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Validation and Modeling of Drivers and Barriers of Multivendor ATM Technology in India from Suppliers' Perspectives

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ABSTRACT

The purpose of the paper is to apply Total Interpretive Structural Modeling (TISM) used to develop a hierarchy among the key drivers and barriers to multivendor ATM Technology adoption in India from the perspectives of suppliers. TISM approach is an extension of Warfield's *(IEEE Transactions: System, Man & Cybernetics 4:405–17, 1974)* Interpretive Structural Modeling(ISM) approach. Based on the literature, drivers and barriers for adoption of Multivendor ATM Technology are identified. TISM is used to develop a hierarchical model which states the interpretation of relationship among these drivers and barriers. Hierarchies of all relevant drivers and barriers are developed and significant interrelationship was found out. Implications for the researchers and Industry Practitioner are highlighted. For Researchers, TISM methodology facilitates to further carry out exploratory studies by identifying the factors in technology adoption domain and focus their interactions through hierarchical structures. For Practitioners with suppliers, a list of relevant barriers and drivers to adoption of this technology in India are indications to take a decision to adopt Multivendor ATM Technology in their respective suppliers. The proposed Model developed through qualitative Modeling technique has been accomplished from the perspectives of suppliers in India in the domain of multivendor ATM Technology for the first time in ATM Banking as a contribution to the Literature.

Keywords: Multivendor ATM Technology, Interpretive Structural Modeling (ISM), Total Interpretive Structural Modeling (TISM), Hierarchical Structures

Ⅰ. Introduction

New technological innovations are happening in society on a regular basis. However, the rate of adoption and diffusion of these innovations determine its success or failure. Preferences and perceptions of technology users facilitates development and improvement of technological innovations (Hou et al.,

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2020; Jung et al., 2015; Koo et al., 2013; Lim et al., 2019; Rindova and Petkova, 2007). In the current context, a number of studies have been conducted in India and abroad on customer's requirements and their perceptions on ATM services. ATM has brought a self-service technology revolution. Customers had very narrow choice offered by the banks when old ATM Software was used in the past with OS/2 Operating Systems. These systems were unable to incorporate customer demands. Today, banks and suppliers of ATMs, both are highly customer driven and are adopting new technology to enhance customer services. Various studies have been conducted in India and abroad to understand the customer's requirements and perception about the customer services (Joshua, 2009; Kal, 2010; Lozano, 1987; Slawsky, 2011). On the basis of these studies, ATMs have been developed with a lot of personalized features. Multivendor ATM technology has brought a paradigm shift in banking technology space. There are various research reports, whitepapers, blogs, newspaper and magazine articles on Multivendor ATMs in India. However, there is a dearth of academic literature of these kinds of ATMs in India. So, this study aims at obtaining a clear understanding of the enablers and issues of multivendor ATMs from the perspective of suppliers.

Here, single software can be implemented in the entire ATM network (Armfield, 2014; Hota, 2012). Based on a study of ATMMarketplace, 32% of the global multivendor market is dominated by NCR Software. This company also linked CRM software and mobile banking. 1.3 million ATMs globally run multivendor software which is 14% more compared to 2016 (ATMMarketplace, 2018).This ATM innovation facilitates a consistent and personalized customer experience. Though this technology is quite matured in developed countries; there is a lot of scope in developing countries like India. The technology is based on central monitoring of ATMs from head office with the help of open operating systems and TCP/IP based network. Real-time central monitoring systems reduce the cost of visiting individual ATMs by site engineers.

The research under consideration is an attempt to explore the domain of Multivendor ATM technology adoption from suppliers' perspectives in India. This study presents a qualitative analysis of the drivers and barriers of Multivendor ATM technology adoption among the ATM suppliers. For this, the factors driving and obstructing the adoption of multivendor ATM technology, identified from the literature, were validated from top officials of ATM supplier companies for the context of India, using an expert survey method. Further, these validated drivers and barriers have been modeled to study their inter-relationships using a qualitative technique called Total Interpretive Structural Modeling (TISM). TISM (Sushil, 2005a; Sushil, 2005b; Sushil, 2012) is an extension to Interpretative Structural Modeling (Warfield, 1973; Warfield, 1974). Such an analysis would provide greater insights about the issues and challenges of adoption of this new ATM technology from the perspective of the service providers.

Ⅱ. Literature on Drivers and Barriers to Adopt Multivendor ATM Technology

A comprehensive literature review on drivers and barriers to adopt Multivendor ATM Technology undertaken by researchers, with an objective to identify these barriers and drivers, resulted in drivers and barriers from the perspective of suppliers. Domain experts further validated these identified drivers and

barriers for the Indian context. A brief explanation of these drivers and their references is summarized in <Table 1>.

The significant barriers identified and further validated by domain experts from the Indian context for suppliers are: 'New Hardware Technology', 'Multivendor Software Environment', 'Remote ATM Monitoring', 'Open Network Architecture', 'Generic Interface and Services', 'XFS fulfillment and EMV compliance issue', 'Software Configuration and Change Management Issues', 'Security Risk', 'Operating System Migration', 'Disintegrated Monitoring', 'Cultural

<Table 1> Description of Drivers and Barriers of Multivendor ATM Technology of Suppliers

Drivers of Multivendor ATM Technology Adoption			
S. No	Drivers of Adoption	Explanation	References
1	New Hardware Technology	Best-in-class hardware technology is a boon for suppliers in reducing transaction cost.	Johnson, 2013; Fiserv, 2014; Atmmarketplace, 2014; Retail banking research, 2007
2	Multivendor Software Environment	This environment is created without supplier lock-in where Banks can separate hardware and software purchase.	Cluckey, 2013; Retail Banking Research, 2010; Thorpe, 2010
3	Remote ATM Monitoring	Site engineer visit is reduced. Improvement in network uptime, transparency in reporting, IT relationships and service quality is improved through remote monitoring.	Macmillan, 2008; Hota, 2012; Fisher, 2013
4	Open Network Architecture	These networks are based on Windows operating systems running multi-vendor software with TCP/IP based network and interoperable.	Hota, 2012; Levelfour, 2008
5	Generic Interface and Services	A common standard and TCP/IP based network facilitate smooth functioning of these ATMs	Levelfour, 2005
Barriers to Multivendor ATM Technology Adoption			
1	XFS fulfillment and EMV compliance issue	Suppliers of ATMs without this Compliance face trouble in the region of ATM Implementation.	Arnfield, 2014
2	Software Configuration and Change Management Issues	Supplier faces a challenge to resolve software configuration and change management. The level of change happening along the ATM software stack in an open environment can be disheartening.	Celent, 2007
3	Security Risk	Multiple third parties are offering cross-channel services and distinct product offerings. This attempt by customers Raises new security risks.	Cluckey, 2016
4	Operating System Migration	Operating system migration to Windows 7 is necessary as the same is built in with security patches. Otherwise, the ATMs without Windows 7 faces security vulnerability.	Korala, 2013; Preimesberger, 2014; Arnfield, 2014
5	Disintegrated Monitoring	Most of the ATM monitoring systems are separate from ATM applications. This is an issue in smooth functioning of these ATMs.	Hota, 2012; Macmillan, 2008
6	Cultural Issues	Multiple subcultures exist in India and a common design may not be a solution for all. Usage of top down /bottom up menu design, color semantics, spatial orientation of information influence usage of ATMs.	De Angeli *et al.*, 2004
7	Changing Government Regulations	Changing government regulation from time to time impacts usage and adoption level of ATMs in India.	Kulkarni, 2011

Issues' and 'Changing Government Regulations'.

Ⅲ. Expert Survey Methodology

In this study, we have identified the drivers and barriers based on literature review and have validated them from the domain experts by undertaking an expert survey. In TISM modeling, identified constructs are verified using one sample t test. Subsequently, the validated constructs are modeled (Biswas, 2017; Deshmukh and Mohan, 2017; Prasad and Suri, 2011; Routroy, 2016; Singh and Singh, 2018). In order to examine the drivers and barriers to the adoption of multivendor ATM technology in banks of India, a survey was conducted based on a structured questionnaire (<Appendix A>). Background of the respondents profile is summarized in <Table 2>.

The online questionnaire was sent to experts working for ATM suppliers with an understanding of technology and also posted in specialized ATM supplier groups in LinkedIn. As per judgmental sampling, 38 experts were identified for the survey. Responses were collected with the help of online questionnaire based on a five-point scale. In total 37 experts responded back and these responses were analyzed to finally select and verify the drivers and barriers to adoption of Multivendor ATM technology in India from the perspective of suppliers. Based on the literature review, five drivers and seven barriers to adop-

<Table 2> Profile of Experts from the Suppliers

S.No.	Category of Experts	Percentage (%)	Profile of the Experts
1	Managers of ATM suppliers/Vendors	35.13%	Managers, Senior Managers, DGMs and GMs
2	Technical and techno-functional experts of Suppliers/Vendors	64.87%	Self Service Technology Consultant, Channel Head-ATMs, Manager-Alternate Channel, Incident Managers, ATM Project Manager, Head-ATM Operation, Professional Service Practice Partner-Self Service, SVP and Head-White Level ATMs, VP, and Chief of operation of Suppliers/Vendors in India.

<Table 3> Expert Verification of Drivers of Multivendor ATM Technology Adoption by Suppliers

S. No	Proposed Drivers of Multivendor ATM Technology in India from supplier's Perspectives	Mean	Mode	Cumulative percentage of experts who agreed/ strongly agreed	Standard Deviation	*t* Value (Test Value = 3*)	Sig. value (2 tailed) (95% confidence interval)	Accept the Drivers as valid if Sig. value < 0.05
1	*New Hardware Technology*	3.78	4	70.3%	.947	5.036	0.000	**Accept**
2	*Multivendor software Environment t*	4.43	5	86.5%	.728	11.968	0.000	**Accept**
3	*Remote ATM Monitoring*	4.43	5	91.9%	.728	1.432	0.000	**Accept**
4	*Open Network Architecture*	4.03	4	83.8%	.957	6.528	0.000	**Accept**
5	*Generic Interface and Services*	4.35	5	89.1%	.676	12.167	0.000	**Accept**

Note: * 5 = Most Significant; 1 = Least Significance

tion of multivendor ATM technology had been identified for verification from experts.

The descriptive statistics (<Table 3> and <Table 4>) provide a fair basis of accepting variables Drivers and Barriers as verified by experts. To examine the survey result, one sample t-test of significance has been used to compare the mean value of each of the driver and barrier with a specified constant or test value. Since the expert responses range from most significant (5) to least significant (1), a mean value of 3 was selected as a reasonable test value for hypotheses testing. The basic hypotheses for verifying the drivers and barriers may be enumerated as follows.

Null Hypotheses (H0): There is no significant difference between the observed mean and specified mean value for the variables (Driver or Barrier)

Alternate Hypotheses (H1): There is a significant difference between the observed mean and specified mean value for the variables (Driver or Barrier)

Thus, a variable will be accepted as valid if the significance value of the t-statistic is less than 0.05 (95% Confidence interval) indicating a higher level of acceptance of a driver or barrier to adoption of multivendor ATM Technology for suppliers in India.

3.1. Results and Discussion of Expert Survey

An analysis of the experts' responses reveals a strong agreement on all the drivers for which the t-value was found to be significant enough to accept (<Table 3>). Among all the drivers, the mean score of Multivendor Software Environment and Remote ATM Monitoring were most significant. New hardware technology was found to be the accepted drivers with the least mean score. In all cases of drivers, significance value was zero which signifies strong relevance of the drivers.

Experts have expressed an acceptance for five barriers for which t test was found to be significant. Two barriers were rejected for which t test was found to be insignificant (<Table 4>). XFS fulfillment and

<Table 4> Expert Verification of Barriers of Multivendor ATM Technology Adoption by Suppliers

Sl No.	Proposed Barriers of Multivendor ATM Technology in India from supplier's Perspectives	Mean	Mode	Cumulative percentage of experts who agreed/ strongly agreed	Standard Deviation	t value (Test Value = 3*)	Sig. value (2-tailed) (95% confidence interval)	Accept the Barri rs as valid if Sig. value <0.05
1	*XFS fulfillment and EMV compliance issue*	**4.16**	**5**	**83.8%**	**0.986**	7.167	**0.000**	**Accept**
2	*Software Configuration and Change Management Issues*	**4.19**	**4**	**86.5%**	**0.66**	10.962	**0.000**	**Accept**
3	*Security Risk*	**3.89**	**4**	**81.1%**	**1.022**	5.311	**0.000**	**Accept**
4	*Operating System Migration Issues*	**3.89**	**4**	**78.4%**	**0.567**	9.571	**0.000**	**Accept**
5	*Disintegrated Monitoring*	**4.16**	**5**	**75.7%**	**0.866**	8.159	**0.000**	**Accept**
6	*Cultural Issues*	**3.08**	**1**	**54.1%**	**1.622**	.304	0.763	**Reject**
7	*Changing Government Regulations*	**2.95**	**1**	**43.2%**	**1.563**	-.210	0.835	**Reject**

Note: * 5 = Most Significant; 1 = Least Significant

EMV compliance issue, Software Configuration and Change Management Issues, Security Risk, Operating System Migration Issues and Disintegrated Monitoring were found to be most significant with zero significant value. Cultural issues and Changing Government Regulations were found to be insignificant with values .304 and -.201 respectively. Software Configuration and Change Management Issues were ranked as the most important barrier with a highest mean score of 4.19.

General analysis of the results indicates a greater consensus and a stronger endorsement of the drivers by the experts as compared to barriers to adoption of Multivendor ATM technology in India from the perspectives of the suppliers. This is also evident from the standard deviation which is also low in case of drivers compared to barriers. This is also further reflected in the cumulative percentage of experts agreeing and strongly agreeing to drivers (70.3% - 91.9%) than barriers (75.7% - 86.5%). So, it is easily understood that drivers or enablers are mostly understood and easily accepted proposition for adoption. But, barriers would need more deliberation and conviction even among experts. However, the result of expert survey signifies both drivers and barriers are quite vital forces for multivendor ATM Technology adoption in India from the perspectives of suppliers (Mode is $\geq$ 4).

Ⅳ. Modeling of Drivers and Barriers from Suppliers' Perspective

After validating the drivers and barriers that influence adoption of multivendor ATM Technology in suppliers for Indian context, it is imperative to delve deeper into the inter-relationship among them. For this, the drivers and barriers for Multivendor ATM Technology adoption by suppliers in India are hierarchically modeled using TISM (Total Interpretive Structural Modelling) technique. TISM modeling is widely used in technological innovations in all sectors (Chatterjee, 2020; Nasim, 2011; Panahifar and Shokouhyar, 2019; Patil and Suresh, 2019; Sagar et al., 2013; Yadav, 2014). ISM modeling addresses "what" and "how" of research. TISM also addresses "why" interpretation through pair-wise comparison in the form of hierarchical structure taking into account the methodology of ISM (Bishwas and Sushil, 2016). An introduction to the methodology of TISM and the interpretation for the study is discussed in the following sub-sections.

4.1. Methodology Adopted for Modeling

This research work explores the enablers and barriers that influence adoption of multivendor ATM Technology with suppliers inside India. The methodology adopted in this research is capturing the response of seven professionals working for ATM suppliers in India who have expertise in Multivendor ATM technology (NCR, Diebold, Wincor Nixdorf and Tata Communications). Most of these subject matter experts were prominent people in the decision process. The interview with them was on the interpretive logic – knowledge base of the experts are as follows.

- Professionals in suppliers inside India with considerable knowledge and expertise on Multivendor ATM Technology.
- Professionals who have worked in multivendor ATM Technology in the past.

Step I: Identify and Define Elements

The first step in a structural modelling process

is to identify and define the elements whose relationships are to be modeled. In the context of this research work, the enablers/drivers and barriers to adoption of Multivendor ATM Technology in India are the elements which are identified from the literature and validated through a questionnaire sent to domain experts in banks and suppliers. The list of elements (drivers and barriers) along with their code used in Modeling is presented in the <Table 5> below.

Step II: Define Contextual Relationships between Elements

For development of the model of the structure relating the elements, it is essential to state the contextual relationship between the elements. The contextual relationship is dependent on the type of structure we are dealing with such as intent, priority, attribute enhancement, process or mathematical dependence. For example, the contextual relationships between different elements (Drivers and Barriers) as identified for the study is: 'Driver (D1) influence/enhance Driver (D2)' and 'Barrier (B1) influence/enhance barrier (B2)'. Such contextual relationships are captured using a TISM Template eliciting response from the domain experts, in this case top level officials from leading suppliers in India.

Step III: Defining Basic Interpretation of Contextual Relationship

In traditional ISM, contextual relationship interprets the nature of the relationship as per the type of structure. It remains silent to interpret how that relationship really works. In order to interpret the ISM further to make it TISM, it is advisable to clarify the interpretation of the relationship. So, we better understand by asking the question "In what way an enabler will influence/enhance another enabler?" The answer to this question provides a unique interpretation of the relationship between the factors so as to make the implicit knowledge explicit.

<Table 5> Elements, Contextual Relationship and Interpretation for Multivendor ATM Technology Adoption from Suppliers' Perspective

Element No.	Elements	Contextual Relation	Interpretation
Drivers of Multivendor ATM Technology adoption from Suppliers' perspective (TISM-I)			
D01	*New Hardware Technology*	Driver D01 will influence/ enhance Driver D02	How or in what way Driver D01 will influence/enhance Driver D02?
D02	*Multivendor software Environment*		
D03	*Remote ATM Monitoring*		
D04	*Open Network Architecture*		
D05	*Generic Interface and Services*		
Barriers of Multivendor ATM Technology adoption from Suppliers' perspective (TISM-II)			
B01	*XFS fulfillment and EMV compliance issue*	Barrier B01 will influence/ enhance Barrier B02	How or in what way Barrier B01 will influence/enhance Barrier B02?
B02	*Software Configuration and Change Management Issues*		
B03	*Security Risk*		
B04	*Operating System Migration Issues*		
B05	*Disintegrated Monitoring*		

Step IV: Interpretive Logic of Pair-Wise Comparison

In ISM, the elements are compared to develop SSIM. The only interpretation that is made here relate to the direction of the relationship. In order to upgrade it to TISM, it was proposed to make use of the concept of the interpretive matrix so as to fully interpret each paired comparison in terms of how that directional relationship operates in the system under consideration by answering the interpretive query as mentioned in step III (Sushil, 2005a). For each link in the knowledge base, the entry could be 'Yes (Y)' or 'No (N)' and if it was 'Yes', then it was further interpreted. So, this unearthed the interpretative logic of the paired relationships in the form of 'Interpretive logic-Knowledge Base'. This is illustrated in <Appendix O> and <Appendix P>.

Step V: Reachability Matrix and Transitivity Check

The paired comparisons in the interpretive logic - knowledge base are translated in the form of reachability matrix. Here, reachability matrix was made by making entry 1, if the corresponding entry in knowledge base was 'Y', or else it was entered as 0 for the corresponding entry 'N' in the knowledge base. The matrix was checked for the transitivity rule and updated till full transitivity was established as shown in <Appendix B>, <Appendix C>, <Appendix I> and <Appendix J>. For each new transitive link, the knowledge base was updated. The 'No' entry was changed to 'Yes' and in the interpretation column 'Transitive was entered'. If the transitive relationship can be meaningfully explained, then the logic is written along with the 'Transitive' entry or else it is left as it is.

Step VI: Level Partition on Reachability Matrix

The level partition is carried out similar to ISM to know the placement of elements level-wise (Saxena et al., 2006; Warfield, 1974). Determine the reachability and antecedent sets for all the elements. The intersection of the reachability set and the antecedent set will be the same as the reachability set in case of the elements in a particular level. The top level elements satisfying the above condition should be removed from the element set and the exercise is to be repeated iteratively till all the levels are determined (<Appendix D> for Drivers and <Appendix K> for Barriers).

Step VII: Developing Diagraph

The elements are arranged graphically in levels and the directed links are drawn as per the relationships are shown in the reachability matrix. A simpler version of the initial digraph is obtained by eliminating the transitive relationships step-by-step by examining their interpretation from the knowledge base. Only those transitive relationships may be retained whose interpretation is crucial. The result of these iterations of the reachability matrix is presented in <Appendix E> for drivers and <Appendix L> for Barriers.

Step VIII: Developing Interaction Matrix and Convert it to Interpretive Matrix

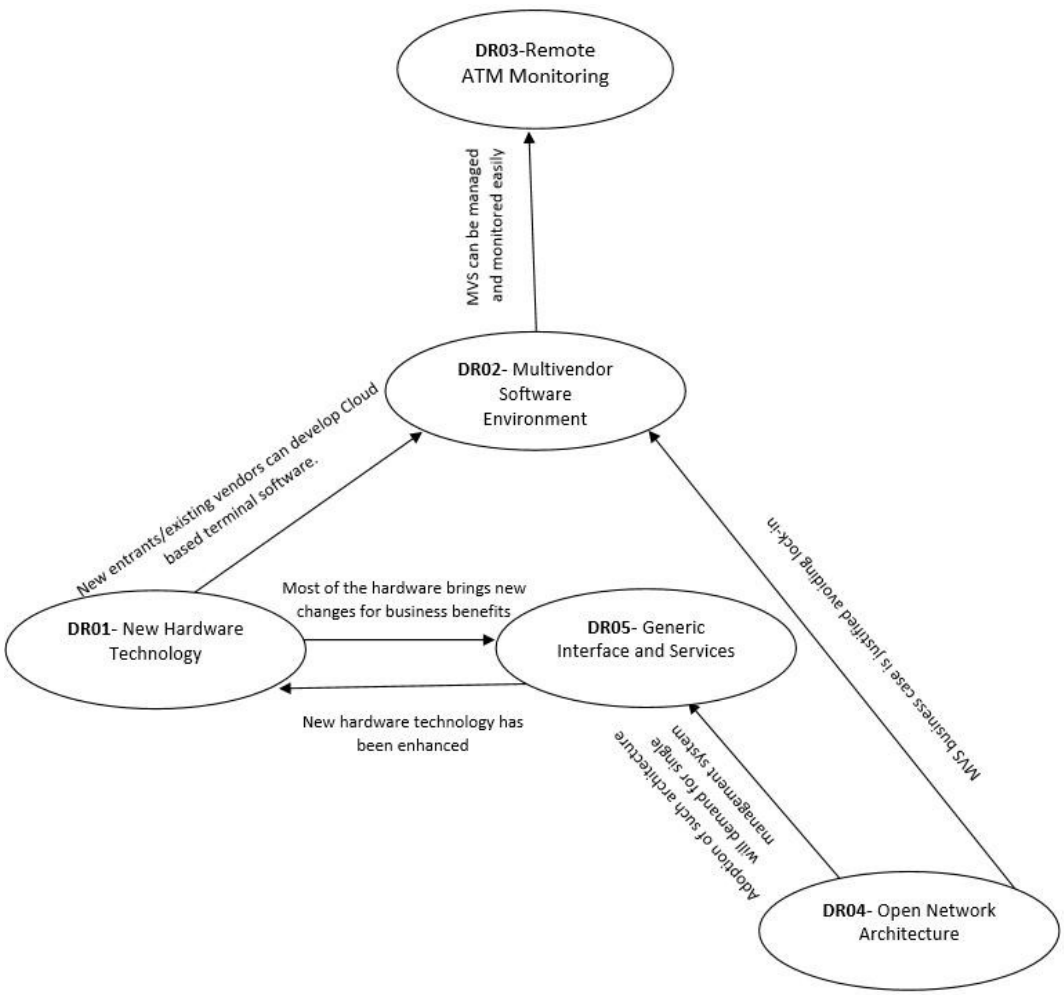
The final digraph is translated into a binary interaction matrix form and interaction matrix form (<Appendix F> for drivers and <Appendix L> for barriers) and is interpreted by picking the relevant interpretation from the knowledge base in the form of interpretive matrix(<Appendix G> for Drivers and <Appendix N> for barriers).

Step IX: Prepare TISM

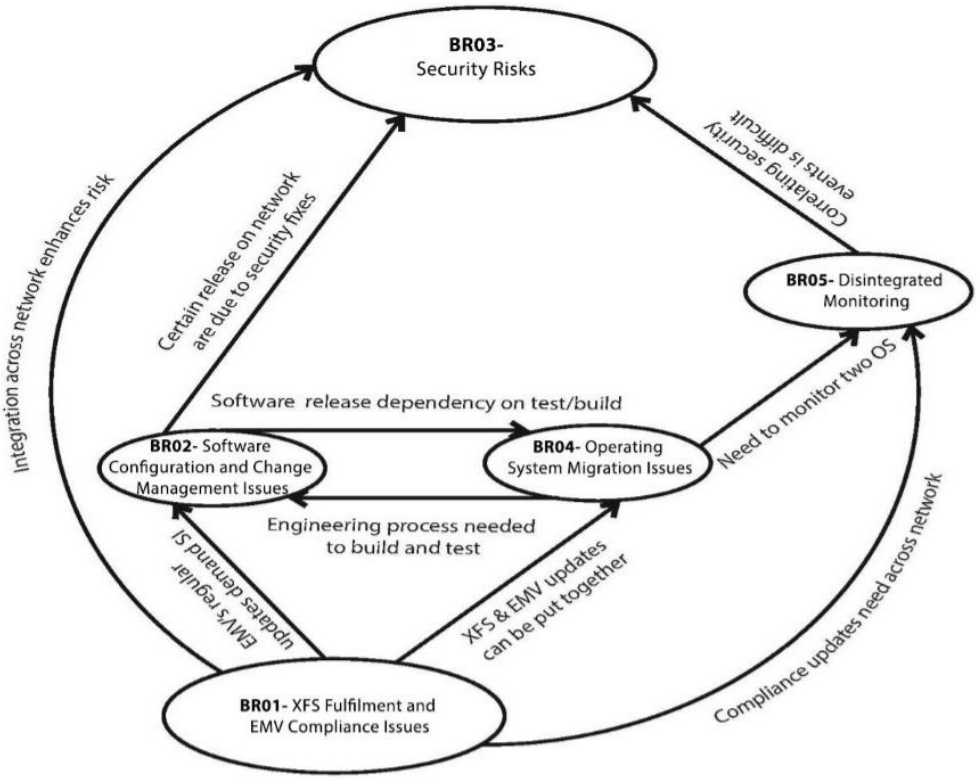
The connective and interpretive information contained in the interpretive direct interaction matrix and digraph is used to derive the TISM. The list of drivers and barriers along with their levels are listed (<Appendix H> for Drivers and <Appendix Q> for Barriers). The nodes in the digraph are replaced by the interaction factors placed in the boxes. The interpretation in the cells of the interpretive direct interaction matrix is depicted by the side of the respective links in the structural model. This leads to a total interpretation of the structural model in terms of the interpretation of its nodes as well as links (See <Figure 1> for Drivers and <Figure 2> for barriers).

Ⅴ. Interpretation of Drivers of Multivendor ATM Adoption

The contextual relationship among the barriers



<Figure 1> TISM Modeling for Drivers of Multivendor Technology Adoption by Suppliers



<Figure 2> TISM Modeling for Barriers of Multivendor Technology Adoption by Suppliers

along with the interpretative logic was captured by conducting a discussion with experts from suppliers in India based on which a TISM model is developed. The step by step process of the TISM methodology has been outlined in the previous section. Based on the feedback from experts, the five drivers were partitioned into four levels. 'Open Network Architecture' is found to be the primary driver which directly influences 'Generic Interface and Services' and 'Multivendor Software Environment'. 'New Hardware Technology' and 'Generic Interface and Services' directly influences on each other. 'New Hardware Technology' directly 'Multivendor Software Environment'. 'Multivendor Software Environment' directly influences 'Remote ATM Monitoring'.

Ⅵ. Interpretation of Barriers to Multivendor ATM Adoption

The contextual relationship among the barriers along with the interpretative logic was captured by conducting a discussion with experts from suppliers in India based on which a TISM model is developed. The step by step process of the TISM methodology has been outlined in the previous section. Based on the feedback from experts, five barriers were partitioned into four levels. 'XFS Fulfillment and EMV Compliance Issues' was the primary driver which directly influences 'Software Configuration and Change Management Issues', 'Security Risks', 'OS Migration Issues' and 'Disintegrated Monitoring'. 'Software Configuration and Change Management

Issues' and 'OS Migration Issues' directly influences each other. 'Software Configuration and Change Management Issues' directly influences 'Security Risks' for certain releases and updates in network due to security fixes. 'Disintegrated Monitoring' directly influences 'Security Risks' due to lack of correlation among security events.

Ⅶ. Conclusion

These research works discusses and elicit a summary of drivers and barriers to adoption of Multivendor ATM Technology in India and illustrates the use of TISM as a qualitative technique to model these drivers and enablers for a deeper understanding of the interplay of these forces. Initially, expert survey was conducted to verify the research constructs for Indian context and all the drivers were found to be significant for suppliers and were strongly endorsed by the experts. However, out of seven barriers, two barriers ('Cultural Issues' and 'Changing government regulations') were dropped as per expert validation.

As per TISM modeling, five drivers have been partitioned into four levels. Summary of key findings of the TISM analysis for drivers of multivendor ATM technology for suppliers are enumerated below. The TISM process involved subject matter experts in making the interpretive logic of the directional relation articulated for each paired comparison. 'Open network architecture' has emerged to be the primary driver for the suppliers, which facilitates in avoiding the lock-in of banks with the suppliers and resolves interoperability issues, thus, providing a generic interface and banking services to customers. 'New Hardware Technology' driver supports new entrants and existing suppliers to support cloud based terminals to 'Multivendor Software Environment'.

Similarly, five barriers were partitioned into four levels. Summary of key findings of the TISM analysis for barriers to multivendor ATM technology for suppliers. Lack of compliance of extensible financial services (XFS) and EMV(Euro, Master and Visa) emerged to be a major barrier for the suppliers as it creates problems for them while migrating from single to multivendor environment. Once, the ATMs are not XFS and EMV compliant, it is difficult to migrate from single to multivendor environment. 'Operating system migration' is a barrier at the ATM site as it requires change management and software configurations. While migrating to multivendor ATMs, at least windows 7 is required and there is a challenge for supplier to locate and install windows 7 wherever Windows XP and other old operating systems (Windows NT and OS/2) are available. 'Disintegrated monitoring' also creates security risks as multiple parties are involved for ATM Applications and ATM monitoring. Security risks are also there due to the presence of multiple applications and multiple suppliers. This model building provides insight to industry experts. This research will also help ATM industry practitioners in identifying areas of importance of enablers and barriers to Multivendor Technology.

7.1. Limitation of Study

This study is based on total interpretive structural Modeling (TISM) as a qualitative tool. Though this tool has a strong relevance compared to interpretive structural Modeling (ISM), subjectivity involved in expert opinion might be there. At the same time, the study has been conducted only on experts with suppliers of India. The study can further generalized from the perspectives of other stakeholders of multi-

vendor ATM Technology.

7.2. Implications for Suppliers

Extensible financial services compliant hardware technology reduces the burden of suppliers of ATMs at the site of the bank with less hassle. The quality of services is improved due to remote ATM monitoring. Due to the generic interface, suppliers of Multivendor ATMs are less burdened in addressing interoperability issues. In the current context, banks are changing their old operating systems (i.e., Windows NT and XP with Windows 7) Once the operating system is not migrated before implementing Multivendor software, there is every possibility of security issues. ATM Application and ATM Monitoring of many banks are separate. Once, there is an attempt from supplier end to integrate these two applications, there will be a convergence of multivendor ATM environment.

7.3. Theoretical Contributions of this paper

The paper is first of its' kind in understanding adoption of multivendor ATM Technology in India from suppliers' perspectives. This paper identifies and interrelates drivers and barriers to multivendor ATM Technology with suppliers inside India. Level partitioning of the drivers and barriers signify the most and least important drivers and barriers. Use of qualitative technique like TISM in this context is also a methodological contribution of this research.

7.4. Major Recommendations

Advantages of multivendor ATM technology have been found to be more pronounced than barriers. There is also a need on the part of suppliers to educate the banks on the technical front so that necessary steps should be taken on part of banks to migrate to Windows 7 operating systems and resolve the XFS (Extensive Financial Services) and EMV (Euro, Master and Visa) compliance before changing their network to multivendor environment from single vendor environment. At the same time, steps should be taken to go for integrated monitoring of ATM Application and ATM Monitoring.

7.5. Direction for Future Research

This multivendor ATM Technology adoption study can be applied to other developing countries. Looking at the barriers of multivendor ATM identified here, an action research involving Govt. and other agencies involved in Multivendor implementation can provide solutions to the issues pertaining to multivendor ATM adoption in India. Study on perception and attitude of bankers and suppliers towards the adoption of multivendor ATM Technology can be researched.

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<Appendix A> Questionnaire for Expert Survey of Suppliers

Dear Respondents,

I am sending a small questionnaire to experts (ATM suppliers/Vendors/3rd party suppliers of software and hardware) who can rank the enablers/drivers and Barriers of Multivendor ATM Technology in India. I have identified 5 drivers or enablers and 7 barriers as per my assessment from various research reports, articles and project reports. Main Objective of the study is to rank the enablers and Barriers to Multivendor ATM Technology Adoption in India for the perspectives of Suppliers. Subsequently, I will conduct a small personal interaction with few experts working in the area of ATM technology in the second phase of this research. Please click the following link to express your personal opinion to complete the survey.

https://www.surveymonkey.com/s/Supplier_Multivendor

Regards,

……

Q.1. Name (Optional):

Q.2. What is you Designation?

Q.3. Name of your Institution.

Q.4. No of Years' Experience

Q.5. Please specify the level of significance for drivers of Multivendor ATM Technology adoption.

SNo	Drivers/Enablers of Multivendor ATM Technology Implementation in India	Least Significant 1	2	3	4	Most Significant 5
1	New Hardware Technology					
2	Multivendor software Environment					
3	Remote ATM Monitoring					
4	Open Network Architecture					
5	Generic Interface and Services					

Q.6. Please specify the level of significance for barriers of Multivendor ATM technology adoption.

Sl no	Barriers of Multivendor ATM Technology Implementation in India	Least Significant 1	2	3	4	Most Significant 5
1	Operating System Migration Issues					
2	XFS fulfillment and EMV Compliance Issues					
3	Software Configuration and Change Management Issues					
4	Security Risks					
5	Disintegrated monitoring and application					
6	Cultural Issues					
7	Changing Regulations					

<Appendix B> Reachability Matrix for Supplier (Drivers)

	DR01	DR02	DR03	DR04	DR05
DR01	1	1	0	0	1
DR02	0	1	1	0	0
DR03	0	0	1	0	0
DR04	0	1	0	1	1
DR05	1	1	0	0	1

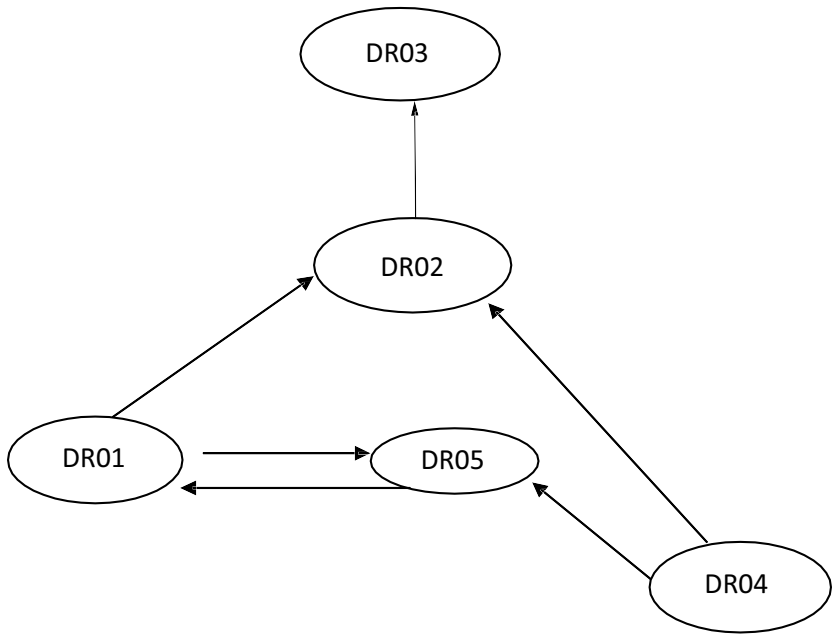
<Appendix C> Post Iterative Matrix for Suppliers (Driver)

	DR01	DR02	DR03	DR04	DR05
DR01	1	1	1*	0	1
DR02	0	1	1	0	0
DR03	0	0	1	0	0
DR04	0	1	0	1	1
DR05	1	1	0	0	1

<Appendix D> Partitioning of the Reachability Matrix of Suppliers (Drivers)

Iterations Level	Elements	Reachability Set	Antecedent Set	Intersection Set
	DR01	1,2,3,5	1,5	1,5
	DR02	2.3	1,2,4,5	2
I	**DR03**	**3**	2,3	**3**
	DR04	2,4,5	4	4
	DR05	1,2,5	1,4,5	1,5
	DR01	1,2,5	1,5	1,5
II	**DR02**	**2**	1,2,4,5	**2**
	DR04	2,4,5	4	4
	DR05	1,2,5	1,4,5	1,5
	DR01	**1,5**	1,5	**1,5**
III	DR04	4,5	4	4
	DR05	1,5	1,4,5	1,5
IV	**DR04**	**4**	4	**4**

<Appendix E> Diagraph for Suppliers (Drivers)



<Appendix F> Interaction Matrix for Suppliers (Drivers)

	DR01	DR02	DR03	DR04	DR05
DR01	---	1	1*	0	1
DR02	0	---	1	0	0
DR03	0	0	---	0	0
DR04	0	1	0	---	1
DR05	1	1	0	0	---

<Appendix G> Interpretive Matrix for Suppliers (Drivers)

	DR01	DR02	DR03	DR04	DR05
DR01	---	New entrants/existing vendors can develop Cloud- based terminal software	**Transitive**	**0**	Most of the hardware brings new changes for business benefits
DR02	**0**	---	MVS can be managed and monitored easily	**0**	**0**
DR03	**0**	**0**	---	**0**	**0**
DR04	**0**		**0**	---	Adoption of such architecture will demand for single management system
DR05	New hardware technology has been enhanced	More adoption of MVS business case to drive existing systems	**0**	**0**	---

<Appendix H> List of Drivers and their levels in TISM

Driver Code	Drivers	Levels in TISM
DR01	New Hardware Technology	III
DR02	Multivendor Software Environment	II
DR03	Remote ATM Monitoring	I
DR04	Open Network Architecture	IV
DR05	Generic Interface and Services	III

<Appendix I> Reachability Matrix for Supplier (Barriers)

	BR01	BR02	BR03	BR04	BR05
BR01	1	1	1	1	1
BR02	0	1	1	1	0
BR03	0	0	1	0	0
BR04	0	1	0	1	1
BR05	0	0	1	0	1

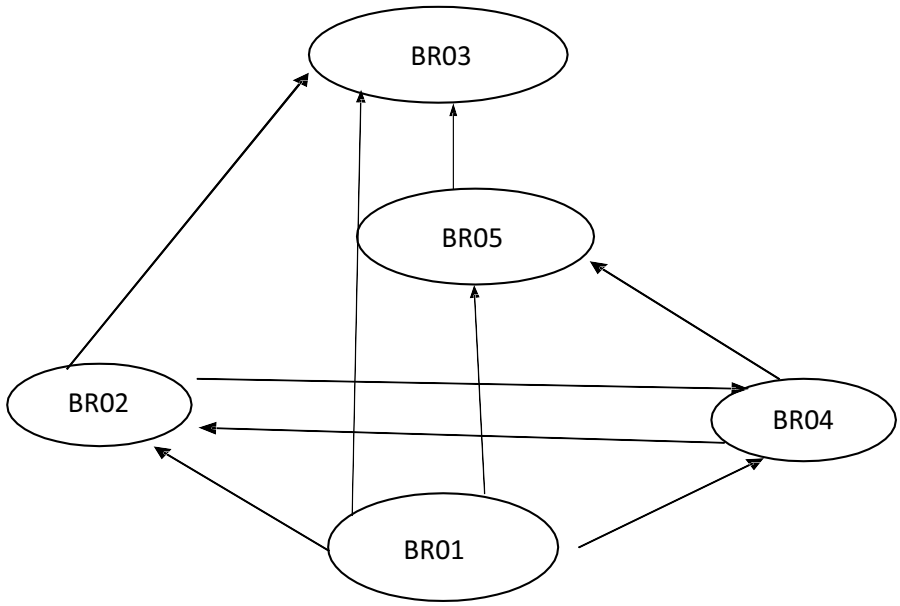
<Appendix J> Post Iterative Matrix for Supplier (Barriers)

	BR01	BR02	BR03	BR04	BR05
BR01	1	1	1	1	1
BR02	0	1	1	1	1*
BR03	0	0	1	0	0
BR04	0	1	1*	1	1
BR05	0	0	1	0	1

<Appendix K> Partitioning of the Reachability Matrix of Suppliers (Barriers)

Iterations Level	Elements	Reachability Set	Antecedent Set	Intersection Set
I	BR01	1,2,3,4,5	1	1
	BR02	2.3,4,5	1,2,4	2,4
	BR03	3	1,2,3,4,5	**3**
	BR04	2,3,4,5	1,2,4	2,4
	BR05	3,5	1,2,,4,5	5
II	BR01	1,2,4,5	1	1
	BR02	2,4,5	1,2,4	2,4
	BR04	2,4,5	1,2,4	2.4
	BR05	**5**	1,2,4,5	**5**
III	BR01	1,2,4	1	1
	BR02	**2,4**	1,2 4	**2,4**
	BR04	2,4	1,2,4	2,4
IV	**BR01**	**1**	1	1

<Appendix L> Diagraph for Suppliers (Barriers)



<Appendix M> Interaction Matrix for Suppliers (Barriers)

	BR01	BR02	BR03	BR04	BR05
BR01	-----	1	1	1	1
BR02		-----	1	1	Transitive
BR03	0	0	-----	0	0
BR04	0	1	Transitive	-----	1
BR05	0	0	1	0	-----

<Appendix N> Interpretive Matrix for Suppliers (Barriers)

	BR01	BR02	BR03	BR04	BR05
BR01	-----	EMV's regular updates demand SI	Integration across network enhances risk	XFS and EMV updates can be put together	Compliance updates need across network
BR02		-----	Certain release on network are due to security fixes	Software release dependency on test/build	Transitive
BR03	**0**	**0**	-----	**0**	**0**
BR04	**0**	Engineering process needed to build and test	Transitive	-----	Need to monitor two OS
BR05	**0**	**0**	Correlating security events is difficult	**0**	-----

<Appendix O> Interpretive Logic - Knowledge Base for Drivers (Suppliers)

Sl no.	Element No.	Paired Comparison of Drivers/Enablers	Yes/No (Please Input Yes or No)	In what way a Driver/Enabler will influence/enhance other Driver/Enabler? Give reason in brief if your answer is YES
DR01-New Hardware Technology				
1	DR01- DR02	New Hardware Technology will influence/enhance Multivendor software Environment	Yes	New entrants/existing vendors can develop Cloud-based terminal software.
7	DR01- DR05	New Hardware Technology will influence/enhance Generic Interface and Services	Yes	Most of the hardware brings new changes for business benefits
8	DR05- DR01	Generic Interface and Services will influence/enhance New Hardware Technology	Yes	New hardware technology has been enhanced
DR02-Multivendor software Environment				
1	DR02- DR03	Multivendor software Environment will influence/enhanceRemote ATM Monitoring	Yes	MVS can be managed and monitored easily
4	DR04- DR02	Open Network Architecture will influence/enhance Multivendor software Environment	Yes	MVS business case is justified avoiding lock- in
6	DR05- DR02	Generic Interface and Services Will influence/enhance Multivendor software Environment	Yes	More adoption of MVS business case to drive existing systems.
DR03-Remote ATM Monitoring				
1	DR04- DR05	Open Network Architecture will influence/enhance Generic Interface and Services	Yes	Adoption of such architecture will demand for single management system

<Appendix P> Interpretive Logic - Knowledge Base for Barriers (Suppliers)

Sl no.	Element No.	Paired Comparison of Barriers	Yes/No	In what way a Barrier will influence/enhance other Barrier? Give reason in brief if your answer is YES
BR01-XFS fulfillment and EMV compliance issue				
1	BR01- BR02	XFS fulfillment and EMV compliance issue will influence/enhance Software Configuration and Change management Issues	Yes	EMV's regular updates demands SI
3	BR01- BR03	XFS fulfillment and EMV compliance issue will influence/enhance Security Risk	Yes	Integration across networks enhances risks
5	BR01- BR04	XFS fulfillment and EMV compliance issue will influence/enhance Operating System Migration	Yes	XFS & EMV updates can be put together
7	BR01- BR05	XFS fulfillment and EMV compliance issue will influence/enhance Disintegrated Monitoring	Yes	Compliance updates need across network
SI - Software Configuration and Change management Issues				
1	BR02- BR03	Software Configuration and Change management Issues will influence/enhance Security Risk	Yes	Certain release on Networks are due to security fixes.
3	BR02- BR04	Software Configuration and Change management Issues will influence/enhance Operating System Migration	Yes	Software release dependency on test/build.
4	BR04- BR02	Operating System Migration Issues will influence/enhance Software Configuration and Change management Issues	Yes	Engineering process needed to build and test
SR- Security Risks				
4	BR05- BR03	Disintegrated monitoring will influence/enhance Security Risk	Yes	Correlating security events is difficult
OM-Operating System Migration Issues				
1	BR04- BR05	Operating System Migration Issues will influence/enhance Disintegrated monitoring	Yes	Need to monitor two OS

<Appendix Q> List of Barriers and their levels in TISM

Barrier Code	Barriers	Levels in TISM
BR01	XFS Fulfillment and EMV Compliance Issues	IV
BR02	Software Configuration and Change Management Issues	III
BR03	Security Risks	I
BR04	Operating System Migration Issues	III
BR05	Disintegrated Monitoring	II

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