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Research paper

Modelling the factors of agile practices in project management A case of illumination project organization

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Abstract

Project management involves various activities which contribute for achieving specific goals and success criteria. The illumination compa-nies involved in project management and related fields face major issues because of rapid changes in technology and environment. The solu-tion to this issue will be to establish a flexible and quick environment in the organization which is easily adaptable to the changes in the ex-ternal environment. In this paper the various factors that influence agile project management in an illumination company has been identified. The Interpretive Structural Modelling (ISM) has been used to analyse the interrelationships among the factors. Finally, the paper concludes that the most influential factors are supervisory behaviours, employee involvement, domain expertise, nature of management.

Keywords: *Agile Project; Agility; Project Management; Interpretive Structural*

1. Introduction

In current scenario the evolution of project management is notable and many new companies in various sectors of project management have emerged. The success of any project is determined by various contributions like skills, knowledge, various techniques and agility. Agile project management is similar to the traditional project management but it emphasis more in terms of flexibility and adaptability of an organization towards the changes of both the internal and external environment. Agile project management must be followed effectively from initiation stage to termination stage of a project.

The project organizations incorporate agility with respect to their corresponding changing environments and requirement in the competitive market. This paper focuses on an illumination project company. The various important factors are identified with respect to agile project management and the interrelationships between the factors are derived from ISM.

2. Literature review

The literature is comprised of two parts, namely agile project factors and it is followed by ISM approach.

2.1. Literature review on agile project factors

Stare (2014) analyzed the project development in manufacturing companies and determined the usage of agile techniques. They found that client collaboration plays a major role in project's success. Hoda et al. (2011) emphasizes the need for client interaction on different agile projects and the impact of client involvement in agile projects. Conforto et al. (2016) have defined the term customer validation as the process by which the customer verifies the results presented at regular intervals of the project. Supervisory behaviors are one of the important factors that rely on the leadership style and how well the style guides the team (Melo et al., 2013). Seger et al. (2008) studied self-efficacy, agile orientation and psychological needs in software development projects.

Pikkarainen et al. (2012) analyzed the strengths and barriers for successful agile deployment in software companies which helps in planning the strategy for agile deployment. Vinodh et al., (2008) developed a decision support system for measuring agility level of the organization. Serrador and Pinto (2015) found that perceived quality was the significant factor in the agile project's success. Charles et al., (2010) developed a framework for measuring agility in supply chains. Vinodh and Devadasan (2011) developed twenty criteria based agility assessment model for manufacturing organisation using fuzzy logic approach. Bernardes and Hanna (2009) discussed that the product differentiation is important for creating an effective strategy and providing value to the customer.

2.2. Literature review on ISM

ISM approach is applied in the various areas and it is demonstrated in Table1

Table 1: ISM Approach Applications

Sl. No	Authors	Application area
1	Faisal (2010)	Applied ISM for analyzing the barriers of CSR activities in supply chains.
2	Talib et al. (2011)	Applied ISM for analyzing 12-TQM barriers in organisations
3	Saleeshya et al.(2012)	Applied ISM with analytic hierarchy process for framework development for agility assessment in supply chain network.

4	Kumar et al. (2013)	Applied ISM customer involvement factors for green supply chain management.
5	Mehta et al. (2014)	Applied ISM for analyzing the TQM factors in engineering educational sector.
6	Varkhedkar et al. (2015)	Applied ISM for analyzing the drivers of demand chain.
7	Ambika Devi Amma et al. (2015)	Applied ISM for analysing major threads of cloud computing.
8	Vinodh et al. (2016)	Applied ISM for analyzing the variables of lean sustainable system in manufacturing organizations.
9	Vasanthakumar et al. (2016)	Applied ISM for analyzing the factors of lean remanufacturing processes.
10	Thirupathi andVinodh (2016)	Applied ISM for analyzing the factors of sustainable manufacturing processes for automotive component manufacturing organisation.
11	Patri and Suresh (2017b)	Applied total ISM for analysing agile factors in healthcare organisation.

3. Methodology

The following steps are used to illustrate modelling procedures of ISM (Patri and Suresh, 2017a):

1) Identification of factors through expert interview and literature survey. Table 2 depicts the identified agile project factors related to illumination projects.
2) Self-structured interaction matrix: Deriving a contextual relationship between the pair of factors which are mentioned below:

V: i influences j
A: j influences i
X: i and j influences each other
O: J and I are not related

The pair wise comparisons of factors are taken from opinions of 8 experts in the illumination project organisation. The highest mode of opinion is selected from the opinions of all experts. The Self Structured Interaction Matrix (SSIM) derived from mode of opinions of each pair is depicted in Table

3) Initial reachability matrix: The development of initial reachability matrix from SSIM and the conversion steps are mentioned below:

From SSIM (i,j)	V	A	X	O
Initial reachability matrix (i,j) entry	1	0	1	0
Initial reachability matrix (j,i) entry	0	1	1	0

The initial reachability matrix for agile project factors is shown in Table 4.

4) Final reachable matrix: Development of final reachability matrix from initial reachability matrix through transitivity analysis which follows that if K=L; L=M; then K=M.

The final reachability matrix is shown in Table 5.

5) Partition of the final reachability matrix: Partitions of the final reachability matrix are mainly based on the three sets, i.e. reachability set, antecedent set and intersection set. Iteration-1, the intersection elements are only present in the reachability set, those enablers are removed from the set and designated as level-1 factors. Then go to next iteration, repeat the process until all the factors are removed from the set. At the end of this process we get partitioned reachability matrix in to different levels and it is depicted in Table 6, 7, 8, 9 and 10.
6) Digraph creation: Directed graph (Digraph) is created using information from final reachability matrix and level partitions. In digraph factors are placed in ascending order i.e. first level factor at top of the digraph and second level factor at second position and so on until the lowest level factor is placed at the lowest level in the digraph. The ISM model is depicted in Figure 1.

Table 2: Identified Agile Factors for Illumination Project

S. No	Factor	Definition	Reference/ Expert opinion
1	Customer and team interaction (F1)	The interaction between the Project manager and the architect or customer.	Conforto et al. (2016)
2	Decision time (F2)	The time taken between the quotation given to the client and the PO from the client to the company.	Conforto et al. (2016)
3	Customer validation (F3)	The customer validates the product's USP and verifies the product according to the architects design.	Conforto et al. (2016)
4	Supervisory behaviors (F4)	The supervisor ensures that the product is installed according to the proposed design layout.	Melo et al.(2013)
5	Employee involvement (F5)	The initiative and engagement the employee has towards the project	Vinodh et al.(2012)
6	Domain expertise (F6)	The knowledge that the employee has about the project / product / Design	Pikkarainen et al. (2012)
7	Nature of management (F7)	The initiative taken by the management to implement the employee's suggestion to achieve the best output and completion of a project.	Vinodh et al. (2012)
8	Perceived quality (F8)	First, to achieve the design intention and lux level and The quality of the product supplied and installed to the client.	Serrador and Pinto (2015)
9	Lead time (F9)	The time taken between the PO given by the company to the supplier and the products sent for shipment	Tsemg et al. (2012)
10	Cost management (F10)	The ability with which the management could keep the	Vinodh and Devadasan (2010)

		running cost at check and maximize the profit to the company	
11	Differentiation (F11)	The efficiency with which the company distinguishes itself from the competitors	Hallgren and Olhager (2009)
12	Procurement (F12)	The import of products from the international branded suppliers.	Expert opinion

Table 3: SSIM for Agile Factors for Illumination Projects

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	1	V	X	O	A	A	O	O	O	O	V	O
F2		1	A	O	O	O	O	O	V	O	O	O
F3			1	O	O	O	O	O	O	O	O	O
F4				1	X	A	V	O	O	O	V	O
F5					1	X	X	V	O	O	V	O
F6						1	O	V	O	O	V	O
F7							1	V	O	V	V	O
F8								1	O	O	V	X
F9									1	A	O	X
F10										1	O	V
F11											1	A
F12												1

Table 4: Initial Reachability Matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	1	1	1	0	0	0	0	0	0	0	1	0
F2	0	1	0	0	0	0	0	0	1	0	0	0
F3	1	1	1	0	0	0	0	0	0	0	0	0
F4	0	0	0	1	1	0	1	0	0	0	1	0
F5	1	0	0	1	1	1	1	1	0	0	1	0
F6	1	0	0	1	1	1	0	1	0	0	1	0
F7	0	0	0	0	1	0	1	1	0	1	1	0
F8	0	0	0	0	0	0	0	1	0	0	1	1
F9	0	0	0	0	0	0	0	0	1	0	0	1
F10	0	0	0	0	0	0	0	0	1	1	0	1
F11	0	0	0	0	0	0	0	0	0	0	1	0
F12	0	0	0	0	0	0	0	1	1	0	1	1

Table 5: Final Reachability Matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	1	1	1	0	0	0	0	1***	1*	0	1	1**
F2	0	1	0	0	0	0	0	1**	1	0	1**	1*
F3	1	1	1	0	0	0	0	1***	1*	0	1*	1**
F4	1*	1**	1**	1	1	1*	1	1*	1**	1*	1	1**
F5	1	1*	1*	1	1	1	1	1	1**	1*	1	1*
F6	1	1*	1*	1	1	1	1*	1	1**	1**	1	1*
F7	1*	1**	1**	1*	1	1*	1	1	1*	1	1	1*
F8	0	0	0	0	0	0	0	1	1*	0	1	1
F9	0	0	0	0	0	0	0	1*	1	0	1*	1
F10	0	0	0	0	0	0	0	1*	1	1	1*	1
F11	0	0	0	0	0	0	0	0	0	0	1	0
F12	0	0	0	0	0	0	0	1	1	0	1	1

Table 6: Iteration-1

Factor	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 2,3,8,9,11,12	1, 3,4,5,6,7	1,3	
2	2,8,9,11,12	1, 2,3,4,5,6,7	2	
3	1, 2,3,8,9,11,12	1, 3,4,5,6,7	1,3	
4	1, 2,3,4,5,6,7,8, 9,10,11,12	4,5,6,7	4,5,6,7	
5	1, 2,3,4,5,6,7,8, 9,10, 11,12	4,5,6,7	4,5,6,7	
6	1, 2,3,4,5,6,7,8, 9,10,11,12	4,5,6,7	4,5,6,7	
7	1, 2,3,4,5,6,7,8, 9,10,11,12	4,5,6,7	4,5,6,7	
8	8,9,11,12	1, 2,3,4,5,6,7,8,9, 10,12	8,9,12	
9	8,9,11,12	1, 2,3,4,5,6,7,8,9, 10,12	8,9,12	
10	8,9,10,11,12	4,5,6,7,10	10	
11	11	1, 2,3,4,5,6,7,8, 9,10,11,12	11	I
12	8,9,11,12	1, 2,3,4,5,6,7,8,9, 10,12	8,9,12	

Table 7: Iteration-2

Factor	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 2,3,8,9,12	1, 3,4,5,6,7	1,3	
2	2,8,9,12	1, 2,3,4,5,6,7	2	
3	1, 2,3,8,9,12	1, 3,4,5,6,7	1,3	
4	1, 2,3,4,5,6,7,8,9, 10,12	4,5,6,7	4,5,6,7	
5	1, 2,3,4,5,6,7,8,9, 10,12	4,5,6,7	4,5,6,7	
6	1, 2,3,4,5,6,7,8,9, 10,12	4,5,6,7	4,5,6,7	
7	1, 2,3,4,5,6,7,8,9, 10,12	4,5,6,7	4,5,6,7	
8	8,9,12	1, 2,3,4,5,6,7,8,9, 10,12	8,9,12	II
9	8,9,12	1, 2,3,4,5,6,7,8,9, 10,12	8,9,12	II
10	8,9,10,12	4,5,6,7,10	10	
12	8,9,12	1, 2,3,4,5,6,7,8,9, 10,12	8,9,12	II

Table 8: Iteration-3

Factor	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 2,3,	1, 3,4,5,6,7	1,3	
2	2	1, 2,3,4,5,6,7	2	III
3	1, 2,3	1, 3,4,5,6,7	1,3	
4	1, 2,3,4,5,6,7,10	4,5,6,7	4,5,6,7	
5	1, 2,3,4,5,6,7,10	4,5,6,7	4,5,6,7	
6	1, 2,3,4,5,6,7,10	4,5,6,7	4,5,6,7	
7	1, 2,3,4,5,6,7,10	4,5,6,7	4,5,6,7	
10	10	4,5,6,7,10	10	III

Table 9: Iteration-4

Factor	Reachability Set	Antecedent Set	Intersection Set	Level
1	1,3,	1, 3,4,5,6,7	1,3	IV
3	1, 3	1, 3,4,5,6,7	1,3	IV
4	1, 3,4,5,6,7	4,5,6,7	4,5,6,7	
5	1, 3,4,5,6,7	4,5,6,7	4,5,6,7	
6	1, 3,4,5,6,7	4,5,6,7	4,5,6,7	
7	1, 3,4,5,6,7	4,5,6,7	4,5,6,7	

Table 10: Iteration-5 of Level Partition of Factors

Factor	Reachability Set	Antecedent Set	Intersection Set	Level
4	4,5,6,7	4,5,6,7	4,5,6,7	V
5	4,5,6,7	4,5,6,7	4,5,6,7	V
6	4,5,6,7	4,5,6,7	4,5,6,7	V
7	4,5,6,7	4,5,6,7	4,5,6,7	V

4. Results and discussions

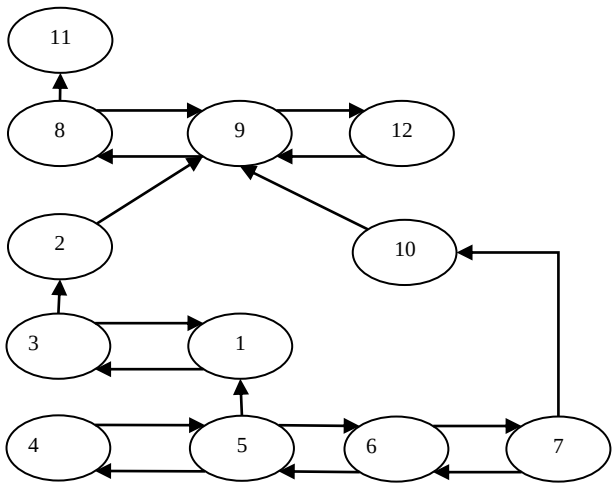

Fig. 1: ISM Model for Agile Factors in Illumination Projects.

Level V factors: [4-5], [6] and 7.

F4 influencing F1: The supervisory behaviour would be more if the team determined the priority of the customer and the expectations from the customer during the customer and team interaction

F4 influencing F3: The supervisory behaviour would be high if the customer validation is high. If the customer takes long time for inspection, the customer would also ensure to have a proper installation.

F4 influencing F5: The supervisory behaviour would always be mostly based on the employee involvement. Thus the supervisory behaviour would be high if the employee's initiatives and commitment is high.

F4 influencing F6: The perfection in supervisory behaviour would be high if the supervisor has more domain expertise. As the supervisor has more knowledge, he would be able to do the job perfectly and within time.

F4 influencing F7: The supervisory behavior is also majority influenced based on the nature of management. The supervisory behaviour would be efficient if the nature of management actually tries to recognize the contributions and suggestions of the employee.

F4 influencing F11: The supervisory behavior would be high if the company plans to differentiate itself from the competitors so that they can get a competitive edge.

F4 influencing F12: Each products has a different method of handling and some have to be handled with utmost care. Similarly few suppliers do not give replacements easily.

F5 influencing F1: When the employee involvement is high the customer and team interaction would be very efficient so that the customer would gain more importance from the company.

F5 influencing F2: When the employee involvement is more they would get in touch with the customers very often and would also create a positive impression in the client so that the decision time would reduce.
F5 influencing F3: As the employee involvement is high the customer validation would be very simple and reduce as every product is already validated by the employee.
F5 influencing F4: When the employee involvement is high the employee would take self-interest and make sure that the supervisory activities are done properly. Thus the supervisory behavior would increase.
F5 influencing F6: With increase in employee involvement the employee would make sure he/she gains more knowledge in the field of work and increase his/her domain expertise.
F5 influencing F7: The employee involvement would be high if the nature of management encourages the employees by taking in their suggestions in the projects.
F5 influencing F8: When the employee involvement is high the employee would make sure that they satisfy the perceived quality as per requirement.
F5 influencing F10: If the employee is more committed and the employee involvement is high. The employee would make sure that they follow up the suppliers and reduce the lead time.
F5 influencing F11: When a company has more employee involvement then definitely it is very easy for them to differentiate themselves from the competitors.
F5 influencing F12: When the employee involvement is high the employees would make sure that they take the best procurement decisions.
F6 influencing F1: When the domain expertise in an employee is high, during the customer and team interaction they can say all the required information and also answer all the questions of the customers appropriately and convince them.
F6 influencing F3: If the domain expertise is high the employee would be able to solve the problems immediately if the errors are solvable during the customer validation.
F6 influencing F4: An increased domain expertise indicates a faster and best supervisory behaviours, this would in turn create a good impression in the customer.
F6 influencing F5: When the employees have good domain expertise the involvement would naturally increase and the employee involvement would be high.
F6 influencing F7: If an employee with good domain expertise suggest a solution or idea to the company the nature of management would be sure that the idea is implemented.
F6 influencing F8: When the employee has good domain expertise they would ensure that the perceived quality is achieved and the caliber is also increased in terms of perceived quality.
F6 influencing F10: The employee who has good domain knowledge would have great tactics to reduce the cost effectively.
F6 influencing F11: If an organization has more domain expertise employees this would create a great differentiation for the company as a whole.
F6 influencing F12: An employee with more domain expertise makes procurement decisions which would be very effective
F7 influencing F1: When the management makes sure that they provide the necessary flexibility and information, the customer and team interactions would be efficient.
F7 influencing F3: Based on the management and the trust they have created to the customers, they would validate accordingly. When the trust increases the customer validation decreases.
F7 influencing F4: When the management makes sure that the supervisory behaviors are very important they would make sure that the emphasis is done to the employees so that the supervisory behavior would be great.
F7 influencing F5: If the nature of management takes up employee suggestion and motivates them the employee involvement would be high.
F7 influencing F6: If the nature of management is such that it gives the employees their chance to increase their knowledge then their domain expertise would increase.
F7 influencing F8: When the nature of management takes up the suggestion of employees from their interaction with the customers, they would be able to give a better perceived quality.
F7 influencing F10: If the management is well planned then they can easily reduce the cost and maintain a good cost management in the company.
F7 influencing F11: It is always the management as a whole which gets differentiated from that of the competitors. Thus if the management has good interaction with employee and creates a good employee oriented company then it can differentiate from the competitors.
F7 influencing F12: Based on the management decisions with help of the employees, the best procurement decisions can be made.
Level IV factors: three, one.
F3 influencing F1: The customer validation would be low if the team has established a trust during the customer and team interaction.
F3 influencing F2: When the customer takes more time to decide the product they are more concerned about the specification and the product. Thus, the customer validation would be more if the decision time was high.
F1 influencing F2: When the customer and team interaction is effective and clear then the decision time that the client takes to give PO to the company will be low.
F1 influencing F3: If the customer and team interaction is successful then the company would be able to satisfy the customer. So, during the customer validation the customer will have a positive response.
F1 influencing F11: The customer and team interaction is very important for the company to differentiate from the competitor. When the customers are impressed by the team and feel they are different, the differentiation would be high.
F1 influencing F12: Based on the effectiveness of customer and team interaction the company would be able to procure the right items from the international brand suppliers.
Level III factors: 2, 10.
F2 influencing F8: The customer inspects whether the company's products satisfies the design intentions. As the decision time increases the customer tends to validate the perceived quality more.
F2 influencing F9: Based on how fast the customer gives the PO to the company they would be able to order the items faster to the supplier so that the lead time will be reduced.
F2 influencing F12: When the customer's decision time increases the procurement will be affected so the suppliers would not only be selected based on quality but also based on faster delivery.
F10 influencing F8: If the products have equal perceived quality and the cost is minimal in one of the supplier, then the company would prefer to go with the low cost one. At times the cost management would be ignored in order to give the customers the perceived quality.
F10 influencing F9: The cost management cannot be maintained in control if the lead time cannot be compromised. When utmost fast delivery must be given to the customer the cost would be high.
F10 influencing F12: Based on the cost management of how to reduce the cost, the suppliers would be chosen for procurement.
Level II factors: 8, 9 and 12.
F8 influencingF9: When the perceived quality is high the lead time would be high as the materials would take time for shipment or air transport.
F8 influencing F11: When the perceived quality is high and the customers get delighted with the product the differentiation that the company creates would be relatively high.
F8 influencing F12: The perceived quality that the customers want would influence the company to make procurement decisions.
F9 influencing F8: The lead time would be more for the products for which the perceived quality is more. The products would either be fast selling or customized production request.
F9 influencing F11: When the lead time is decreased the company would be able to deliver the products faster so their differentiation from competitors would increase.

F9 influencing F12: The lead time would be different for different suppliers and products. As the stock out and the distance of supplier increases during procurement, the lead time also increases.
F12 influencing F8: The procurement would be based on the perceived quality that the customer expects to be delivered, so that the customer would be satisfied.
F12 influencing F9: The procurement would be based on how fast the company can deliver in other words, the low lead time.
F12 influencing F11: When the company wants to differentiate from the competitors, they would make sure, that the product the company procures should be more than what the customers want so that the differentiation would become high.
Level I factor 11.

5. MICMAC analysis

MICMAC analysis is the cross-impact matrix multiplication applied to classification and it is an operational method. MICMAC rank helps to classify the identified factors based on their driving power and dependence power.

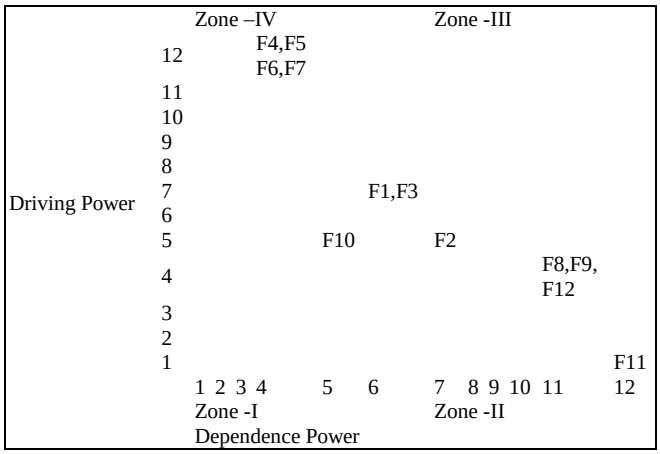

Fig. 2: MICMAC Graph.

Autonomous factors (Zone-I): Cost management
Dependent factors (Zone-II): Decision time, perceived quality, lead-time, differentiation and procurement
Linkage Factors (Zone-III): Nil.
Independent/Key Factors (Zone-IV): Customer and team interaction, customer validation, supervisory behaviors, employee involvement, domain expertise and nature of management
Table11 represents the MICMAC rank of the study where Rank-1 corresponds to the most crucial factors and Rank-6 corresponds to the least important factors among all.

Table 11: MICMAC Analysis of Factors Rank

Factor	Driving power	Dependence power	Driving power / Dependence power	MICMAC rank
F1	7	6	1.166	2
F2	5	7	0.714	4
F3	7	6	1.166	2
F4	12	4	3	1
F5	12	4	3	1
F6	12	4	3	1
F7	12	4	3	1
F8	4	11	0.363	5
F9	4	11	0.363	5
F10	5	5	1	3
F11	1	12	0.083	6
F12	4	11	0.363	5

6. Conclusion

This paper aims to provide a model which helps in identifying the most important factors which influence agile project management in illumination project company. This study takes into consideration of twelve factors and the interrelationships of all the factors are identified. The factors are distributed across 5 levels based on the influencing capability. The usage of MICMAC approach in this study is added advantage of ranking variables will help to identify specific one which contributes to agility. The supervisory behaviors, employee involvement, domain expertise, and nature of management are the most influential factors found to improve the agility in the illumination project organization.

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