representation of organizational perspectives in the literature (see Figure 1). However, 67% (31) of the articles view organizations as either organisms, machines, or brains. Other metaphors are more scarcely represented (political system, psychic prison, culture, and flux and transformation) or not represented at all (instrument of domination). As much of the controversy in the literature relate to the feasibility of SPI as an approach to improve software practices and to the adverse impact SPI tactics might have on creativity and innovation, there is an obvious need to expand our knowledge by further exploring SPI issues from less mainstream organizational perspectives. More research is needed on how other national cultures cope with SPI models that are based on western management ideals. The Thai case is presently the only example of such research (Phongpaibul & Boehm, 2005). Organizational culture is another subject that has received only scant attention. Even though the cultural understanding underlying some of the maturity models (People CMM and SW-CMM) has been the subject of study (Ngwenyama & Nielsen, 2003), the impact of workplace culture, i.e. organizational culture, on SPI efforts has not been thoroughly examined. Also, interesting questions related to investigating the role of power and politics in SPI remain unexplored. Politics has been investigated in relation to assessing process maturity (Nielsen & Nørbjerg, 2001), but the more broad influence of politics on SPI practices and outcomes has not yet been studied. Finally, we need to know more about SPI approaches as instruments of domination. In what ways and to what extent do SPI approaches reinforce existing practices and power structures creating barriers to innovation as well as exploitation of groups of employees within organizations?

On a more detailed level, it is interesting to note how organizational perspectives distribute differently across types of articles. First, articles published in high ranking journals view SPI as brains (33% (3)), organisms (33% (3)), cultures (11% (1)), or a combination of multiple perspectives (22% (2)). None of the high ranking articles are based on the more simplistic view of organizations as machines. The 22% (10) of the articles in the sample that view organizations as machines are either published in practitioner journals (2) or in low ranking academic journals (8). Second, a broad representation of most perspectives on organizational change is evident in both the Scandinavian and the American articles (see Figure 6). In contrast, among the articles originating in other parts of the world, as many as 73% (8) are based on the organization as machine metaphor.

Finally, while Scandinavia and the Americas are the major contributors to our knowledge about SPI as organizational change, there are remarkable differences between articles from these two parts of the world. As many as 50% (15) of the articles in academic journals are from Scandinavia and only 20% (6) are from the Americas. In contrast, a total of 68% (11) of the articles in practitioner journals are from the Americas, while only 19% (3) of these articles originate in Scandinavia. Adding to this picture is the fact that 57% (17) of the articles that are characterized as very theoretical are from Scandinavia whereas only 13% (4) of these articles are from the Americas. Correspondingly, as many as 81% (13) of the articles that are characterized as less theoretical are from the Americas, while only 6% (1) of these articles originate in Scandinavia. Hence, American research on SPI as organizational change is mainly published in practitioner journals and is weakly grounded in theory. In contrast, the Scandinavian articles are mainly published in academic journals

and more strongly grounded in theory. In fact, the American theoretical contributions to our understanding of SPI as organizational change are rare (Umarji & Seaman, 2005; Slaughter & Kirsch, 2006; Green et al., 2005; Gresse von Wangenheim et al., 2006). This is surprising given that SPI originated in the U.S. and still today is mainly driven by U.S. institutions and the U.S. software industry.[ix]

7. Conclusion

SPI efforts involve complex organizational change of engineering and management practices in software firms. There is therefore a growing interest in the literature of how managers can address change issues during SPI. This paper has reviewed what we currently know and don't know about this important issue and it provides a roadmap to help identify insights and specific articles related to SPI as organizational change. The current literature offers important insights into organizational change in SPI from machine, organism, and brain perspectives. Practitioners may use these articles as a guide to SPI insights relevant to their improvement initiatives. In contrast, the impact of culture, dominance, psychic prison, flux and transformation, and politics in SPI have only received scant attention. We argue that these perspectives offer important insights into the challenges involved in managing change in SPI. Researchers are therefore advised to engage in new SPI research based on one or more of these perspectives.

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Notes

[i] In a similar vein, Iversen et al. define SPI as "an organizational change process, which introduces new and improved methods, techniques, and tools, as well as changes to work organization, attitudes, and work and management practices at all levels of a software producing organization" (1999: 66). Another definition is provided by Arent & Nørbjerg who state that "Software Process Improvement (SPI) is an approach to systematic and continuous improvement of a software producing organization's ability to produce and deliver quality software within time and budget constraints" (2000: 1).

[ii] Single-loop learning has to do with the ability to detect and correct errors in relation to a given set of operating norms. Double-loop learning depends on being able to take a look at the situation and question the relevance of such operating norms and their underlying assumptions (Morgan, 1996: Chapter 4).

[iii] 15 journals (JDA, InfoSys, CompDcsn, DataMgmt, JISM, JOR, JITCA, AJIS, JEMIS, AIExp, JMSM, INTFC(Edu), CompAuto, IJITMS, and IBSCUG) did not provide such search facilities.

[iv] The academic journals are MISQ, ISR, IEEETrans (IEEE Transactions on Engineering Management), IEEETSE, ISJ, DATABASE, IT&P, ACMSIG (both ACM SIGSOFT Software Engineering Notes and ACM SIGICE Bulletin), JS&S, IJIM, IST, and SJIS, whereas the pactitioner journals are CACM, IEEESw, IEEEComp, and QP.

[v] MISQ, ISR, CACM, IEEETrans (IEEE Transactions on Engineering Management), IEEESw, IEEETSE, IEEEComp, ISJ, DATABASE, IT&P, ACMSIG (both ACM SIGSOFT Software Engineering Notes and ACM SIGICE Bulletin), JS&S, IJIM, IST, SJIS, and QP.

[vi] Number of articles within each metaphor: political system = 1, brain = 9, organism = 12, multi-perspective = 3, machine = 10, psychic prison = 2, culture = 4, and flux and transformation = 5.

[vii] "Key process areas" in CMM terminology.

[viii] The MAP – Management (organization, plan, and feedback), Approach (evolution, norm, and commitment), and Perspective (process, competence, and context) – framework (Aaen et al., 2001).

[ix] Hansen et al. emphasize that the SEI is the source of many of the major contributions to SPI (Hansen et al., 2004).

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