Measuring Agility of Organizations – A Comprehensive Agility Measurement Tool (CAMT)

Ameya S Erande, Alok K Verma
Old Dominion University
aeran001@odu.edu , averma@odu.edu

Abstract

Since "Agility" is ability to respond to unpredictable changes with quick response and profitability, it is not industry specific. This "not industry specific" nature of agility makes it hard to assess and measure it on a fixed scale. Measurement of agility of an enterprise has been a major topic of research since inception of agility in 1991. Though some methods have been developed to measure agility, they mainly remain tied to manufacturing industry. As agility is present in all the industries, comprehensive tool to measure it is a necessity in order to determine responsiveness of an enterprise to external turbulences.

Comprehensive Agility Measurement Tool (CAMT) measures agility on the scale of 1-5; 1 being least agile and 5 being highly agile. This tool captures agility using 10 agility enablers and thus also points out areas lacking agility. Use of Analytic Hierarchy Process (AHP) gives flexibility to this tool and also solves the problem of changing priorities of agility enablers from enterprise to enterprise. This paper describes methodology used to develop Comprehensive Agility Measurement Tool. CAMT considers most important factor responsible for agility – human resource management and uses training of employees, attrition rate and percent increase in yearly profit to measure human resource agility and visionary leadership.

Introduction

A committee set up to study lack of international competitiveness of the US industry coined the term "agility" in 1991. US industry lacked agility and hence was not able to compete internationally.

Goldman, Nagel and Preiss define agility as "A comprehensive response to the business challenges of profiting from the rapidly changing, continually fragmenting global markets for high quality, high performance, customer configured goods and services. Thus agility is dynamic, content specific, aggressively change embracing and growth oriented. Agility is a comprehensive response to new competitive forces that have undermined the dominance of the mass-production system" [1].

An agile company involves equally-efficient response from all its constituents namely, supply chain, customers and external partners. Therefore it is very important to measure agility of each constituent while measuring overall agility.

Need to measure agility

Agility, since its inception in 1991, has been the Buzzword for all the industries in today's globally competitive dynamic market. Companies try hard to achieve an upper edge over competitors in this continuously changing and unpredictable market.

- Agility is very important to stay competitive in the market
- Measurement of agility gives enterprise measure of its competitiveness and readiness for changes in the market
- Measuring agility identifies "less agile" areas in an enterprise and thus it can plan for improvements

Methodology of Agility Measurement

Lean is a pre-requisite for being agile. Lean enterprise uses tools like Value Stream Mapping, supplier management, TAKT time, flow, TPM, set-up, Poka-Yoke, Kaizen, production planning, pull, inventory, uptime measurement, equipment flexibility, employee training, skill development and quality awareness etc. to achieve the goal of waste reduction[2]. Going from lean to agile is a transition and agility indicates the state of the company. It is a continuous improvement process. Thus study of leanness measurement tools becomes imperative while developing agility measurement tool. A quick survey of tools to measure degree of leanness shows that there are 7-10 tools in practice [2]. Some of them are listed below.

1. Lean Manufacturing Screening Tool Developed at University of Toledo.
2. Virginia Philpott Manufacturing Extension Partnership(VPMEP) Lean Assessment Tool
3. A model for Evaluating the degree of Leanness of manufacturing firms
4. Assessment tool by Saturn Electronics & Engineering Inc.
5. West of England Aerospace Forum (WEAF)
6. Lean Aerospace Initiative – Lean Enterprise Self Assessment Tool (LAI-LESAT)
7. The Lean Extended Enterprise Assessment Process (LEEAP)

LAI-LESAT and LEEAP are more comprehensive in nature as they cover most of the attributes of lean enterprise and hence are briefly discuss in this paper.

Lean Aerospace Initiative – Lean Enterprise Self Assessment tool (LAI-LESAT)

This is a tool [2] [3] for self assessing the present state of leanness of an enterprise and its readiness to change. It comprises of capability maturity model for enterprise leadership, life cycle and enabling processes.

LESAT takes into consideration the entire enterprise, which the other assessment tools fails to take into account. It also provides both the measure of Lean and Gap analysis. It also clearly identifies the "next" step to be taken.

The LESAT architecture shown in figure 1 consists of three main sections viz.

1.Lean transformation / Leadership: the process and leadership attributes nurturing the transformation to lean principles and practices.

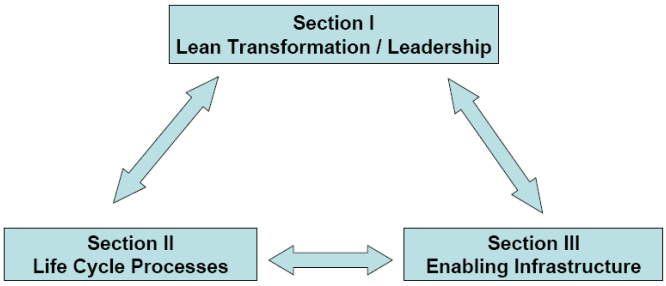

Figure 1 LESAT Architecture

2. Life cycle processes: the processes responsible for the product from conception through post – delivery support.
3. Enabling infrastructure processes: the processes that provide and manage the resources enabling enterprise operation.

Following steps are taken while deploying LESAT as a tool for measuring organizational leanness:

Step 1: Facilitate meeting to introduce tool.
Step 2: Leaders and staff conduct LESAT assessment.
Step 3: Leadership reconvenes to jointly determine present maturity level.
Step 4: Leadership determines desired level and measures gap.
Step 5: Develop action plan and prioritize resources.

Lean Extended Enterprise Assessment Process (LEEAP)

The Lean Extended Enterprise Assessment Process (LEEAP) [2] [4] is the framework for measuring the Lean Extended Enterprise Reference Model (LEERM) as shown in table 1. LEEAP includes detailed assessment and scoring process for the lean extended enterprise across 7 best practice categories and 42 best practice criteria.

LEEAP provides quantitative assessment of the company's ability to execute, sustain and realign itself for strategic improvement. It covers extended enterprise, the enterprise, core business processes and daily operation performances.

Table 1: LEERM Best Practices and Principles Panel

Leadership	**Customer and Market Focus**	**Uniform improve-ment Infra-structure**	**Value Stream Process**	**Extended Enterprise Integration**	**Organization al Learning**	**Perfor-mance Measure-ment**
Recognitio n of Need Internalized	Customer Intimacy and Value	Data and Fact driven improvement	End to End perspective	Single Entry No walls	My Business Mindset	Cash to Cash Perspectiv e
Clarity in Directions and Goals	Mass Customization	Project Selection Criteria	Value Stream Pull / Rhythm	Collabora-tive Develop-ment Process	Professional Growth Experience	Closed-Loop Financial Validation
Define Value Proposition	Pulse and Flexibility	Chunking and Resource Management	Soft Business Process Integration	Collabora-tive Planning Process	Knowledge Management	Value Stream Performan ce
Values and Standards of Conduct	Instantaneous Information and Response	Empower-ment and Teaming	Standard-ized Processes and Practices	Collabora-tive Commerce Process	Relationship Management	Strategic Performan ce
Awareness and Communi-cation	Velocity Improvement	Spectrum of Methodo-logies and Tools	Stability and variation Reduction	On-Line Market-place	Change as the Norm	Organizati on-al Performan ce
Fluid Seamless Organiz-ation	Solution Delivery	Education Based on Certification	Value Stream Quality and Perfection	Other IT Enabled Techno-logies	Cultural Transform-ation	Social and Economic Performan ce

LEEAP and LAI-LESAT cover all the factors in lean journey of an enterprise. But these two tools leave out e-manufacturing, takt time, problem solving, plant capacity, continuous improvement, operational flexibility, SMED/quick changeover, TPM, small lot operation, decentralization, internal customer satisfaction and inventory. All these factors are very important from agility point of view. Also continuous improvement, operational flexibility, plant capacity and internal customer satisfaction are critical factors in an agile company. Since the need for measuring agility was felt in the past decade, about 9 tools have been developed to measure agility of an enterprise. These tools are listed below [2].

Agility Measurement Tools

1. This approach uses level of adoption of a number of criteria for an agile enterprise. For example, Yusuf et.al defined 32 key attributes in 10 different domains.

Ren et.al propose 6 key attributes as speed, productivity, flexibility, cost, quality and innovation.

2. Questionnaire based approach used for industry managers weighs each attribute based upon its contribution in overall agility.

3. Kumar and Motwani propose a methodology for time based competitive advantage through the self assessed survey.

4. Giachettie et.al. use measurement of structural properties of business (info and material flow, organizational relationships, and communication network) instead operational properties (batch size, change over times etc.)

5. Giachettie and Aeteta propose assessment of firm's complexity. According to them, complexity is directly related to firm's agility.

6. Rameshash et.al suggest a quantitative framework to explore the value of agility in financial terms, the Net Present value (NPV) of all relevant cash flows being the measure of agility.

7. CDW Lomas et.al. [5] give a method to measure design process agility for a single company product development process. Key Agility Index (KAI) is calculated to measure agility of a process.

$$\text{Key Agility Index (KAI)} = \frac{Time Taken\ to\ Complete\ Change\ related\ Task}{Time\ Taken\ to\ Complete\ Whole\ \text{Pr}oject}$$

8. Dr. Charlene Yauch developed a survey based method that calculates agility by measuring turbulence and organizational success [6]. She has categorized external turbulences in 8 domains. Agility is given by the formula

$$\text{Agility} = \sqrt[3]{S}\, x \frac{T}{5}$$

Where, S is success score and T is turbulence.

9. Nikos Tsourveloudis et.al. break-down manufacturing agility into four divisions / infrastructures in order to measure it [7]. Overall agility is calculated by applying fuzzy logic to individual agility scores in production infrastructure, market infrastructure, people infrastructure and information infrastructure.

Some observations on the agility measuring methods discussed in chapter 2 are as follows.

- Majority of the methods rely on the data gathered by a long questionnaire, meaning that the data used will be the opinion of whoever completes the questionnaire, not necessarily the person best placed to do so.

- Level of data is often too detailed and the level of data required is inaccessible or even not recorded by the company.
- These methods do not take into account "soft" domains like human resources (training and skills development, leadership etc.) which is one of the important characteristics of an agile organization.

These methods are limited to manufacturing industries. Agility is the property which is independent of industries; thus limiting effective use of these methods.

Comprehensive Agility Measurement Tool (CAMT)

CAMT should be easy to use, and it should measure agility independent of industry it is used in. This requires consideration of agility enablers from all the domains in an enterprise. Dr. Zaki Kuruppalil identifies 41 agility enablers for a job shop from 14 domains [8]. After reviewing number of agility enablers, CAMT considers 10 most critical agility enablers that are present in any enterprise independent of industry it is operating in. These are 1) TAKT time 2) Plant Capacity 3) Inventory 4) Problem Solving 5) e-manufacturing 6) Continuous Improvement 7) Operational Flexibility 8) SMED / quick changeover 9) Internal Customer Satisfaction 10) Human Resource Management.

For all these subjective parameters CAMT uses a questions to capture readiness to face external turbulence timely and profitably . Short description of each parameter and a question for measurement with the scale of 1 – 5 are given below.

Takt Time: Percentage of work balanced at or slightly below TAKT time.

1	2	3	4	5
0-20	20-40	40-60	60-80	80-100

Plant Capacity: Percent overload capacity of plant

1	2	3	4	5
0-20	20-40	40-60	60-80	80-100

Inventory: Inventory turnover rate for past 1 year

1	2	3	4	5
01	02	03	04	05 or more

Problem Solving: Number of critical problems faced and solved in past 1 year.

1	2	3	4	5
01-03	04-06	07-08	09-10	more than 10

E-manufacturing:E-manufacturing offers manufacturers with an option of conveniently recognizing the manufacturing capability with agility to respond to the opportunities and demands of a changing market [6].

Combined percentages of products and processes that involve e-manufacturing

1	2	3	4	5
0-20	20-40	40-60	60-80	80-100

Continuous Improvement: Number of successful continuous improvement projects undertaken in past 1 year.

1	2	3	4	5
01-03	04-06	07-08	09-10	more than 10

Operational Flexibility: Percentage of workforce - Percentage of equipments readily available to handle turbulent situations.

1	2	3	4	5
0-2-02	2-5-2-5	5-10-5-10	10-15-10-15	15+ - 15+

Quick changeovers: Percentage of quick changeover issues successfully handled in past 1 year

1	2	3	4	5
0-20	20-40	40-60	60-80	80-100

Internal Customer Satisfaction: Internal customer satisfaction index on the scale of 1-5; 1 being unsatisfied.

1	2	3	4	5
01	02	03	04	05

Human Resource Management: An organization can not be agile without agile workforce. It is humans and not the machines that anticipates changes and react to them. If human resources are not properly trained and are not aware of company's goals, it is impossible for it to be agile. This domain is abstract and measuring human responsiveness is difficult. Expertise within the workforce shown in figure 2 plays key role in building agile workforce.

CAMT considers 4 factors to judge the agility of human resources in an enterprise

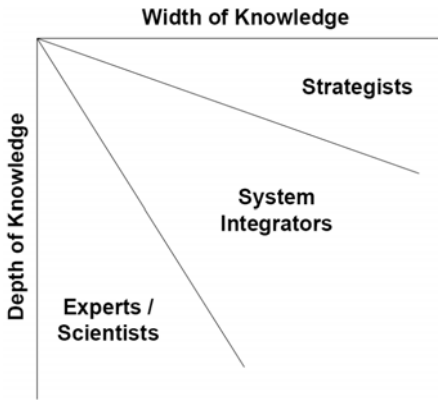

Figure 2 Expertise with in the Workforce

.Number of Training / Skill Development Programs Completed

Score	1	2	3	4	5
%	0-30	30-50	50-80	above 80	100

% of Attrition for Employees with Experience Less than 2 Years

Score	1	2	3	4	5
%	>20	20-15	15-10	10-05	05-0

% of Attrition for Employees with Experience More than 2 Years

Score	1	2	3	4	5
%	>10	10-08	08-06	06-04	04-02

% of Profit Increase from Past Year

Score	1	2	3	4	5
%	0-20	20-40	40-60	60-80	80-100

Sample Results

Figure 3 shows sample result sheet of CAMT. Comprehensive Agility Index (CAI) measures the agility of an enterprise on the scale of 1-5; 1 being least agile and 5 being highly agile. Sample calculations assuming values for each agility enablers are done to obtain sample results. Complete validation of this tool will require data from atleast 3 different industries, e.g. automobile, shipbuilding and software. This tool also provides guidelines to achieve agile status based on the answers to the questions. For example, if score registered in Inventory Turnover Rate is 1, which is very less indicates certain efforts to improve agility in that particular field.

	1	2	3	4	5	6	7	8	9	10	Normalized Sum	% Weights	CAMT Scale	Weighted CAMT
1	1.00	1.00	3.00	0.14	1.00	1.00	0.33	1.00	1.00	1.00	0.83	8.25	3	24.764898
2	1.00	1.00	3.00	0.20	1.00	1.00	1.00	1.00	1.00	1.00	0.89	8.86	4	35.451214
3	0.33	0.33	1.00	0.33	3.00	1.00	5.00	1.00	3.00	1.00	1.31	13.05	1	13.050659
4	7.00	5.00	3.00	1.00	3.00	1.00	1.00	1.00	1.00	1.00	1.80	17.97	2	35.931292
5	1.00	1.00	0.33	0.33	1.00	3.00	1.00	1.00	1.00	1.00	0.86	8.56	3	25.675546
6	1.00	1.00	1.00	1.00	0.33	1.00	0.33	1.00	1.00	1.00	0.75	7.54	5	37.677422
7	3.00	1.00	0.20	1.00	1.00	3.00	1.00	1.00	1.00	1.00	1.06	10.57	4	42.269178
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	8.56	3	25.6854
9	1.00	1.00	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.81	8.08	2	16.162062
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86	8.56	3	25.6854
														282.35307
	17.33	13.33	13.87	7.01	13.33	14.00	12.67	10.00	12.00	10.00	10.00	100.00		2.8235307 ← **CAI**

1. TAKT Time
2. Plant Capacity
3. Invenntory Turnover Rate
4. Problem Solving
5. e-Manufacturing
6. Continuos Improvement
7. Operational Flexibility
8. SMED ? Quick Changeovers
9. Internal Customer Satisfaction Index
10. Human Resource Management

Figure 3: Result of CAMT

Conclusion

The Comprehensive Agility Measurement Tool measures agility takes 10 most critical agility enablers while calculating Comprehensive Agility Index (CAI) on the scale of 1-5. Since the agility enablers used are critical in all the industries, CAMT can be used to measure agility of an enterprise independent of the industry it is operating in. Use of AHP gives CAMT flexibility and comprehensive nature by solving the problem of industry dependent nature of agility enabler priorities. This tool is repeatable, provides guidance regarding future course of action, goes hands-in-hands with company's goals, and accommodates all levels and functions of an organization.

References

[1] Preiss, Kenneth, "Agility – the Origins, the Vision and the Reality", International Conference on Agile Manufacturing, 2005

[2] Verma, Alok, Hirkannawar, "Assessment Tools for Lean Enterprise Implementation", International Journal of Agile Manufacturing, Vol 7, Issue 2, 2004Preiss, Kenneth, (2005): Keynote Address ICAM.

[3] Nightingale, Deborah, MIT, "LAI – Lean Enterprise Self Assessment Tool", 2001

[4] Burton, T, Boeder, S, "The lean Extended Enterprise", J Ross Publishing Inc Florida, 2003

[5] Lomas, CDW, et. al. "Measuring Design Process Agility for A Single Company Product Development Process" International Conference on Agile Manufacturing", 2006

[6] Yauch, Charlene, "Measuring Agility: Combining Organizational Success and Turbulence", International Conference on Agile Manufacturing, 2005

[7] Tsourveloudis, Nikos, et.al. "On the Measurement of Agility in Manufacturing Systems

[8] Zaki, Kuruppalil, "Key Domains of Leanness and Agility in Job Shops", International Conference on Agile manufacturing, 2008

[9] Saaty, T. L, "The Analytic Hierarchy Process", Planning, Priority Setting, Resource Allocation, McGraw Hill, New York 1980.

Biographies

AMEYA S. ERANDE received his Bachelor of Engineering in Mechanical Engineering from University of Pune, India, in 2002. Presently he is pursuing Master of Science in Mechanical Engineering from Old Dominion University. His research interests include Lean-six sigma, Agile Manufacturing, Robotics, CAD/CAM and Simulations.

ALOK K. VERMA is Ray Ferrari Professor and, Director of the Lean Institute at Old Dominion University. He also serves as the Director of the Automated Manufacturing

Laboratory. Dr. Verma received his B.S. in Aeronautical Engineering from IIT Kanpur, MS in Engineering Mechanics and PhD in Mechanical Engineering from ODU. Prof. Verma is a licensed professional engineer in the state of Virginia, a certified manufacturing engineer and has certifications in Lean Manufacturing and Six Sigma. He has organized several international conferences as General Chair, including ICAM-2006 and ICAM-1999 and also serves as associate editor for three International Journals. He serves as the President of the International Society of Agile Manufacturing and as the chief editor of the International Journal of Agile Manufacturing. Dr. Verma's scholarly publications include more than 77 journal articles and papers in conference proceedings and over 50 technical reports. He is actively involved in applied research, and has served as a PI or Co-PI on several funded competitive grants exceeding $4.0 million. Dr. Verma has developed and delivered training program in Lean Enterprise & Design for Manufacturing for Northrop Grumman Newport News, STIHL and several other companies in U.S. He has developed simulation based training programs for shipbuilding and repair industry under a grant from the National Shipbuilding Research Program (NSRP). He is well known internationally and has been invited to deliver keynote addresses and invited papers at more than 12 national and international conferences on Lean/Agile manufacturing. Dr. Verma has received the Regional Alumni Award for Excellence for contribution to Lean Manufacturing research, the International Education Award at ODU and Ben Sparks Medal by ASME. He is active in ASME, ASEE, SME, IIE and SNAME. Dr. Verma continues to serve the Hampton Roads community in various leadership positions.