Modelling the key challenges in Agile Adoption: An Indian Perspective

Jagpuneet Kaur Bajwa
Department of Computer Science
Punjabi University, Patiala, Punjab, India

Dr. Kwaljeet Singh
Punjabi University, Patiala, Punjab, India

Dr.Neeraj Sharma
Punjabi University, Patiala, Punjab, India

Abstract: The adoption of agile methods is the most talked about issue in the software development domains. Many software organizations have decided to go for Agile and some are still in the transition phase. For successful adoption of agile methodologies, there is a dire need for the creation of an organizational culture which is completely different from the working culture of traditional (Waterfall) backdrop. The transition from traditional methodology to Agile seems to be a daunting task for organizations which are striving for better customer satisfaction. This is mainly due to internal and external barriers which hamper the pace of methodology adoption. This paper investigates the underlying barriers which deter successful Agile adoption. The present study is instrumental in tapping the mutual influences present between various Agile challenges/ barriers. The main focus is to classify barriers which are independent, those which are helping other barriers (driving barriers) and also those which are being regulated by other barriers (dependent barriers). Interpretive Structural Modeling(ISM) methodology has been employed to extract relationships present among identified adoption barriers.

Keywords-agile software development, agile adoption, methodology transition, barriers, interpretive structural modeling (ism), mathematical modeling.,

I. INTRODUCTION

The Software development world was largely using traditional software development methods, also called heavyweight methods (Code and Fix, Waterfall, Spiral etc). The developers were using old methods for requirement capturing, analysis, coding and testing. There was hardly any user involvement; requirements were frozen, and no feedback mechanism was followed. The development teams were use to spending time in doing heavy documentation, producing artifacts etc. Software development was done in isolation from the customer using fixed requirements only. As a result, the customer use to remain disconnected from the delivery product. The resulting product usually was not as per the expectations of the customer. With the advent of Internet, the software development industry became more turbulent. The software developers became more desperate for refining the existing software processes. The need of the hour was a set of practices and methods which could provide a more flexible and dynamic approach to handle rapidly changing requirements coming from business. The ever increasing size and scope of software projects was another major concern. Moreover, traditional methods were not able to cope with the complexity of large projects. This further resulted into chaos in software arenas where quality of projects was suffering mainly due to cost and time overruns. These challenges imposed by the changing market scenarios lead to crafting of 'light weight' methods which focused on user centric software processes, effective feedback mechanisms, involvement of fewer ceremonies and quick deliveries. Therefore, in 2002, Agile methodology came as a formalized collection of several lightweight methods (XP, Scrum, Crystal, DSDM, etc). These methods triggered a discussion in software arenas about their efficacy and applicability in various real time situations. Adoption of Agile methods became a vital necessity for several Waterfall based organizations. Even today, this methodology transition is imposing greater organizational challenges for software houses as these methodologies are rooted in altogether opposite principles and concepts. This paper discusses the identified challenges/ barriers and their mutual influences on the adoption of Agile methodology in Indian software development concerns. This is

done using ISM (Interpretive Structure Modeling) approach. ISM is capable of establishing relationships between factors which may be poorly related to each other. The relationships between the barriers in our study have been decided by the knowledge and interpretation of Agile experts. The previous work of researchers who have explored Agile adoption in general has also been considered.
The rest of the paper is organized as follows. The literature review of Agile and its related adoption barriers is explained in section II. The development of ISM model is presented in section III. Concluding remarks are given in section IV.

II. AGILE ADOPTION BARRIERS: LITERATURE REVIEW

'Agile' is an umbrella term which includes a collection of practices and methods that adhere to the set of principles described according to Agile Manifesto. Agilists propagate that they have developed software development methodologies by utilizing iterative development, prototyping, templates and minimal documentation of requirements (Livermore 2008) [16]. Agile methods are a subset of iterative and evolutionary methods which are based on iterative enhancement and opportunistic development processes [23]. Non agile methods are unable to handle rapidly changing requirements. But agile methods deploy short product cycles with short feedback loops, which help in better understanding of customer requirements and thus mitigate any conflicting issues during sudden requirement changes[15]. 'Human factor' is given importance by involving all stakeholders and developers during each release therefore increasing collaboration and feedback mechanisms between them [25]. Cockburn and J. Highsmith [14] underline the importance of people and their creativity in agile development. Agile methods focus on teamwork and collaboration between teams as opposed to individual role assignment done in plan-driven methods. The Agile literature also reveals contradictory views of practitioners about the efficacy of agile methods and the authenticity of claims made by agile communities about low process ceremonies viz. negligible documentation and relying on teams' tacit knowledge etc. In spite of the perceived benefits of agile, the software community is facing challenges/barriers in handling methodological shift. Cohn and Ford [19] have reported a number of organizational setbacks such as resistance or over-enthusiasm of agile teams; change in structure, culture and management practices during the transitional move from traditional methods to agile processes. Bohem and Turner [2] opine that agile adoption becomes more challenging; when it comes to changing the mindsets of people who are well rooted in traditional methods. They categorize major challenges which software managers are facing during transition namely 'developmental process conflicts', 'business process conflicts' and 'people conflicts'. Empirical studies [5][12] also indicate several challenges during the process of successful Agile adoption like ignorance of agile, lack of facilities for pair programming, individual resistance and the exclusive reliance on economic evaluation criteria. Alena Buchalcevova [1] reported legal reasons, customer non-acceptance and minor stress on documentation as major barriers for the use of agile methods in Czech Republic. The objective of this research paper is to highlight the barriers in integration of new agile values into the prevailing traditional plan driven development scenario of Indian software firms. Based on the general agile studies, we have identified twelve barriers to Agile adoption as shown inTable1below.

Table 1: Major barriers of agile adoption

Barrier No.	***Major Barrier of Agile Adoption***
Barrier1	**Non alignment of software methodology with business strategies.**
Barrier2	**Lack of training**
Barrier3	**Fund non availability**
Barrier4	**Lack of skilled people**
Barrier5	**Bottleneck between teams**
Barrier6	**Scalability problem**
Barrier7	**Internal opposition to cultural shift**
Barrier8	**Lack of collaboration between stakeholders**

Barrier9	**Lack of flexibility in organizational attitude**
Barrier10	**Absence of standards**
Barrier11	**Lack of human centric approach**
Barrier12	**Lack of management commitment**

III. SM METHODOLOGY AND MODEL DEVELOPMENT

Agile adoption in itself is a complex issue and there are a number of problematic factors related to this issue. With the help of ISM methodology, we have tried to establish direct and indirect relationships between the barriers or problematic factors. Therefore ISM develops an insight into the collective understanding of the aforesaid relationships. It is a step by step process and is briefly outlined below:

1)Identifying factors which are related to the identified problem. This is done through literature survey and discussions with Agile experts;

2)Relationships between elements are developed in a contextual manner;

3)Pair wise relationships is determined through Structural Self-Interaction Matrix (SSIM);

4)A reachability matrix is developed by converting SSIM into binary form and transitivity between the related elements is checked;

5)Reachability matrix is further partitioned into separate levels.

6)Depending upon the relationships and levels obtained from the above step, a diagraph is drawn.

7)This diagraph is further converted into a model. The nodes in the diagraph are replaced by the barrier elements.

8)Possibility of any inconsistency in the ISM model is removed by re-consulting the experts. The suggested modifications are included in the final model.

The procedure for developing the Interpretive Structural Model is described below.

A. *Structural Self-Interaction Matrix (SSIM)***:** The domain experts from industry were consulted for determining the contextual relationships among different barriers. The existence of a relationship between any two barriers (i and j), is calculated and tabulated in the form of SSIM matrix as shown in Table 2. For example, barrier2 ‘lack of training’ will influence/enhance the effect of barrier3 ‘fund non availability’ or not. The following symbols were used to denote the direction of relationship between the barrier i and barrier j in SSIM:
V: Barrier i will lead to barrier j;
A: Barrier j will lead to barrier I;
X: Barrier i and j will lead to support each other; and
O: Barrier i and j are not related to each other.

Table 2: *Structural Self-Interaction Matrix (SSIM)*

Barrier Number	Barrier Description	Barrier Number											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Skeptical about Agile	X	O	O	O	O	V	O	V	A	A	V	A
2	Lack of training	O	X	A	V	V	V	V	V	0	O	V	A
3	Fund non availability	O	V	X	V	O	V	O	O	X	V	O	A
4	Lack of skilled people	O	A	O	X	V	V	V	V	O	O	O	A
5	Bottleneck between teams	O	V	O	V	X	0	X	V	O	O	O	A
6	Scalability problem	A	A	A	A	O	X	0	O	A	A	A	A
7	Internal opposition to cultural shift	O	O	O	A	A	0	X	V	O	O	V	A
8	Lack of collaboration between stakeholders	A	A	O	A	A	0	A	X	A	A	A	A
9	Lack of flexibility in organizational attitude	V	O	X	O	O	V	O	V	X	A	A	A
10	Absence of standards	V	O	A	O	O	V	O	V	V	X	X	A
11	Lack of human centric approach	A	A	O	O	O	V	A	V	V	X	X	A
12	Lack of management commitment	V	V	V	V	V	V	V	V	V	V	V	X

B. Reachability Matrix

The above matrix is converted into initial reachability matrix shown in Table 3 by assigning V, A, X and O by 1 and 0 using following rules:-

If the (i,j) entry in the SSIM is V, then (i, j) entry in the reachability metrics will be 1 and (j, i) entry will be 0;

If the (i,j) entry in the SSIM is A, then (i, j) entry in the reachability metrics will be 0 and (j, i) entry will be 1;

If the (i,j) entry in the SSIM is X, then (i, j) entry in the reachability metrics will be 1 and (j, i) entry will be 1and

If the (i,j) entry in the SSIM is O, then (i, j) entry in the reachability metrics will be 0 and (j, i) entry will be 0.

Table 3: *Reachability Matrix*

Barrier Number	Barrier Description	Barrier Number												Driving Power
		12	2	3	10	4	5	9	11	7	1	6	8	
12	Lack of management commitment	1	1	1	1	1	1	1	1	1	1	1	1	12
2	Lack of training	0	1	0	0	1	1	0	1	1	0	1	1	7
3	Fund non availability	0	1	1	1	1	0	1	0	0	0	1	0	6
10	Absence of standards	0	0	0	1	0	0	1	1	0	1	1	1	6
4	Lack of skilled people	0	0	0	0	1	1	0	0	1	0	1	1	5
5	Bottleneck between teams	0	1	0	0	1	1	0	0	1	0	0	1	5
9	Lack of flexibility in organizational attitude	0	0	1	0	0	0	1	0	0	1	1	1	5
11	Lack of human centric approach	0	0	0	1	0	0	1	1	0	0	1	1	5
7	Internal opposition to cultural shift	0	0	0	0	0	0	0	1	1	0	0	1	3

1	**Skeptical about Agile**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**4**
6	**Scalability problem**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
8	**Lack of collaboration between stakeholders**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Dependence Power		**1**	**4**	**3**	**4**	**5**	**4**	**5**	**6**	**5**	**4**	**9**	**10**	

C.Level Partitions

In this step reachability matrix is used as base to derive two kinds of relationship sets. These are antecedent set and reachability set. Intersection of these sets is derived for every element. For computing the level of partition, the value similarity of reachability set and intersection set is compared for each element. If the value is same, then the particular element is designated the highest level and is removed from further calculations. This process is repeated for every element. This process may involve varied number of iterations. We computed all the partition levels in six iterations shown in Table 4 and 5. These partition levels assisted us in deriving the diagraph and the ISM model.

Table 4: *Partition levels for barrier 12*

Barrier Number	Antecedent Set (AS)	Reachability Set (RS)	RS∩AS	RS∩AS=RS
1	**1,6,8,11**	**1,9,10,12**	**1**	
2	**2,4,5,6,7,8,11**	**2,3,5,12**	**2,5**	
3	**2,3,4,6,9,10**	**3,5,12**	**3**	
4	**4,5,6,7,8**	**2,3,4,5,12**	**4,5**	
5	**2,4,5,7,8**	**2,4,5,12**	**2,4,5**	
6	**6**	**1,2,3,4,6,9,10,11,12**	**6**	
7	**7,8,9**	**2,4,5,7,12**	**7**	
8	**8**	**1,2,4,5,7,8,9,10**	**8**	
9	**1,3,6,8,9**	**3,9,10,11,12**	**3,9**	
10	**1,6,8,9,10,11**	**3,10,11,12**	**10,11**	
11	**6,8,9,10,11**	**1,2,7,10,11,12**	**10,11**	
12	**1,2,3,4,5,6,7,8,9,10,11,12**	**12**	**12**	**Yes (Level 1)**

Table 5: Partition level for the barriers

Barrier Number	Antecedent Set (AS)	Reachability Set (RS)	RS∩AS	RS∩AS=RS
12	**1,2,3,4,5,6,7,8,9,10,11,12**	**12**	**12**	**Level 1**
5	**2,4,5,7,8**	**2,4,5**	**2,4,5**	**Level 2**
3	**3,6,9,10**	**3,9**	**3,9**	**Level 3**
7	**7,8,11**	**7**	**7**	**Level 3**
10	**1,6,8,10,11**	**10,11**	**10,11**	**Level 4**
1	**1,6,8**	**1**	**1**	**Level 5**
8	**8**	**8**	**8**	**Level 6**
6	**6**	**6**	**6**	**Level 7**

D.Classification of barriers

The aim of classification of the barriers is to determine their dependence power and driving power. The four categories are autonomous, dependent, driver and linkage barriers. The cluster diagram for adoption barriers is shown below in Figure1.

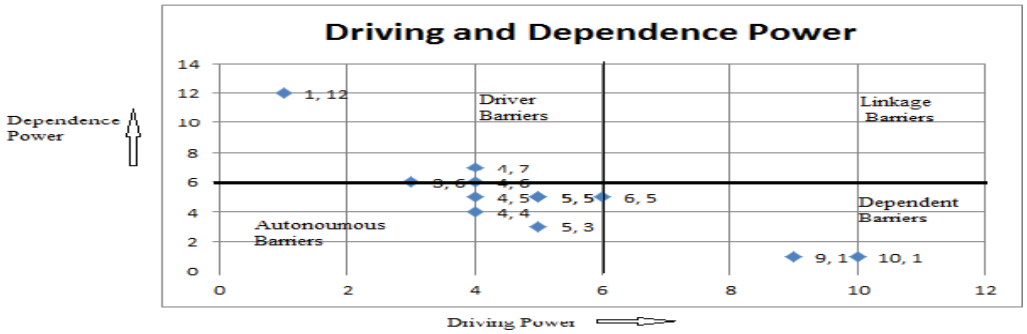

Figure 1: Cluster of barriers

From Figure 1, we can infer that barrier 1 has similar dependence and driving powers of value 4 and it falls in the first cluster of autonomous barriers. Similarly, barriers 1,4,5,7 and 9 are autonomous barriers. The second category of cluster of barriers is dependent barriers having weak driving and strong dependence power. In the present study, we have barriers 6 and 8 as dependent barriers. The third cluster is of linkage barriers having strong driving and dependence powers. But in the present context, there are no such barriers. The forth cluster is of driver barriers and they are have strong driving power and weak dependence power. Barriers 2, 3, 10, 11and 12 belong to the cluster of driver barriers.

E.Formation of diagraph and model

The interpretive model is derived from reachability matrix (Table 3). The relationship between various barriers is depicted through directed lines. The transitivity between adoption barriers was checked and removed. The resulting directed graph is depicted in Figure 2.

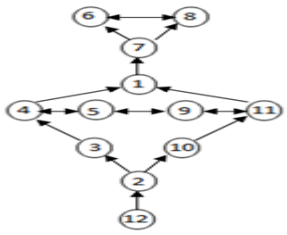

Figure2: Diagraph

The interpretive structure model for depiction of Agile adoption barriers is obtained by converting the directed graph into the relationship model shown Figure 3. This is done by replacing the nodes by the barrier elements.

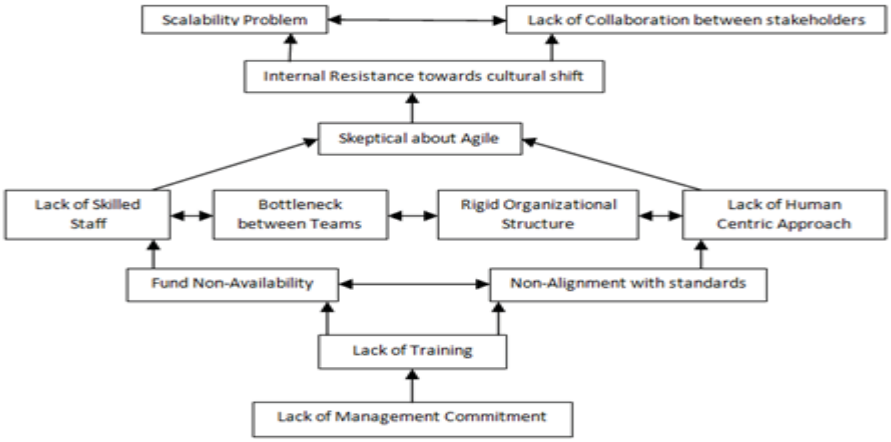

Figure3: ISM Model

IV.DISCUSSION

The relationship levels are an important aspect in order to understand Agile adoption. 'Lack of management commitment' is a major factor disrupting Agile adoption and rest of the barriers are dependent upon this most important factor. This is proved by diagraph as well as reachability matrix. Therefore in Indian context we can conclude that Agile can be adopted on a larger scale if the organizational managements become committed towards process improvement. Sincere efforts are required on the part of managements for the creation of a conclusive environment where Agile methodology can thrive and flourish properly. Moreover, for successful Agile adoption, organizations should focus on changing the mindset of humans involved in Agile transition process. This will resolve other hitches like improper training, bottlenecks between teams, dissatisfied customer and resource allocations. The adoption of agile needs complete cultural revamping and honest efforts by stakeholders to abide by its values.

V.CONCLUSION

Through this study we have identified the inherent relationship between Agile adoption barriers by using interpretive structural modeling technique. The present work is an initial effort towards identification of problems which hinder the process of successful adoption of Agile methodology in Indian software organizations. In this paper, we have just identified twelve adoption barriers. This work is currently being enhanced using large survey sample set of Indian software professionals and will be validated using Structural modeling approach (SEM).

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