

## DESSAC: A DECISION SUPPORT SYSTEM FOR AGILITY ASSESSMENT

Vinodh, S., Sundararaj, G. and Devadasan, S.R.

Department of Mechanical Engineering,

PSG College of Technology, Coimbatore-641 004, TamilNadu, India,

E-mail: vinodh\_sekar82@yahoo.com, gsraj\_558@yahoo.com, devadasan\_srd@yahoo.com

**Abstract:** *This paper traces the origin and development of Agile Manufacturing (AM). The industrial sectors, which have imbibed agility, are today's winners in the competitive markets. In order to implement twenty criteria AM effectively, the agility level at which currently a company operates needs to be quantified. Hence, a scoring pattern analogous to the one used in Malcolm Baldrige National Quality Award is integrated with the twenty criteria AM model. Applying this quantifying model in real time practice will be a time consuming and tedious process. In order to overcome this difficulty, a Decision Support System named as DESSAC (stands for DEcision Support System for quantifying Agile Criteria) has been developed during the research being reported in this paper.*

**Key words:** *Agile Manufacturing; Lean Manufacturing; Decision Support System; Flexible Manufacturing Systems; Implementation Study*

### 1. INTRODUCTION

The competitive scenario changed during 1980s, when the world witnessed the globalization (Hartungi, 2006). During this period, the gates stopping the entry of products from various countries were opened in global as well as local markets. Because of this condition, the world witnessed the entry of enormous number of players in the markets. In order to achieve this task, a variety of criteria which are highly contrasting with the mass production system have to be inculcated in the organizations. At one point of time, researchers encapsulated these criteria under the terminology, 'Agile Manufacturing' (AM).

It is even difficult to point out the exact changes that those sectors have to undergo to acquire AM characteristics. In this background, a handful of researchers have identified the elements and criteria which are the constituents of AM. These research contributions are useful to understand the nature of characteristics that should prevail in AM companies. Hence, a common model cannot be evolved to operate agility in all the traditional companies for they exercise agility at different levels. Therefore, the need of quantifying agility is realized. On realizing this imperative, during the recent years, some researchers have begun to work in the direction of quantifying agility. This paper reports a research, which was carried in this context.

The agile quantification model being proposed in this paper is lucid in pinpointing the gaps and actions to be undertaken to attain AM criteria. A Decision Support System (DSS) is required to help the traditional industry captains, not only to quantify agility but also to analyze them. Since, manual support will be time consuming and error prone, a computer assisted DSS is needed for this purpose. In order to fulfill this need, a DSS for quantifying and analyzing agility has been developed during the research being reported in this paper. The details of this DSS and the efforts made to examine its

practical adaptability have also been described in this paper.

### 2. LITERATURE REVIEW

The dynamic demands of the customers began to spontaneously drive the organizations towards acquiring agility. In fact, AM practices informally existed in organizations right from 1970's. However, AM became one of the research agenda only when a group of researchers instituted Agility forum at Iacocca Institute, Lehigh University, United States of America in the year 1991 (Jin-Hai et al. 2003). Thereafter a considerable number of researchers started to work in the direction of evolving the principles of agility. Many of them have brought out a number of definitions. Jin-Hai et al. (2003) have enumerated some of those definitions. In essence, these definitions envisage AM as the capability of a manufacturing system to respond quickly in response to the customers' dynamic demands.

An overview of literature in this direction indicates that management oriented AM research has so far been conducted in more number in comparison to that of the technological oriented AM research. On realizing the need of blending these two aspects of AM research, a handful of researchers have started to work on identifying AM elements and criteria. A search was made in literature to find out the research on quantifying agility. Some of the papers which have reported this kind of research are enumerated in Table 1.

A careful study of these papers indicated that all the above researches require the help of researchers to quantify agility. Moreover, the outcomes of these researches are seldom practically adopted in real time situations. Besides, these models are not fully practically compatible.

Table 1. Research on quantifying agility in organizations

Research Paper	Quantification of agility
Arteta & Giachetti (2004)	Agility measurement methodology
Yang & Li (2002)	Design of the agility evaluation of mass customisation product manufacturing index system
Zhang & Sharifi (2000)	Assessment model for agility
Sharifi & Zhang (1999)	A model for determining agility need level
Kumar & Motwani (1995)	Development of agility index

### 3. TWENTY CRITERIA AM MODEL

Since the twenty criteria AM model (Devadasan et al. 2005) adopted in this paper is not widely publicized, its conceptual features are presented in this section. This will enable the readers to appreciate the background of developing agile quantification model. A careful study of them would indicate that the twenty criteria facilitate agility in organizations by blending five enablers. Those enablers with their corresponding criteria are shown in Table 2.

Table 2. Agility enablers and the criteria

Agility Enabler	Criteria
1.Organisational Structure Enabler	Organisational Structure, Devolution of authority, Nature of Management
2.Manufacturing Management Enabler	Customer Response Adoption, Change in Business and Technical Processes and Outsourcing
3.Employee Enabler	Employee Status and Employee Involvement
4.Technology Enabler	Manufacturing Set-ups, Product Life Cycle, Product Service, Design Improvement, Production Methodology, Manufacturing Planning, Automation Type and IT Integration
5.Manufacturing Strategy Enabler	Status of Quality, Status of Productivity, Cost Management and Time Management.

Thus the twenty criteria agile model not only blends agility with technology and manufacturing management, but also the other three competitive enablers namely organisational structure, employee and manufacturing strategy. In this background, this twenty criteria agile model was adopted to propose an agile quantification model.

### 4. AGILE QUANTIFICATION MODEL

The agile quantification model reported in Ramesh & Devadasan (2007) was subsequently refined by considering certain remarks made by the anonymous referees of a paper reporting the previous research. As mentioned earlier, the scoring structure similar to that is adopted in the most coveted quality award, MBNQA was integrated with this model. Like in the case of MBNQA, a system of awarding scores to a maximum of 1000 has been infused in this model. Since there was no supporting research available to guide the distribution of marks among the 20 criteria, a critical thinking was made in this regard. Finally the scores were apportioned among the five agility enablers. This score apportionment is shown in Table 3.

Table 3. Agility Enablers and the scores

Agility Enabler	Scores
1.Organisational Structure Enabler	500
2.Manufacturing management Enablers	150
3.Employee Enabler	130
4.Technology Enabler	120
5.Manufacturing strategy Enabler	100
Total	1000

The rationale behind apportioning the scores is described here. In the absence of an AM compatible organisational structure, a company will not be able to implement AM (Maskell, 2001). Hence, out of 1000, 500 marks have been allotted to the organizational structure enabler. The decision rule formulated here is that, a company will be able to implement AM principles only if it scores more than 500 marks. In case the company has incorporated all the agility enablers except the organizational structure enabler, the company will not be able to score more than 500 marks and hence, will fail to achieve agility. Next to the organizational structure, the manufacturing management enabler plays an important role in achieving agility. The company's policy should facilitate the culture of outsourcing new components and processes, adoption of customer response and changing the business and technological processes. These criteria are essential to acquire agility. Subsequently, depending upon the roles played by the employee, technology and manufacturing strategy enablers, they have been allotted the scores 130, 120 and 100 respectively. Subsequent to the allotment of scores, the questionnaires pertaining to each criterion for assessing the level of its existence in the company were developed. The responses of the competent personnel were used to calculate the scores. As a sample, the questionnaire developed and scores allotted for the criterion number 1 titled as 'Organizational Structure' is given in Tables 4 and 5 respectively.

Table 4. Excerpt of the questionnaire of the criterion ‘Organisational Structure’

**(Please tick in the boxes provided adjacent to the choices you prefer.)**

**1. ORGANIZATIONAL STRUCTURE**

An agile company will often need more than one organizational structure at the same time. Different customers will need to be served differently. These differences will often require different internal structures. These are the challenges of agility. Leadership, motivation, and trust must replace the traditional management style of command and control.

1. What is the type of organizational structure existing in your company?  
 a) Flattened [ ] b) combination of a & c [ ]  
 c) vertical (traditional) [ ]

1a. if it is Vertical, how many layers are there?  
 a)  $\leq 3$  [ ] b) 4 to 6 [ ] c) 7 to 9 [ ]  
 d)  $> 9$  [ ]

1b. If the organizational structure is vertical how is it distributed?  
 a) Individual departments [ ]  
 b) Cluster of departments [ ]

1c. Is the company prepared to change its organizational structure to a flattened one?  
 a) yes [ ] b) partially [ ] c) no [ ]

Table 5. Excerpt of the Scores allotment table for the ‘Organisational Structure’ criterion

Number	Criteria	Question Number	Responses			
			a	b	c	d
1	Organisational Structure Score [Out of 50]	1	20	15	0	-
		1a.	5	4	3	0
		1b.	0	5	-	-
		1c.	5	3	0	-

For example, if a competent personnel in the company responds with a preference b) against question 1 in Table 4, then the corresponding score to be allotted has to be referred to Table 5, which will indicate that it is 15. This process has to be carried out for all the responses of the questions under the 20 criteria which would be collected from several competent personnel in the company. Besides the knowledge of AM coordinator is required to interpret the findings to bring out an agenda for infusing agility in the organization. This tedious and time consuming exercise may even lead to the making of inaccurate decisions. In this background, the need of a DSS for quantifying and analysing agility is realised.

## 5. DSS and DESSAC

One of the major applications of software engineering field found in manufacturing arena is the DSS. The birth of DSS is traced to early 1970s (Marakas 2003). During those years, the DSSs were not fully exploited presumably due to the lack of software utilities. Due to the advancement of software engineering field and the support extended by IT, DSSs have been applied in various fields.

The DSS developed in this context to quantify and analyze agility in this research work is given the name DESSAC (stands for DEcision Support System for quantifying Agile Criteria). DESSAC has been developed using Visual Basic 6.0 as the front end and Microsoft Access as the back end. The screens of DESSAC have been designed by referring to the twenty criteria agile model and its score allotment structure.

## 6. PRACTICALITY OF DESSAC

In order to examine its practicality, DESSAC was introduced to the competent personnel of Salzer. Salzer’s main product is cam operated rotary electronic switches. Salzer is incorporated with the capability to meet varied customers’ product specifications. Other products are direct current switches, relays, starters and modular switches. Hence, the shadow of agility was visible in Salzer’s working environment. Yet the term AM was not formally introduced to the management and employees of salzer. However, the first author had introduced about AM criteria as a module of his previous research. Hence today, the competent personnel of Salzer possess certain theoretical knowledge on AM. Because of this exposure on AM, those personnel viewed DESSAC with interest. Therefore, the introduction of DESSAC at Salzer was a fruitful experience.

After this demonstration, these personnel were asked to operate DESSAC. One of its beginning screens is shown in Fig. 1.



Fig. 1. A beginning screen containing twenty agile criteria

As shown, the user is not shown the grouping of agile criteria under AM enablers. This has been deliberately done to avoid the user getting biased to allot higher or lower scores against any of the criterion. Now the user is

free to click any one of the agile criterion for responding to the respective questions.

The user will be able to know the characteristics of the respective criterion on pressing the button given at the bottom of the screen. The screen displaying the narration on the characteristics of the agile criterion ‘Organisational Structure’ is shown in Fig. 2.

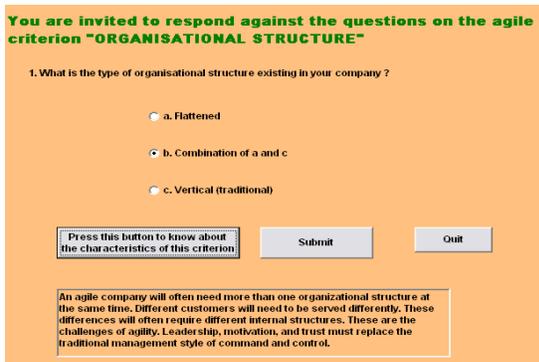


Fig. 2. Screen narrating the characteristics of ‘Organisational Structure’

On pressing the “Overall Score” button, the screen showing the agility score and index will appear. This screen is shown in Fig. 3.

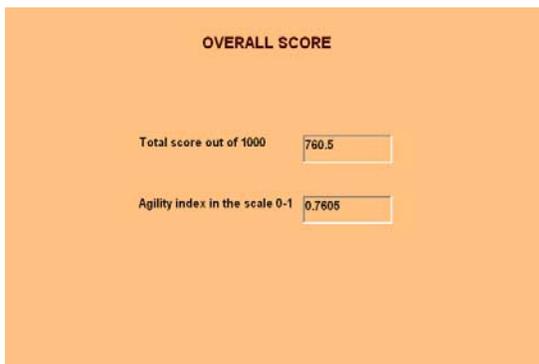


Fig. 3. Screen that appears on pressing the button ‘Overall Score’

On clicking “Overall Bar Chart”, the screen showing the agility levels and gaps of the 20 agile criteria will appear. This screen is shown in Fig. 4. Similarly the pie chart presentation can also be viewed. In case the user wants to know the action to be taken to implement agility, then he/she is required to press the “proposal” button in the consultation screen. The knowledge base incorporated into the DESSAC will be used to evolve the proposals.

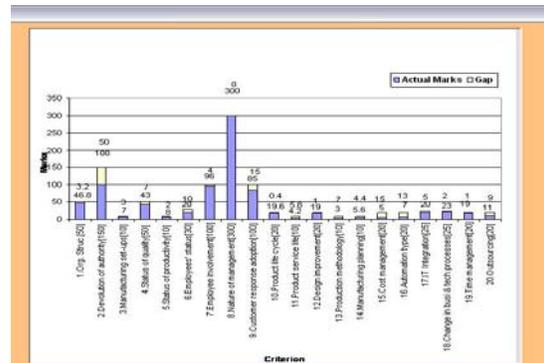


Fig. 4. Screen that appears on pressing the button ‘Overall Bar Chart’

In whichever criterion are found, the DESSAC’s knowledge base will provide the proposal for mitigating the same. The user is given the option of viewing the overall proposal or criterion-wise proposal. As a sample, the proposal screen displayed against the agile criterion “Organisational Structure” is shown in Fig. 5.

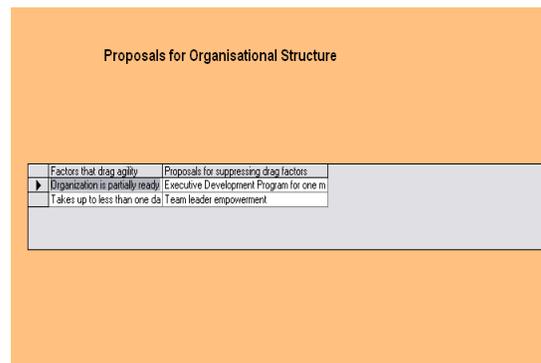


Fig. 5. Sample Screen for the ‘Criterion wise proposal’ for the criterion “Organisational Structure”

Thus DESSAC enables the quantification and analysis of agility level in the company.

## 6. FEEDBACK ON DESSAC

The questionnaire contained three questions. Two questions enabled the respondents to indicate their views in a Likert’s scale of range 0-10. The third question is open-ended type, which enabled the respondents to write their overall opinion about DESSAC. Altogether the questionnaire was given to five executives of Salzer. Their positions and responses are indicated in Table 6.

Table 6. Feedback of Salzer executives on DESSAC

Designation of personnel	To what extent do you believe that, the use of DESSAC leads to easy quantification of Current agility Level?	To what extent do you believe that, company managers and competent employees will show interest to use DESSAC?
	Response in Likert's scale of range 0-10	
Manager – Standards & Systems	10	9
Deputy Manager (Works)	8	8
Senior Engineer – Quality Control	9	8
Senior Engineer – Machine Shop	10	8
Engineer -Design	9	9

Alternatively, the screens of DESSAC can be projected in a screen and the unanimous responses could be entered in it. The outcome of DESSAC can subsequently be used to take appropriate actions to infuse agility in organisations. Further DESSAC can be used as a test kit in the companies at regular intervals (say, once in three months). This will enable the organisation to reach a winning position in the market and generate wealth to the society in which it operates.

## 8. REFERENCES

Arteta, B.M. & Giachetti, R.E. (2004). A measure of agility as the complexity of the enterprise system. *Robotics and Computer-Integrated Manufacturing*, Vol. 20, pp. 495-503.

Devadasan, S. R.; Goshteswaran, S. & Gokulachandran, J. (2005). Design for quality in agile manufacturing environment through modified orthogonal array-based experimentation. *Journal of Manufacturing Technology Management*, Vol. 16, No.6, pp.576-597.

Hartungi, R. (2006). Could developing countries take the benefit of globalisation. *International Journal of Social Economics*, Vol. 33, No.11, pp.728-743.

Jin-Hai, L., Anderson, A. R. & Harrison, R. T. (2003). The evolution of agile manufacturing. *Business Process Management Journal*, Vol.9, No.2, pp.170-189.

Kumar, A. & Motwani, J. (1995). A methodology for assessing time-based competitive advantage of manufacturing firms. *International Journal of Operations & Production Management*. Vol.15, No.2, pp.36-53.

Marakas, G. M. (2003). *Decision Support Systems in the 21<sup>st</sup> Century, 2<sup>nd</sup> Edition* (New Delhi, INDIA: Prentice-Hall of India Private Limited).

Maskell, B. (2001). The age of agile manufacturing. *Supply Chain Management: An International Journal*, Vol.6, No.1, pp.5-11.

Ramesh, G., & Devadasan, S.R. (2007). Agility assessment through qualification and quantification tools: a case study in an Indian pump manufacturing company. *International Journal of Mass Customisation*, Vol.2, Nos.(1/2), pp.139-160.

Sharifi, H., & Zhang, Z. (1999). A methodology for achieving agility in manufacturing organisations: An introduction. *International Journal of Production Economics*, Vol. 62, pp.7-22.

Yang, S. L. & Li, T. F. (2002). Agility evaluation of mass customisation product manufacturing. *Journal of Materials Processing Technology*, Vol.129, pp.640-644.

Zhang, Z., & Sharifi, H., (2000). A methodology for achieving agility in manufacturing organisations. *International Journal of Operations & Production Management*, Vol.20, No.4, pp.496-512.