# A Guideline for Supporting Agile Process Assessments

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***Abstract*—A critical factor in determining whether a company achieves competitive advantage in the market is its ability to deal with unexpected and continuous changes. This critical determinant is addressed by the term "agility". The current paper proposes a methodology for assessing agility at the organizational level, based around a reference model governed by a set of agile capabilities. The capabilities were selected from a review of the relevant literature in the manufacturing and software development fields. Along with this capability set, the reference model identifies an array of enablers and metrics, which facilitate their implementation. Finally, a case study discusses the experience of applying the proposal in the real environment of an established software company.**

***Keywords: software agility evaluation; agile assessment.***

## I. INTRODUCTION

A critical factor in determining whether a company achieves competitive advantage in the market is its ability to deal with unexpected and continuous changes. This critical determinant is addressed by the term "agility". Companies must reconfigure all the various elements of which they are composed (human, managerial, and technological) in order to successfully adopt agile methodologies.

Both the manufacturing and software development fields have faced similar challenges in recent years. Indeed, due to the commonalities between the fields some authors assign the core ideas in agile software development to trends in the manufacturing area [4][6][23].

The concept of agility was first formalized in a report entitiled '21st Century Manufacturing Enterprise Strategy', published by the Iacocca Institute in 1991 [3][11][10][15]. In this work agility is defined as a strategic ability, suggesting that being agile means being proficient at change. Consequently, a number of works were published in the literature which focused on refining the meaning of the term [14][8][10][20][21]. In software development context, new proposals emerged in the 90s as Scrum [18], XP [1], Crystal Clear [2], FDD [13], and DSDM [19].

Some authors promote ways for assessing agility, as in [17]. However, few are concerned with assessing agility from software organizations perspective.

This paper presents a model to support software organizations assess their agility status. Section II shows a brief overview about agility evaluation. Section III describes a reference model proposed to serve as a basis to the assessment process. Section IV reports a study applied in a real organization. Finally, Section V presents the conclusions of this work.

## II. AGILITY EVALUATION

Several efforts have been published in order to propose ways to evaluate organizational agility. Sharifi and Zhang [28][29] proposed a conceptual model with agility drivers, capabilities and providers.

Meredith and Francis [6] defined a set of agility components organized into four categories: agile strategies, agile processes, agile linkages, and agile people. Maskell [12] defined four elements of Agile Manufacturing: customer prosperity; people and information; cooperation; and fitness for change. Jin-Hai et al. [10] proposed a concept they called "real agile manufacturing" based on the critical aspects of strategic processing, multiple winners, integration, core competence, and IT. Ramesh [15] presented a literature review by identifying a set of criteria for attaining agility and also suggested a procedure for its successful implementation. Dove [4][27] stated that "Being Agile means being proficient at change – and allows an organization to do anything it wants to do whenever it wants to do". Plonka [14] specifies the critical attributes of an agile workforce: an attitude towards learning and self-development; problem-solving ability; being comfortable with change, new ideas and technologies; the ability to generate innovative ideas; along with the readiness to accept new responsibilities. Gunasekaran [8] defined a set of characteristics for agile teams: self-directed, containing IT-skilled workers with knowledge of team working, negotiation, advanced manufacturing strategies and technologies, who are also empowered, multifunctional and multilingual.

The assessment process proposed by this work is set within the context of software development at an organizational level, and comprises the reference model, assessment team, the company, and the evaluation process. Figure 1 illustrates the assessment environment.

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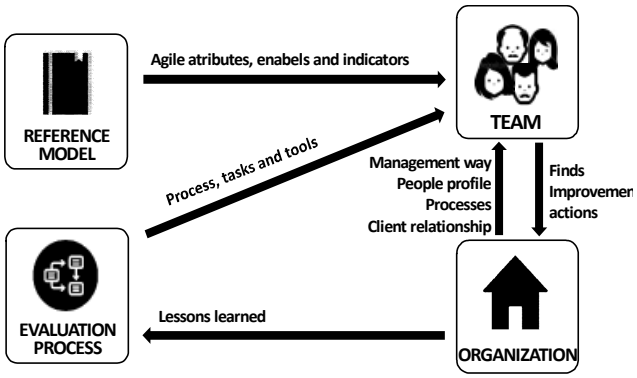


Figure 1. Assessment Environment

## III. THE REFERENCE MODEL

As shown in Figure 1, the team assesses the software company guided by the reference model and the evaluation process, making discoveries and recommending actions to increase agility levels within the company. Figure 2 illustrates the model in detail and lists the specific agile attributes, enablers, and indicators on which the assessment process is based.

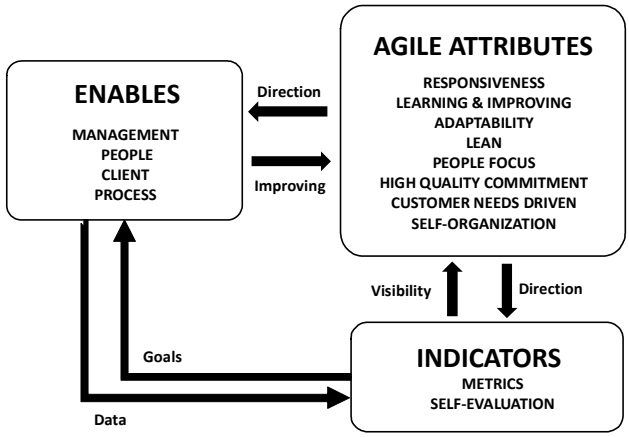


Figure 2. The Reference Model

As listed in the figure, the set of agile attributes includes the following characteristics: responsiveness, learning and improvement oriented; adaptability; lean; focus on people; commitment to high quality; driven by customer needs; and self-organization. It is this set of attributes that propels the enablers to implement and improve the agile capabilities of the company. At the same time, they establish the indicators, which are first obtained from metrics or evaluation results and then executed by accepted practices and tools.

### A. Software Agility Capabilities

To identify the common capabilities and attributes that define an agile company, a literature review was conducted in both the manufacturing and software fields. The review considered works that contained the following keywords; 'agile attribute', 'agile criterion', 'agile concept', 'agile definition', or 'agile capabilities'. The search process focused on articles from the following sources: ACM Digital Library; IEEE Computer Society Digital Library; and Google Scholar (in order to widen the search). The results of the search, the majority of which came the manufacturing research field, were combined to construct Table I, which shows that agility converges into six common capabilities.

*1)* Responsive

The quality of responsiveness can be defined as the capability to easily accept and deal with changes; to identify changes and respond to them both reactively and proactively; and to recover from them [28].

*2)* Fast

Since agility is a rapid and proactive adaptation to continuous and unpredicted changes, speed is an essential attribute of an agile organization. A fast organization gets to the market quickly, with a production time that guarantees the fast delivery of products and services. However, this capability should not be limited to the time of production: it must be evident throughout the company. Some authors, Breu et al. [21] for example, cite the speeds of skill development, adaptation to new work environments, and information access as indicators for evaluating the agility of a workforce.

TABLE I. SOFTWARE AGILE ATTRIBUTES

| Agile Capability | Author |
|---|---|
| Responsive | [1]; [3]; [4]; [9]; [12]; [18]; [21]; [23]; [24]; [26]; [28]; [30]. |
| Fast | [1]; [3]; [4]; [7]; [9]; [18]; [21]; [24]; [27]; [28]; [30]. |
| Adaptable | [1]; [3]; [4]; [18]; [23]; [24]; [27]; [28]; [30]. |
| Knowledge-driven | [7]; [18]; [21]; [23]; [24]; [25]; [28]; [30]. |
| Self-organized | [7]; [9]; [12]; [18]; [23]; [24]; [28]; [30]. |
| Quality and Improving Committed | [1]; [7]; [9]; [18]; [23]; [24]; [30]. |

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3) Adaptable

Adaptability is commonly related to flexibility. To adapt itself to the demands of the market, a company requires flexible processes and structures, as well as flexible people. The concept of organizational adaptability originated from the contingency approach in organizational research, and the theory that the organizing style is dependent on the situational constraints of the environment in which the company operates [30].

4) Knowledge-Driven

According to the literature review, a focus on knowledge represents a critical aspect of agility. Goldman et al. [25] for example, link competitive agile environments to knowledge and experience. Yusuf et al [23] cite that the best practices of a knowledge-rich environment provide the means to produce customer-driven products in a fast changing environment. Sherehiy [30] states decentralized knowledge as a characteristic of an organic organizational design. Knowledge management and change proficiency are co-dependent relationships, and the enabling competencies of an agile company [5]. The emphasis on short development cycles, reviews, collaborative work and retrospectives found in the Agile Manifesto, also agile practices such as XP and Scrum, reflect the importance given to organizational knowledge in software development.

5) Self-organized

Organizational agility demands proactive and adaptive responses, and thus certain key skills are required in an agile workforce. Based on the evidence from the review, these skills are directly linked to empowered and self-organized teams. Particularly considering the environment of agile software development, the requirement for a high level of both individual and team autonomy is viewed as a prerequisite attribute.The Agile Manifesto explicitly includes this aspect in one of its 12 agile principles, affirming that the best architectures, requirements, and designs emerge from self-organizing teams.

6) Quality and Improving Committed

As agility is a dynamic and competitive ability, its institutionalization demands high quality with decreasing lead time [4]. Retrospectives are recommended by agile methods as a mechanism to discover means to increase effectiveness. According to the Agile Manifesto, a team tunes and adjusts its behavior driven by the desire to improve its performance.

### *B. Supporting Enablers*

Agile capabilities represent the direction of organizational improvement, and are achieved through the implementation of accepted practices and tools (enablers). Institutionalized agile enablers are the clear indicators of the agility journey during an agile assessment evaluation, therefore agile companies must understand and identify which enablers are appropriate for each project or program. Table II presents a set of common enablers selected from the results of the literature review and connects each capability with its relevant agile capability as stated by the Agile Alliance in its Agile Practices Guide [31].

TABLE II. AGILE CAPABILITIES AND SUPPORTING ENABLERS

| **Capabilities** | **Enablers** |
|---|---|
| Responsive | Continuous deployment, Frequent releases, Daily meeting, Incremental development, Rules of simplicity |
| Fast | Automated build, Automated test, Continuous delivery, Continuous integration, Incremental development, Planning Poker, Rules of simplicity |
| Adaptable | Automated test, Continuous integration, Daily meeting, Frequent releases, Incremental development, Pair programming, Rules of simplicity |
| Knowledge-driven | Pair programming, Retrospectives, reviews, Collective ownership, Incremental development, Kanban boards, Refactoring |
| Self-organized | Daily meeting, Retrospective, Kanban boards, Planning Poker |
| Quality and Improving Committed | Acceptance test, TDD, Daily meeting, Retrospective, Incremental development, INVEST, Kanban boards, Pair programming, Refactoring, Usability tests |

### *C. Supporting Metrics*

In order to evaluate the improvement of agility, the assessment guideline considers a set of metrics to be monitoring. Table III shows the list of metrics adopted. Besides, the table presents the mapping between each capability and the supporting metrics.

Table III helps software organizations to identify what to consider to measure in order to monitoring its agile way. Metrics listed should be collected and tracking at the organizational level, and it can be a team, a project, a department or the whole company.

Some of the metrics support directly one specific capability. For example, Lead Time (the time between the initiation and completion of a production process) is related directly to capability fast. Throughput, on the other side, is related to self-organized indirectly.

The evolution of each metric should be closely monitored and analyzed during the assessment to identify both the capabilities that are improving and the key areas that require further work.

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TABLE III. AGILE CAPABILITIES AND SUPPORTING METRICS

| METRIC | CAPABILITIES: RESPONSIVE | FAST | ADAPTABLE | KNOWLEDGE-DRIVEN | SELF-ORGANIZED | QUALITY AND IMPROVEMENT COMMITED |
|---|---|---|---|---|---|---|
| Cost of change (effort) | X | X | X | | X | |
| Time to change | X | X | X | | X | |
| Improvement frequency | | | X | X | | X |
| Lead Time | X | X | | | | |
| Throughput | X | X | | | X | |
| Takt time | X | X | | | | |
| Team building speed | X | X | X | | X | |
| Client Satisfaction | | X | | | | X |
| Requirements or BV burn downs | X | X | | X | | X |
| Role variety | X | | X | X | X | |
| Cumulative Flow | | X | | X | | |
| Re-work measurement | | | | X | | X |
| Technical Debt | X | | | | | X |
| Defect Density | X | | | | | X |

## IV. ASSESSMENT PROCESS APPLIED IN A REAL CASE STUDY

The goal of the case study was to validate the suitability of the proposal in a real situation. The assessment process was applied to a small Brazilian company that produces software in the industrial automation area and first adopted agile and Lean approaches in 2011. At the beginning of the process, the complete team consisted of 20 employees, of whom 15 were directly involved in software development and the remainder in administration, marketing and sales. During the assessment period of 3 months a set of metrics was collected at monthly intervals to verify the degree of improvement in agile capabilities.

An analysis of the data available in the company was performed to define a set of suitable metrics. These were: lead time (the period of time between the beginning and the end of user story development); throughput (number of user stories divided by total time); takt time (the total time divided by the number of user stories); improvement frequency (the number of actions implemented as a result of retrospectives); and client satisfaction (collected from a systematic monthly survey made by the organization). Figure 3 is a selection of metrics for one small project over the three month period.

According to Figure 3, throughput, takt time and lead time all demonstrated improving curves during the study. 59 user stories (attributed by the team as smalls) were collected and developed. In the first month, the team produced a thoughput of 0.5 user story, improving to 0.7 and 0.8 in the consecutive months. Takt time values demonstrated a similar improving behavior. This represents a good indicator of capabilities as being responsive and quality and improvement committed. Similar results were found in the other collected metrics. It is important to state that during this period the organization applied enablers in order to improve its results.

Each metric was analyzed in terms of its institutionalization as well as its application for improvement. Parallel observation and self-evaluation was performed by the team to verify the level of institutionalization of each agile metric or practice. Table IV gives the results of the evaluation, where each agile enabler or metric was evaluated by the team as Institutionalized (I), In Progress (P), or Not Worked (N).

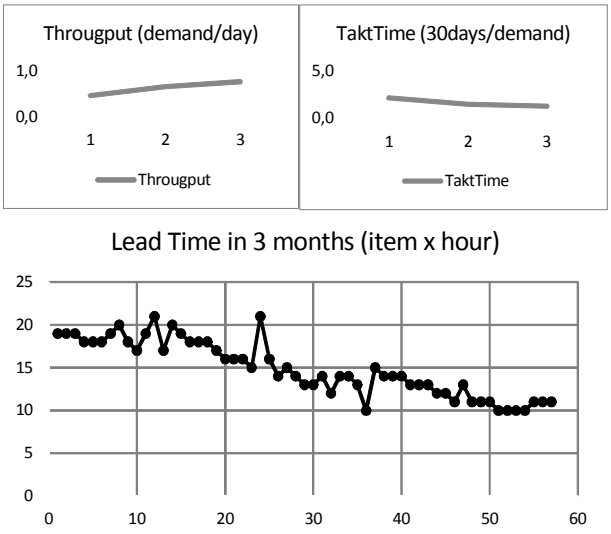


Figure 3. Throughput, Lead Time and Takt Time collected from case study

Figures 4 and 5 give a graphical view of the evaluation results in terms of the degree of institutionalization for each agile practice and the attendance of a capability.

The case study results highlight areas of improvement, demonstrating the impact of these improvements in terms of agile capabilities. It should be stated that it is not mandatory for a company to implement all the recommended agile practices. That is the reason that an agile capability being worked through at least one enabler and metric was classified as 'In Progress' in the evaluation.

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TABLE IV. AGILE CAPABILITIES ATTENDANCE ANALYSIS

| | CAPABILITIES | | | | | |
|---|---|---|---|---|---|---|
| **METRIC** | RESPONSIVE | FAST | ADAPTABLE | KNOWLEDGE-DRIVEN | SELF-ORGANIZED | QUALITY AND IMPROVEMENT COMMITED |
| Cost of change (effort) | N | N | N | | N | |
| Time to change | N | N | N | | N | |
| Improvement frequency | | | P | P | | P |
| Lead Time | P | P | | | | |
| Throughput | P | P | | | P | |
| Takt time | P | P | | | | |
| Team building speed | N | N | N | | N | |
| Client Satisfaction | | I | | | | I |
| Requirements or BV burn downs | P | P | | P | | P |
| Role variety | N | | N | N | N | |
| Cumulative Flow | | P | | P | | |
| Re-work measurement | | | | N | | N |
| Technical Debt | N | | | | | N |
| Defect Density | P | | | | | P |
| How we monitoring the agile capabilities attendance? | P | P | P | P | P | P |
| **ENABLER** | | | | | | |
| Continuous deployment | P | P | P | | | |
| Frequent release | I | P | I | | | |
| Continuous delivery | I | I | I | | | |
| Daily meeting | | I | I | I | I | I |
| Incremental development | I | | I | I | | |
| Rules of simplicity | N | I | N | | | |
| Pair programming | | N | N | N | N | N |
| Retrospectives, reviews | | | | P | P | P |
| Collective ownership | | | P | P | P | |
| Kanban boards | | | | I | I | I |
| Refactoring | | | | N | | N |
| Automated test | P | | P | | | P |
| Continuous integration | N | P | | | | N |
| Acceptance test | I | N | | | | I |
| TDD | N | | | | | N |
| INVEST | N | | | | | N |
| Planning Poker | P | | | | P | P |
| Automated build | P | P | P | | | |
| Usability tests | | P | N | | | N |
| How we apply enablers to intensify agile capabilities attendance? | P | N | P | P | P | P |

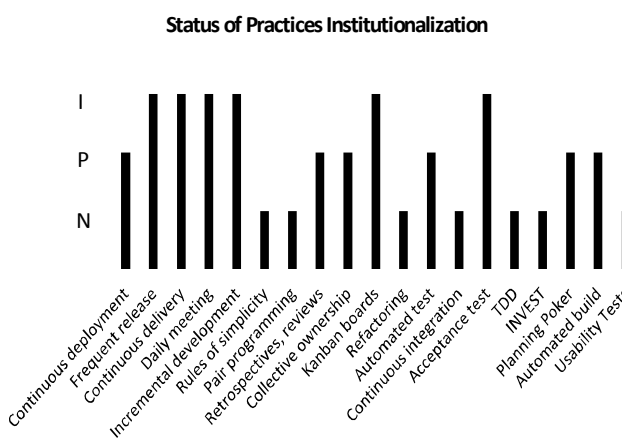


Figure 4. Agile Practices Institutionalization

## V. CONCLUSION

A proposal was presented for assessing organizational agility which could be applied at company, department, and team levels. The basis of the proposal is a reference model that is driven by a set of agile capabilities selected from a literature review carried out in the manufacturing and software development fields. To accompany this set of capabilities, the model offers an array of enablers and metrics that can facilitate a company to achieve these agile capabilities. Each agile enabler was linked to the capability it supported and demonstrated the relationship between each capability and its supporting metrics. Finally, a case study was included to illustrate the experience of the proposal being applied to a small Brazilian software company.

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