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Original

TADS: An assessment methodology for agile supply chains☆

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Abstract

Globalization has been facilitating the entry of numerous competitors in the world of manufacturing market. As a result, modern manufacturers are approached by numerous players in the market to provide varieties of products. To achieve competitive edge in the rapidly changing business environment, organizations must align with suppliers and customers to streamline operations and work together to achieve desired levels of agility. In a bid to cope with market instability, companies now look beyond cost advantage. Speed, quality and agility are being emphasized as means of responding to the unique needs of customers and markets. This study deals with improving the flexibility levels of the supply chain of an organization by analyzing various agility criteria and calculating the agility index. This is a distinguished effort in creating agile supply chains using Total Agile Design Systems as an assessment tool.

Keywords: Agility; Total Agile Design Systems; Flexibility; Agility index

1. Introduction

The ever increasing competition compels the modern organizations to react quickly in accordance with the dynamic demands of the customers which are referred to as agility. Essentially organizational agility addresses an organization's ability to respond to external market stimuli like the threats posed by competition or even simply changes in demand. In particular, an agile enterprise will have to develop its capabilities to minimize both the costs and time-scales of any change in terms of initial outlay and subsequent operations. Though various models have been proposed to measure the organization's agility, a very minimal work has been attempted in the stream of Total Agile Design Systems (TADS). TADS is a model specifically brought out for aiding an organization to acquire better agility level through the adoption of advanced technologies. TADS implementation demands the necessity of determining whether or not the organization is agile and what is the present agility level of the organization. This is made possible with a tool called agile quantification tool. Various agility criteria can be identified pertaining to organization's environment and scores may be allocated for each criterion on some prioritization basis. Questionnaire-based approach is being followed to determine the score pertaining to each criteria. Agility index is then calculated which spells the current agility level of the enterprise. Subsequently, an implementation study will have to be carried out after investigating the practical feasibility of this model. Successful implementation of TADS shall warranty acquirement of higher quantum and quality of agility. The parameter of agility index will have to be calculated in the similar method after the implementation of TADS for drawing comparisons. The experience of conducting this research and attempting to improve agility is presented in this paper. The first section focuses on the literature review that was made to identify various agile criteria and the past methods to measure the agility levels of the organizations are reported. The following section describes the importance of supply chain agility. The next section orients the features of the Total Agile Design Systems. Then the paper addresses a few words about the organization after which the methodology adopted to determine the agility index before implementation of TADS have been discussed. A few lines on gap analysis and TADS

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implementation are also briefed before determining the agility index after implementation. The fag end of the paper briefs on the final discussions and conclusions which can be drawn on this research.

2. Historical background

The literature review was done to identify the criteria that would enable the formation of agile supply chains and the various models proposed for agility measurement were studied.

Zhang and Sharifi (2000) have said that understanding and responding to changes, and taking advantage of changes through strategic utilization of managerial and manufacturing methods and tools, are some of the pivotal concepts of agile manufacturing.

Arteta and Giachetti (2004) in their paper notify that the primary dimension of agility is the ability of a system to respond to change. Taking this perspective they further argue that less complex processes are easier to change and thus more agile. This line of reasoning is based on the previous literature alluding to the relationship between agility and complexity. In this paper, they have expanded the earlier work by developing a complexity measure at the business process level of an organization. The methodology to calculate the complexity measure starts by creating a Petri Net model of the system in order to derive the state probabilities for the system.

Devadasan, Goshteeswaran, and Gokulachandran (2005) emphasized that the manufacturing organizations are fast becoming agile, due to the customers dynamic demands coupled with competition, and the fear of traditional quality improvement techniques becoming obsolete. The model contributed in their paper was useful in achieving continuous quality improvement in an agile manufacturing environment.

Vinodh, Sundararaj, Devadasan, Kuttalingam, et al. (2008) emphasize the adoption of Computer Aided Design (CAD) technology for enabling the contemporary organizations to acquire agile characteristics. This research culminated in the development of a roadmap and the practicality of implementing TADS in contemporary organizations.

Vinodh, Sundararaj, and Devadasan (2008) in their paper explored the researches reported in literature on agile manufacturing (AM) and determined the avenues by which agility can be imparted in traditional sectors. After designing TADS, their work was exposed to 25 industry captains and their feedback was gathered using questionnaires. The results of their analysis indicate the practical compatibility of TADS.

Lin, Chiu, and Chu (2006) in their paper presented the development of the absolute agility index and a unique and unprecedented attempt in agility measurement, using fuzzy agility evaluation.

Sherehiy, Karwowski, and Layer (2007) reviewed and identified the global characteristics of agility which can be applied to gain impetus in lines of flexibility, responsiveness, speed, culture of change, integration and low complexity, high quality and customized products, and mobilization of core competencies. The need for further research in order to empirically establish and validate the attributes and indices of the agile workforce and agile enterprise has also been discussed.

3. Supply chain agility

Companies over the years have implemented global systems, improved the cost structures, and implemented lean programs, have improved strength, but not driven balance or flexibility into supply chain systems. This makes them brittle and drives them color blind in assessing the risk. In other words it can be said that the supply chain is less agile. Supply chain agility is an operational strategy focused on inducing velocity and flexibility in the supply chain. All organizations have supply chains of varying degrees, depending upon the size of the organization and the type of product manufactured and now it is time to inject nerves of flexibility in their flow.

It is inevitable for organizations to operate with agile supply chains. Some of the common agility criteria include Commitment of the top management, Organizational Structure, Employee Status, Status of Productivity, Manufacturing Set-up, Automation, Time Management, etc.

The difference between supply chain management and supply chain agility is the extent of responsive capability that the organization possesses. Key to the success of an agile supply chain is the speed and flexibility with which these activities can be accomplished and the realization that customer needs and customer satisfaction are the very reasons for business.

4. Total Agile Design Systems

TADS demonstrate the supply chain's agility through adapting the technological advancements and self-equipping to unforeseen changes. In TADS, the varying customer requirements are given due impetus and translated to supply requirements using relevant technologies as shown in Fig. 1. This transformation of the voice of the customer can be generated using quality function deployment.

Once the supply requirements have been finalized, then by making use of information technology, electronic commerce or Digital Product Catalogue (DPC) software packages, the supply team can derive digital designs of the customers' aspirations and later on the manufacturing phase could be initiated. This is done generally for ensuring the process of manufacturing the agile products in line with the requirements of the customers. Suggestions for the improvement in the supply chain have to be addressed through industrial engineering concepts such as business process reengineering well in advance before implementing TADS. For this purpose the survey is most often used. In the survey, a number of factors called the "agile criteria" is provided to the customers for which their responses are translated to compute the parameter called the agility index. The agility index is computed with the following formula (Vinodh, Sundararaj, & Devadasan, 2010)

$$\text{agility index} = \text{total score}/1000 \quad (1)$$

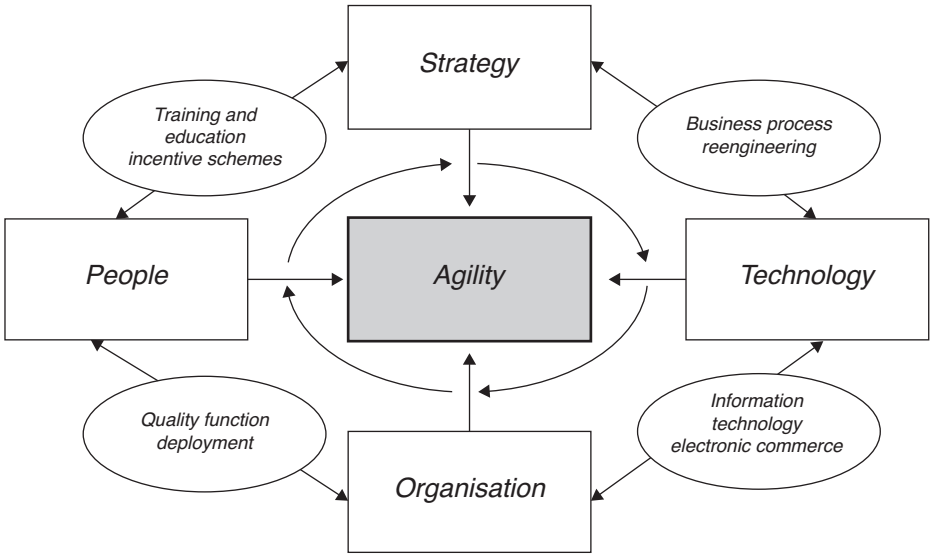

Fig. 1. Contributors to agility

Likewise the agility index is calculated before and after TADS to justify the research process. TADS implementation has so far been done frequently in the manufacturing sectors and this paper proposes the implementation of TADS in few links of supply chain of the organization which is a distinguished effort.

5. About the organization & industry structure

The organization under limelight are prime manufacturers of Carbon and Alloy Steels, Stainless Steel, Nickel-based Alloy Steel and are in this field for past three decades and the company is located in Tamil Nadu, India. The manufacturing activities are headed by a manager assisted with energetic engineers and highly skilled team of technicians. They have a full-fledged pattern shop, molding shop, melting shop, core shop, fettling shop (heat treatment, shot blasting, welding and grinding) and quality control testing. Although the set-up is quite traditional and paid returns, in recent past the organization faces stiff competition and lack of flexibility and is reducing customer base. This has necessitated the paradigm shift towards agility for challenging market dynamism.

6. Measurement of agility index

In order to measure 'agility index', an agile quantification tool is used. This agile quantification tool determines the agility level of an organization on a 1000 score scale. For this, a study was done and the various agility criteria which best suits the organization and the scores were distributed among these criteria on some prioritization basis. Agile quantification tool facilitates the apportionment of scores among the agility criteria. As shown in Table 1, the 'The Nature of the Management' has scored the maximum score of 200, and this may be due to the reason that without the support of top level management new changes in technology could not be implemented. The total score of 1000 is distributed among the 11 agility criteria as shown in Table 1.

Table 1
Distribution of score among the various criteria.

Criterion number	Criterion	Score
1	Employee involvement (Ramesh & Devadasan, 2007)	120
2	Trust among supply chain partners (Bottani, 2009)	100
3	Customer satisfaction (Barve, 2011)	90
4	Training and development (Yusuf, Sarhadi, & Gunasekaran, 1999)	20
5	Technology advancement and organization adoption (Gunasekaran & Ngai, 2004)	100
6	Market demand (Yusuf et al., 1999)	50
7	Nature of management (Ramesh & Devadasan, 2007)	200
8	Waste management (Vinodh, Sundararaj, & Devadasan, 2009)	80
9	Process and production methodology (Devadasan et al., 2005)	60
10	Time management (Devadasan et al., 2005)	100
11	Quality of product (Yusuf et al., 1999)	80
	Total score	1000

7. Assessment of agility level before implementation of TADS

The assessment of the current agility level of the company is carried out with a similar scoring model. During this research, questionnaire-based approach was followed. A number of questions were designed to assess the availability and strength of various capabilities in dealing with problems corresponding to the individual criteria. In total, for 11 agility criteria, 81 questions were developed and given to the employees, from which an average score was computed as the current agility level of the company. One such sample questionnaire of the criteria 'employee involvement' is shown in Section 7.1.

Table 2
Key pertaining to employee involvement.

Criterion number	Criterion	Question number	A	B	C
1	Employee involvement/ 120	1	20	5	0
		2	20	0	–
		3	20	10	0
		4	20	0	–
		5	20	0	–
		6	20	0	–

7.1. Employee Involvement

(1) Is job-rotation encouraged?
(a) Yes (b) In some cases (c) No
(2) Do the employees follow their work instructions?
(a) Yes (b) No
(3) Is power sharing encouraged?
(a) Yes (b) In some cases (c) No
(4) Are the employees encouraged to focus on what is truly core to the business?
(a) Yes (b) No
(5) Are they effectively utilizing the equipments being provided?
(a) Yes (b) No
(6) Do the employees meet the organization demands?
(a) Yes (b) No

In order to calculate the score obtained before and after implementation of TADS, a key was set. A key for employee involvement is shown in Table 2. Fifteen executives were selected from the company and the questionnaires were given to them. The meaning of each agility criterion and its contribution towards attaining agility in the company were explained to them. The executives responded to the questionnaires against the respective agile criteria which were used to carry out the computation of agility index before TADS implementation. The score pertaining to the criteria "employee involvement" was 40 out of 200 which is 33.33%. Likewise the scores for other criteria were calculated and tabulated as shown in Table 3. Agility index before implementation of TADS is calculated as follows:

Agility index before implementation of TADS = 675/1000 = 0.675 = 67.5%

Table 3
Score obtained before implementation of TADS.

Criterion	Total score	Score obtained
Nature of management	200	200
Employee involvement	120	40
Trust among supply chain partners	100	60
Customer satisfaction	90	35
Training and development	20	5
Technology advancement and organization adoption	100	85
Market demand	50	30
Waste management	80	40
Process and production methodology	60	50
Time management	100	70
Quality of product	80	60
Total	1000	675

Table 4
GAP analysis.

Criterion	Total score	Score obtained	GAP	Percent GAP
Nature of management	200	200	0	0%
Employee involvement	120	40	80	66.66%
Trust among supply chain partners	100	60	40	40%
Customer satisfaction	90	35	55	61.11%
Training and development	20	5	15	75%
Technology advancement and organization adoption	100	85	15	15%
Market demand	50	30	20	40%
Waste management	80	40	40	50%
Process and production methodology	60	50	10	16.667%
Time management	100	70	30	30%
Quality of product	80	60	20	25%

Table 5
Drag factors and proposals.

Drag factor	Proposal
Demotivated employees reduce productivity levels, increase absenteeism levels and propagate industrial accidents.	JCM model can be followed to enhance the employee motivation levels and unearth their hidden potential, and harnessing towards achieving organizational goals.

8. GAP analysis

In order to determine which criteria need to be focused, the gap analysis was done. The gap between the total score and the score obtained for each criterion was calculated and the percentage of gap was found out. The gap between the total score and score obtained and their percentages are shown in Table 4.

It was found from the table that training and development has 75% of gap which is the highest and hence it can be inferred that more attention has to be given to this criterion.

9. Implementation of TADS

The importance of agile concepts was oriented to the employees and suppliers using motivational tools such as Job Characteristics Model (JCM) which is a widely studied model of motivational job design. Smooth flow of information through Digital Product Catalogues, Electronic Data Interchange (EDI) (Kumar & Motwani, 1995), collaborative design, Partner Unit Information Systems (PUNIS), Integrated Business Information Systems (IBIS), Virtual Information System for Agile Manufacturing (VISAM) and Collaborative Forecasting Planning and Replenishment (CPFR) were also stressed for reducing the bullwhip effects in the chains and perfect alignment of agile

Table 6
Score obtained after implementation of TADS.

Criterion	Total score	Score after TADS
Nature of management	200	200
Employee involvement	120	110
Trust among supply chain partners	100	90
Customer satisfaction	90	75
Training and development	20	20
Technology advancement and organization adoption	100	85
Market demand	50	40
Waste management	80	60
Process and production methodology	60	50
Time management	100	90
Quality of product	80	70
Total	1000	890

Table 7
Comparison of agility index before and after implementation of TADS for each criterion.

Criterion	Percentage of agility before TADS	Percentage of agility after TADS	Improvement
Nature of management	100%	100%	–
Employee involvement	33.33%	91.67%	58.34%
Trust among supply chain partners	60%	90%	30%
Customer satisfaction	38.89%	83.33%	44.44%
Training and development	25%	100%	75%
Technology advancement and organization adoption	85%	85%	–
Market demand	60%	80%	20%
Waste management	50%	75%	25%
Process and production methodology	83.33%	83.33%	–
Time management	70%	90%	20%
Quality of product	75%	87.5%	12.5%

practices in the organization. Finally, after a series of hurdles an agile system was developed and the employees in the system were asked to follow agile concepts, which put the foundation steps for the transformation of the austere set-up to an agile and responsive enterprise.

10. Drag factors and remedial measures

In this phase the various drag factors have been identified from the agility criteria. Some of the notable drag factors include lack of frequent training, discouragement of job rotation, improper usage of equipments and raw materials, inadequate attention to customers warranty claims, lack of choice of proper logistic mode, unstructured wages, imbalance between primitive and JIT production systems, etc.

Various other proposals were given to eliminate these drag factors and one sample pertaining to the criteria "employee involvement" is shown in Table 5.

11. Agility index after implementation of TADS

After the suppression of various drag factors, the agility index is computed using a similar method. The score was calculated and it was found to be 890 after TADS implementation. That is the agility index increased to 89%.

$$\text{Agility index after implementation of TADS} = 890/1000 = 0.89 = 89\%$$

The score obtained for each criterion is shown in Table 6. The percentage improvement in the agility index was found to be 21.5% after implementation of TADS.

The percentage improvement in the agility index for individual criterion before and after TADS is shown in Table 7.

12. Discussions and conclusion

Agility is the ability to detect the changes in the business environment, and respond swiftly by acquiring the appropriate skills. Strategic intent to become agile and leveraging the core competencies of the company towards achieving the competitive advantages are essential. Improvement in supply chain agility can be achieved with the improved co-ordination among the different levels of supply chain which is the greatest asset of any supply chain. It makes the supply chain more profitable and flexible. The negative impacts of the co-ordination can be eliminated by carefully implementing TADS. Also the levels of supply chain agility can be improved by around 20–25% on the whole, which can be made to perfection in the longer run.

Conflict of interest

The authors have no conflicts of interest to declare.

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