Studying agile organizational design to sustain innovation

Celina Maki Takemura[1], **Claudia de O. Melo** [2]

[1]Brazilian Agriculture Research Corporation - Embrapa
Satellite Monitoring Research Center, Campinas, Brazil

[2]Department of Computer Science, University of São Paulo, São Paulo, Brazil

celina@cnpm.embrapa.br, claudia@ime.usp.br

Abstract. *Innovation is a core part of software development companies, frequently determined by organizational design variables including structure, capacity for learning, for change and adaptation. Agile software methods have evolved as approaches to promote agility and innovativeness in software development organizations. However, little research has examined organizational innovativeness and its relationship with organizational design and adoption of agile methods. In this work, we propose a conceptual framework to characterize innovation's prone and averse patterns on organizational design in agile companies by measuring diffusion and integration of technologies and practices within individual, team, organizational, and environmental levels.*

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1. Introduction

Innovation is fundamental to economic growth, the creation of new industries and businesses, and competitive advantage of organizations (Damanpour and Aravind, 2012). Innovation is more than a creative process. It includes implementation and application. Its scope takes in not only product and service, but process, marketing, organizational design and practices. Therefore, it is not only related to Research and Development (R&D) activities. Thus, innovation comprises internally conceived and externally adopted innovation. Moreover, it is relative, i.e., an innovation may be commonplace in other organizations, but would still be considered innovation if it were a novelty to the researched subject.

The extent of software contribution to innovation is widely studied (Pikkarainen et al., 2011). Although software development, *per se*, is not considered an innovation activity, it copes with the various dimensions of innovation. Software development is a R&D activity if its completion is determined by a scientific and/or technological advance. Software acquisition or deployment may also be related to a new process or a new marketing methodology, for example. Moreover, it may represent an innovation on organizational design.

Propensity to innovation or to the adoption of innovations, a dynamic capability, i.e, **innovativeness**, is a non-tangible variable, however it is dependent on a number of innovation determinants. In literature we find innovation determinants expressed over three levels, i.e., individual level, team level and organizational level that may bond with innovative processes surrounding research. Thus, there is an environmental aspect underlying innovation (economic, political, etc.).

On the other hand, by definition, **agility** is the ability to both create and respond to change in order to profit in a turbulent business environment. Agile software development

recognizes the value of team member competencies and diversity when bringing agility and innovativeness to development processes (Nerur and Balijepally, 2007). Abrahamsson et al. (2009) points that supporting evidence relating the true ability of agile methods and practices and innovation is much needed.

However, while most agile methods advocate their adoption to facilitate innovation, there is a lack of rigorous research evaluating innovation in an agile context (Moe et al., 2012), particularly within the organizational design.

The intent of this research is to establish the basis of innovation and organizational design analysis on agile software development companies on grounds of the present consensus on innovation, agility and organization design research. It is not our purpose that our ideas represent an absolute renewal or evidentiate outright originality. We present our ideas as a complete formulation of concepts that researchers of these three areas have individually elaborated progressively and spontaneously.

Therefore, the aim of this paper is to develop a conceptual framework to characterize innovation's prone and averse patterns on organizational design in agile software development companies. The main issue is to recognize the multiple dimensions of innovation and normalize language and practices. Our framework is a guideline to evaluate innovation in agile companies at the organizational level by measuring diffusion and integration of technologies and practices, i.e., individual, team, organizational, and environmental forms combined together.

The remainder of this paper is organized as follows. Section 2 presents a review of innovation and innovation activities concepts; Section 3 synthesizes research on how agile methods foster innovation; Section 4 summarizes how organizational design is related to innovation and agility; Section 5 presents a conceptual framework with links among its components, enabling research on agile organizational design to sustain innovation; Section 6 concludes and provides suggestions for further work.

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2. The innovation and innovation activities concepts

According to the Oslo Manual (Oecd, 2005), **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. **Innovation activities** are all scientific, technological, organizational, financial and commercial steps which actually lead, or are intended to lead, to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation. Moreover, an innovative firm is one that implemented an innovation (Oecd, 2005).

Software development is classified as R&D, and therefore an innovation activity, if its completion is dependent on a scientific and/or technological advance, and the aim of the project is the systematic resolution of a scientific and/or technological uncertainty. Furthermore, services development is classified as R&D if it results in new knowledge or involves the use of new knowledge to devise new applications (Oecd, 2002).

Finally, it is possible to visualize two different types of innovation processes. The first one, the *generation* of innovation, results in an outcome - a product, service, or tech-

nology - that is at least new to an organizational population. The second one is innovation *adoption*, which results in the assimilation of a product, service, or technology that is new to the adopting organization (Oecd, 2002).

3. Agile software development practices fostering innovation

Agile software development is defined as a business of innovation, emphasizing practices such as feature planning and dynamic prioritization; feedback and change; and focus on teamwork (Highsmith and Cockburn, 2001). Agile assumes that change is not only inevitable, but also necessary to foster innovation and adaptation (Vinekar et al., 2006).

Conboy et al. (2011) presented a review of the current state of innovation in agile development focusing on the creativity aspect, that is the ability to produce work that is considered novel, appropriate and adaptive. Creativity has been advocated by agilists as "the only way to manage complex software development problems"(Highsmith and Cockburn, 2001). However, there is a lack of understanding of what constitutes creativity and innovation in software development in general, and to what extent agile methods actually facilitate these processes. Creativity by individuals and teams is the starting point for innovation; creativity might be necessary, but is not sufficient for innovation to occur (Amabile, 1988).

Conboy et al. (2011) argue that agile teams need to include multiple stakeholders outside the business unit in order to promote intra-organizational innovation, identifying new concepts for products, processes, marketing methods or organizational changes. The whole team practice propitiates communication and interaction among the different roles, favouring the identification of "new".

Moreover, the role of the agile coach is part embedded trainer, part consultant – an advisor. Even the best agile training courses cannot cover every detail or eventuality a team will encounter. The coach is there to continue the training after the formal classes are over. Consequently, agile development promote human skills by means of development (through internal training) or purchase (by hiring). Tacit and informal learning - "learning by doing" - are also involved in agile practices as pair programming, continuous peer review, job rotation, TDD (immediate feedback after mistakes).

Agile promotes double-loop learning, intertwining thought and action, critical reflection and learning after action. This "generative" learning process increases both learning and the ability to innovate and use change to one's advantage (Nerur and Balijepally, 2007). Practices such as continuous integration, refactoring, retrospectives and stand-up promote the feedback from team members and stakeholders, fostering the double-loop learning. As a counterpoint, Moe et al. (2012) found that simply adopting agile practices is not sufficient to maintain innovative edge. Agile practices were found to support only two antecedents of innovation: empowerment and knowledge management.

4. Organizational determinants of innovation capabilities in agile software companies

As argued by Lam (2004), there are three innovation determinants over organization design: a) the relationship between organizational structural forms and innovativeness; b) innovation as a process of organizational learning and knowledge creation; and c) organizational capacity for change and adaptation. Environmental determinants might mediate

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the relationship between organizational determinants and innovation, as well as directly influence innovativeness (Crossan and Apaydin, 2010).

4.1. Organizational structural forms and innovativeness

Different organizational arrangements are suited to different types of competitive environments and differing types of innovation. For instance, Japanese firms are said to have gained a competitive advantage because of their superior organizational capacity for integrating shop-floor workers and enterprise networks, enabling them to plan and coordinate specialized divisions of labour and innovative investment strategies (Nonaka and Takeuchi, 1995). However, this Japanese model of organizational integration ('**J-form**') works well in established technological fields in which incremental innovation is important, but not necessarily in rapidly developing new fields where radical innovation is vital for competitiveness, i.e., focusing mainly on the innovation generation process.

By contrast, **adhocracy** Mintzberg (1980) focuses on the adoption process, thriving on information acquisition and fostering risk taking. Moreover, adhocracies tend to rely more upon individual specialist expertise organized in flexible market-based project teams capable of speedy responses to changes in knowledge and skills, and on integrating new kinds of expertise to generate radical new products and processes. Both the J-form and adhocracy are learning organizations with strong innovative capabilities, but they differ markedly in their structural forms, patterns of learning and in the type of innovative competences generated (Lam, 2004).

To compete, companies must continually pursue many types of innovation aimed at incremental and radical innovations as well as existing and new customers. **Ambidextrous organization**s encompass these two profoundly different types of businesses - those focused on exploiting existing capabilities for profit and those focused on exploring new opportunities for growth. Therefore, ambidextrous organizations encompass the generation and adoption processes of innovation.

Other structural archetypes and their innovative potentials are studied by Mintzberg (1980) and retrieved by Lam (2004) are simple structure, machine bureaucracy, professional bureaucracy and divisionalized form. They classify as simple structure an organic, centrally controlled firm that can respond quickly to changes in the environment. On the other hand, machine bureaucracy is a mechanistic organization characterized by a high level of specialization, standardization and centralized control. It is designed for efficiency and stability, thus good at dealing with routine problems, but highly rigid and unable to cope with novelty and change.

The **professional bureaucracy** is characterized by a decentralized mechanistic form which accords a high degree of autonomy to individual professionals, and by functional specialization, with a concentration of power and status in the "authorized experts'. The **divisionalized form** is composed by quasi-autonomous entities loosely coupled together by a central administrative structure. It is typically associated with larger organizations designed to meet local environmental challenges, in which have the ability to concentrate on developing competency in specific niches.

4.2. Innovation as a process of organizational learning and knowledge creation

Some organizational researchers regard innovation as a process of bringing new, problem-solving, ideas into use (Amabile, 1988, Lam, 2010). An innovative organization is one

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that is intelligent and creative, capable of learning effectively (Argyris and Schön, 1978) and creating new knowledge (Nonaka and Takeuchi, 1995).

Gassmann and Enkel (2004) define three core innovative capabilities: (a) Absorptive capability related to the outside-in process; (b) Multiplicative capability related to inside-out process; (c) Relational capacity related to coupled process - an ambidextrous organization.

The *absorptive capability* covers all efforts and activities aimed at creating new ideas and getting them to work. Considering organizations, the learning goal is to gather new, unrelated knowledge to create untapped future opportunities (Cohen and Levinthal, 1990). The *multiplicative capability*, on the other hand, is usually a problem-solving process in which an existing idea is adapted to address the recognized needs and identified problems within an organization. The learning goal for organizations here is to gain new knowledge that is related to current areas of expertise, in order to advance the organization's existing technologies and products (Cohen and Levinthal, 1990).

The innovation-generating organization depends more heavily on its technological knowledge and market capabilities to develop and commercialize innovations. The innovation-adopting organization relies more on its managerial and organizational capabilities to select and assimilate innovations. Therefore, although organizational units pursuing exploration are expected to be small and decentralized with loose process, organizational units that pursue exploitation are expected to be larger, more decentralized, and with tight processes.

Tushman and Smith (2002) describe incremental innovations as exploitative and radical innovations as explorative. Ambidexterity is the ability to simultaneously pursue both incremental and discontinuous innovation, and has been proposed as a viable solution to balance agile and traditional systems' development while maintaining the necessary organizational cultures for each approach (Vinekar et al., 2006). Most of the solutions to cope with ambidexterity are related to two basic underlying concepts: spatial separation (at the business unit or corporate level) and parallel structures.

Agility is the ability to both create and respond to change in order to profit in a turbulent business environment; it is the ability to balance flexibility and stability (Highsmith, 2004). According to Lyytinen and Rose (2006), it is the ability to sense and respond swiftly to technical changes and new business opportunities; it is enacted by exploration-based learning and exploitation-based learning. By definition, agile teams would be able to learn in both ways.

However, agile software development methods are mostly limited to the micro-context of software product design and delivery (exploitation), whereas higher-level innovation capabilities are needed during exploratory phases (such as new base technology adoption) (Lyytinen and Rose, 2006). Kettunen (2009) noted that the latest trends in agile software development seek for combinations of exploitative and explorative methods to reach ambidexterity in larger scale, i.e., in the agile organizational level. He exemplifies it describing the synthesis of agile methods principles and lean principles to support innovative capabilities.

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4.3. Organizational capacity for change and adaptation

A third strand of research concerns organizational change and adaptation, and the processes underlying the creation of new organizational forms. Its main focus is to understand whether organizations can overcome inertia and adapt in the face of radical environmental shifts and technological changes, and whether organizational change occurs principally at the population level through selection (Lam, 2010).

According to Lam (2010), there are two broad theoretical views on how organizations adapt when facing the need of change. The first view is to spin out new business ventures in an environmental selection process. The second perspective views organizational change as a product of an actor's decisions and learning, rather than the outcome of a passive environmental selection process. In this work, we adopt Lam's second view.

Organizational design theories focus predominantly on the link between structural forms and the propensity of an organization to innovate (Mintzberg, 1980). Although the unit of analysis is the organization and the main research aim is to identify the structural characteristics of an innovative organization, or to explore the effects of organizational structural variables on product and process innovation, we consider two levels of innovativeness: i) creativity at the individual and team levels, and ii) innovation at the organizational unit and organizational levels.

4.3.1. Individual and team levels predictors for innovation

Creativity is an input to the innovative outcome or a part of the innovation process. Creativity requires freedom and a climate of support where individuals are unrestricted in their search for solutions (Amabile, 1988).

Individual and team creativity feed organizational innovation (Damanpour and Aravind, 2012). Amabile (1988) describes individual and team creativity determinants as: expertise, creativity skills and intrinsic task motivation. Although the two skill components determine what an individual is capable of doing in a given domain, it is the task motivation component that determines what a person will actually do.

Team processes have strong relationship with creativity and innovation. Team interaction processes like exchanging information, learning, motivating, and negotiating, as well as composition and structure, i.e. functional heterogeneity and frequency of meetings, are more strongly related to creativity and innovation measured at the team than at the individual level.

One core value of agile software development methodologies is: "individuals and interactions over processes and tool" (Beck et al., 2001). To facilitate interactions, agile methods rely on frequent inspect-and-adapt cycles. These cycles can range from every few minutes with pair programming, to every few hours with continuous integration, to every day with a daily stand-up meeting, to every iteration with a review and retrospective. To foster respect for the worth of every person, truth, transparency, trust and commitment to and within the team and to the team's goals, agile management must provide a supportive environment, team coaches must facilitate member inclusion, and team members must exhibit their commitment.

Agile methodologies facilitate commitment by encouraging teams to pull from a

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prioritized work list, manage their own work, and focus on improving their work practices. This practice is the basis of self-organization, which is the driving force for achieving results in an agile team. In addition, agile principles (Beck et al., 2001) such as "close, daily co-operation between business people and developers", "face-to-face conversation is the best form of communication", "projects are built around motivated individuals, who should be trusted" and "self-organizing teams" attempt to communication issues on software development. On the other hand, the principle of "continuous attention to technical excellence and good design" is related to individual expertise. Agile methods, therefore, provide specific values, principles, and practices that reinforce team climate and freedom to be creative.

However, because of the concept of sprints/iterations and the truly customer-driver aspect of agile methodologies, it is possible that technical cutting-edge knowledge may be not used. Higman et al. (2002) approach to deal with that and the issue of individual recognition is the Gold Card System that grants the developer who has it, one day of work on a topic of their choice.

4.3.2. Organizational Design level predictors for innovation

Organizational structure is the necessary division of work and establishment of communications channels which allows an organization to reach its goal. Organizational structure is a combination of the number of layers in hierarchy, the relationship between employees and managers, the level of participation of the employees in the decision-making process, and finally the interactions between services and participants of vertical and horizontal integration. In other words, organization is the way in which a company structures itself, its partnerships and its employee roles and responsibilities.

Organizational structure innovation, i.e. innovation at the organizational level. Organizational innovation often involves rethinking the scope of the companies activities as well as redefining the roles, responsibilities and incentives of different business units and individuals (Sawhney et al., 2006).

Organizational structure and innovation generation and adoption. Understanding how social interaction and group dynamics within organizations shape collective intelligence, learning and knowledge generation yields important insights into the innovative capability of organizations. Indeed, certain organizational structures facilitate the creation of new products and processes, especially in terms of fast changing environments.

4.4. Environmental Determinants

Environment has a strong impact on an organization's ability to adapt and innovate (Damanpour and Gopalakrishnan, 1998). Different segments operate under different environmental conditions imposed on **economic**, **technological** and **political-legal** aspects related to the industry type. The degree of **uncertainty** refers to the extent of change (rate and velocity) in the business environment. Finally, **complexity** refers to the extent of complexity in the business environment.

5. Assessing the influence of organizational design and agile practices on innovativeness

To achieve our research goal, we propose a guideline to evaluate innovation in agile companies at the organizational level by measuring diffusion and integration of technologies

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and practices, i.e., skill, technologies and organizational forms combined together, thus, adequately measuring innovation, incorporating both technological and non-technological dimensions. The key challenge is the need for a consensus among researchers on measures, scales, and methods of inquiring innovation, particularly on agile software development companies. The first step it to assess **innovation**, frequently measured by the protocols suggested by OECD (Oecd, 2002, 2005) .

In our work, we adapted the conceptual framework on organizational innovation developed from a systematic review conducted by Crossan and Apaydin (2010), who suggested an overarching framework that links different theoretical units into a coherent whole: individual, team, organizational, and environmental levels impacting on innovation. We also considered results from the meta-analysis conducted by Damanpour and Aravind (2012), which analyzed organizational design determinants for innovation, as well as Lam (2010) work on innovative organizations in the 21st century. We aim to describe a more coherent framework for agile organizational design's influence on innovation. Figure 1 summarizes our conceptual framework.

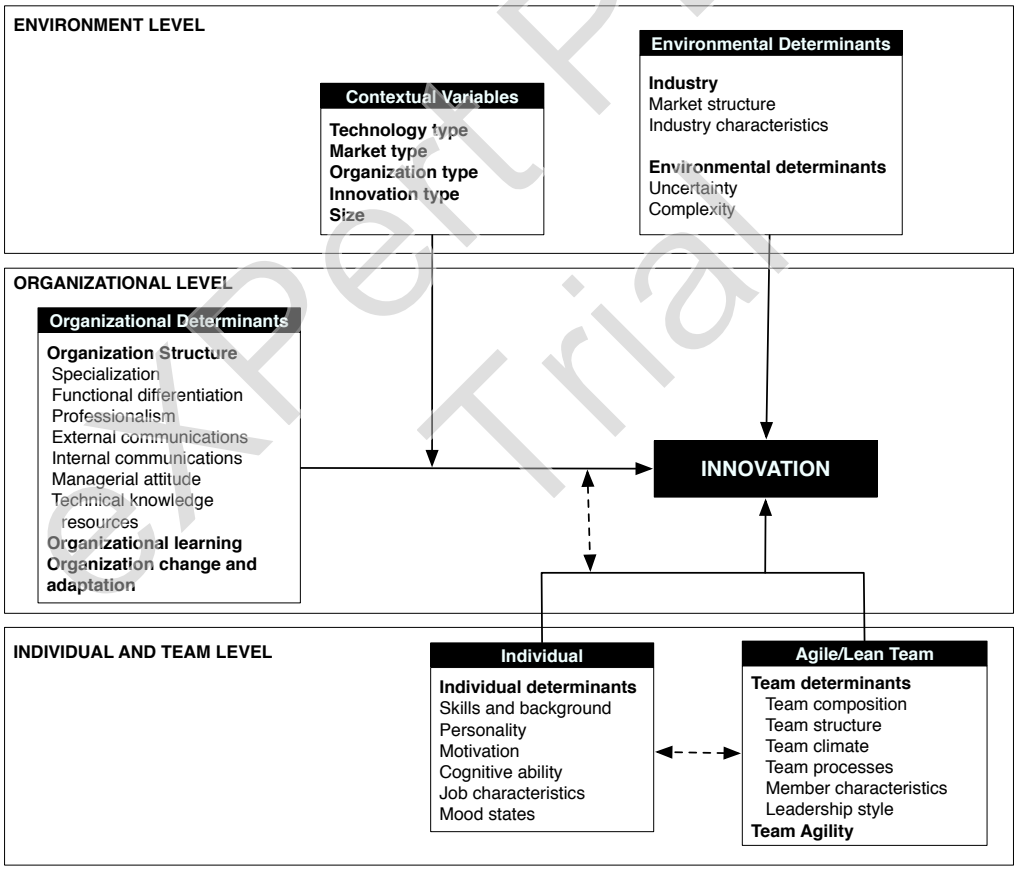

Figure 1. Conceptual framework of Agile Organizational Design's influence on Innovation

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5.1. Individual and Team Level

Individual Level. It is clear that special types of structure/organization design attracts and are more prone to develop certain types of people. In addition, some tasks motivate and are better carried out by particular people. Apart from the task's level of interest, engagement and challenge, other variables like condence, clarification of personal responsibility, financial and non-nancial incentives, sense of significance are motivational items

to be evaluated. Since the key element in agile software development are people, human behavior factors may be evaluated to assess their influence on innovativeness. Here we presume that skill, background, personality, motivation, cognitive ability, job characteristics, and mood states variables can model the individual innovativeness degree. Therefore, **skills and background** may be measured as amount of education, age, tenure, diversity of background, experience, extra-industry ties (Crossan and Apaydin, 2010).

Personality is a complex set of relatively stable behavioral and emotional characteristics that can be used to uniquely identify a person. Thus, personality represents those characteristics of the person that account for consistent patterns of behavior. By means of the Myers-Briggs Type Indicator (Myers et al., 1985), it is possible to assess **cognitive style**, mental set, self-efficacy, assertiveness, tolerance to anxiety and ambiguity, etc.

Motivation. Intrinsic motivation is animated by personal enjoyment, interest, or pleasure. Researchers often contrast intrinsic motivation with extrinsic motivation, which is governed by reinforcement contingencies. In general, motivation on an industry context is analysed as **job and mood** dependent. A review on job characteristics, motivation and psychological states of software engineers team members can be found in Beecham et al. (2008). Motivation is frequently assessed using either self-report measures or rating scales completed by teachers or parents (Broussard and Garrison, 2004). Such instruments usually include questions organized under several subscales, such as interest, attributions, self-perception and self-efficacy, preference for challenge, curiosity, mastery orientation, persistence, and enjoyment of learning.

Team Level. At the team level, team design is of foremost importance, because the resources (knowledge, skills, abilities) to be innovative mainly reside with the team members. However, team processes will determine the extent to which the innovative potential of the team is fully realized. Team processes are a not tangible variable, however they depend on team structure, climate and leadership, and also on variables in the wider organizational context (Anderson et al., 2004).

Campion et al. (1993) examined 19 group-mensurable characteristics within social psychology, socio-technical theory, industrial engineering and organizational psychology variables while attempting to analyse relationships between design characteristics and effectiveness. The effectiveness criteria is given by means of productivity, satisfaction and manager judgement degrees. Our hypothesis is that the measurements developed by them are extensible to innovativeness analysis from that define the length of team composition, team structure, team processes and leadership style measurements. Moreover, they use the organization's opinion survey as measurement for employee satisfaction (over it, it is possible to derive team climate).

Qumer and Henderson-Sellers (2006) suggest agility can be described and possibly measured by the attributes: flexibility, speed, leanness, responsiveness and learning. As a further matter, **team agility** may be assessed using proposed agility taxonomies (e.g., Conboy (2009), Qumer and Henderson-Sellers (2006)) and a corresponding set of metrics. Moreover, Conboy et al. (2011) describes a set of recommendations to overcome a broad range of problems from recruitment of agile staff, to training, motivation and performance evaluation, among others.

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5.2. Organizational Level

Organizational structure. Structural theories of innovation usually aim to specify organizational design characteristics that lead to innovation (Damanpour and Gopalakrishnan, 1998). Mintzberg (1980) synthesized much of the work on organizational structure and proposed a series of archetypes presented in Section 4.1. We aim to describe a company's structural configuration using his taxonomy. Burton et al. (2011) provided a step-by-step approach for assessing the organizational design based on the multi-contingency approach. Their questionnaire is one possible instrument to define organizational structure.

Organizational learning. Cohen and Levinthal (1990) argue that innovative outputs depend on the prior accumulation of knowledge that enables innovators to assimilate and exploit new knowledge. From this perspective, understanding the role of organizational learning in fostering or inhibiting innovation becomes crucially important (Lam, 2010). Assessing organizational learning is complex because of its multidimensional nature. Recent research, e.g. Jerez-Gomez et al. (2005), have proposed scales to measure Organizational Learning that can be useful to concretize our framework.

Organization capacity to change and adapt. As we discussed before, agility is the capacity to change and adapt in turbulent environments. Kettunen (2012) suggests a reference framework with a prototype tool called *Agility Profiler* for exploring and exploiting agility in software-intensive product development organizations. The tool can be used to assess the organizational degree of agility.

5.3. Environmental Level

Contextual variables. OECD Manuals (Oecd, 2002, 2005) provide a protocol to gather data regarding technology type, market type, organization type, innovation type, and company size. **Market structure and industry type.** Every country has a classification of industry type. Moreover, interest rates expectation, inflation rates, expenditure on R&D, total expenditure, patent protection, new products, antitrust regulations, protection law, tax law, special incentives, foreign trade regulation, labor law, lifestyle changes, career, consumer, rate of family formation, population growth rate, age distribution may all affect innovation drivers (Morck and Yeung, 2001).

Uncertainty. Kotha and Nair (1995) suggest four dimensions of environment to capture uncertainty: resource availability, competitive interdependence, technological change, and industry concentration. Past research implied that a mechanistic structure is more suitable for conditions of certainty when, under conditions of uncertainty, an organic structure would be more responsive to changes (Kotha and Nair, 1995).

Complexity. Some measurements of degree complexity are: geographic concentration of competitors, industry sales, and labor availability; level of products/services differentiation; geographic concentration of customers; and technological diversity used in the industry (Kotha and Nair, 1995).

6. Conclusion

In this work, we synthesized research on innovation, agility and organization design, and presented a guideline to evaluate innovation in agile companies at the organizational level. Future work is needed to both confirm and extend the usefulness of our conceptual model through empirical tests.

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According to (Anderson et al., 2004), there are two important directions for future research on innovation. First, to progress our understanding of innovation as a quintessentially multi-level phenomenon, researchers should use multi-level theory. The multi-level nature of innovation is first and foremost important because different variables will influence innovative behavior at different levels. Our proposal is a multi-level conceptual framework to analyze agile software companies considering four levels: individual, team, organizational, and environmental. Second, cross-cultural differences and the international generalizability should be considered when studying innovation. We aim to conduct a multiple-case study in Brazil to explore the multi-level relationship between agile methods, organizational design and innovation using the proposed conceptual framework as a guideline.

Finally, since innovation is an ongoing process, its consequences cannot be truly detected unless theoretical models explain composite effects of innovations over time. Damanpour and Aravind (2012) recommend that research on innovation must rely on longitudinal analytical methods to examine these conceptual models. Thus, we suggest that our framework should be applied in longitudinal studies, both exploratory and confirmatory.

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