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Research on the Effect of Benchmark Learning to the Advanced Manufacturing Technology Implementation Success

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Abstract: This study tried to develop a theoretical model to explore the mediating effect of organizational culture and knowledge sharing on benchmark learning and Advanced Manufacturing Technology (AMT) implementation success. For analyzing both the measurement and structural models of this study, the Structural Equation Modeling (SEM) method was employed as it was capable of allowing the incorporation of both unobserved (i.e., latent) and observed variables in the same model and being able to handle errors of measurement within exogenous variables in a better manner. Results suggest that benchmark learning is directly related with all the four types of organizational culture development culture, group culture, hierarchical culture and rational culture and is indirectly related with knowledge sharing and AMT implementation success. Specifically, development culture has direct impact on AMT implementation success, while hierarchical culture, group and rational culture are indirectly related with AMT implementation success, mediated by explicit and tacit knowledge sharing.

Key words: Benchmark learning, AMT, Organizational culture

INTRODUCTION

The process of introducing a new technology into a company's operations systems makes changes in organizational structures, processes and spaces; firms face obstacles during its implementation phase. All these elements refer to a new organizational architecture in such a way that these changes may be addressed through organizational design reviews. This study explores the introduction of Advanced Manufacturing Technologies (AMT), which are the subject of those changes, that is, their adoption and/or implementation involve changes in the organizational structure, processes and spaces. These technologies can be regarded as resources used by companies to develop higher levels of performance and competitiveness. In the present study, AMT are approached through a bought-in perspective or according to the Resource-based View (RBV). Even though, other perspectives are recognized in terms of a product service definition.

A Product-Service System (PSS) is a special case of servitization, which can be thought as a market proposition that extends the traditional functionality of a product by incorporating additional services.

When organizations integrate their production systems (e.g., through automation), they encounter problems regarding the identification of a model for the organizational design. This model should be compatible with the adopted technological resources and external market requirements. The availability of new technologies such as the AMT and the associated possibility of their use as competitive weapons forces companies to reorganize their operations systems motivated by the technological update. As in the studies based on technological innovation that specifically evaluate the introduction of new technologies, the importance of the compatibility of the organizational design with the technology being introduced is highlighted.

The objectives of this study are three folds. Firstly, we want to explore the mediating effect of four typologies of organizational cultures (development culture, group culture, hierarchical culture and rational culture) on benchmarking learning style and knowledge sharing. Secondly, we'd like to explore the mediating effect of two types of AMT knowledge sharing (AMT explicit knowledge sharing and tacit knowledge sharing) on organizational culture and AMT implementation. Thirdly, we want to explore the relationship between AMT explicit knowledge sharing and tacit knowledge sharing.

ASSUMPTIONS AND THEORETICAL MODEL

In AMT assimilation phase, most of the radical customizations and business process reengineering are

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complete and the system is considered officially "rolled out" for routine usage. However, having the system up and running does not automatically produce the expected benefits to both business operations and the financial performance. Organizations are faced with a new set of challenges in the assimilation phase.

Drawing on the extant literature, we argue that in order to stimulate employees' intrinsic motivation to learn systems functionalities and facilitate organizational sharing of AMT knowledge, the top executive needs to promote a trust-oriented group culture that focuses on belonging and participation by expressing concern for followers and taking account of their individual needs and these leadership traits are largely exhibited in sub-dimension of supportiveness of benchmarking learning (Agourram, 2009). This leads to the following assumptions:

- **H1:** Organizational group culture mediates the relationship between benchmarking learning and AMT knowledge sharing
- **H1a:** Benchmarking learning is positively related with organizational group culture
- **H1b:** Organizational group culture is positively related with AMT knowledge sharing

AMT assimilation also requires users to develop an exploratory learning of system's capabilities and potentials, to think innovatively for new possibilities and applications of AMT systems. Since its complexity, an exploratory learning of AMT systems may need a climate in which the organization accepts conflicts and risk (Bass *et al*., 2003). These behaviors are beneficial to enhance individuals' motivation to explore new system functions. we argue that in order to improve competitive advantage with AMT systems and achieve AMT implementation success, the top executive needs to facilitate a development culture that focuses on innovativeness, creativity and adaptation to the external environment, thus to offer the users a vision of organizational strategic directions and inspire the users to think innovatively about how the system might enable the business to accomplish its goals and achieve business performance and these traits are largely exhibited in sub-dimensions of vision, inspirational communication and intellectual motivation of benchmarking learning. This leads to the following assumptions:

- **H2:** Organizational development culture mediates the relationship between benchmarking learning and AMT implementation success
- **H2a:** Benchmarking learning is positively related with organizational development culture
- **H2b:** Organizational development culture is positively related with AMT implementation success

In order to promote individuals' active participation in AMT systems training, the top executives need to set up appropriate evaluation mechanisms and orchestrate a system of reward mechanisms to foster a hierarchical culture that emphasizes efficiency, uniformity and coordination, thus to accommodate the new system functions and processes and resolve any misfit that might arise. The required leadership traits are largely exhibited in sub-dimension of personal recognition of benchmarking learning. This leads to the following assumptions:

- **H3:** Organizational hierarchical culture mediates the relationship between benchmarking learning and AMT knowledge sharing
- **H3a:** Benchmarking learning is positively related with organizational hierarchical culture
- **H3b:** Organizational hierarchical culture is positively related with AMT knowledge sharing

We posit that in AMT assimilation phase, the top executives also need to promote a rational culture and the required leadership traits of clear goal setting and articulation are largely exhibited in sub-dimensions of vision and inspirational communication of benchmarking learning. This leads to the following assumptions:

- **H4:** Organizational rational culture mediates the relationship between benchmarking learning and AMT knowledge sharing.
- **H4a:** Benchmarking learning is positively related with organizational rational culture.
- **H4b:** Organizational rational culture is positively related with AMT knowledge sharing.

Drawing from the existing literature, we argue that in assimilation phase, knowledge sharing is important for organizational members to assimilate AMT knowledge, thus to have a deeper understanding of system functionalities and capabilities. This leads to the following assumptions:

- **H5:** AMT knowledge sharing is positively related with AMT implementation success in assimilation phase

Based on the above theoretical analysis and five hypotheses, we develop a research model that integrates

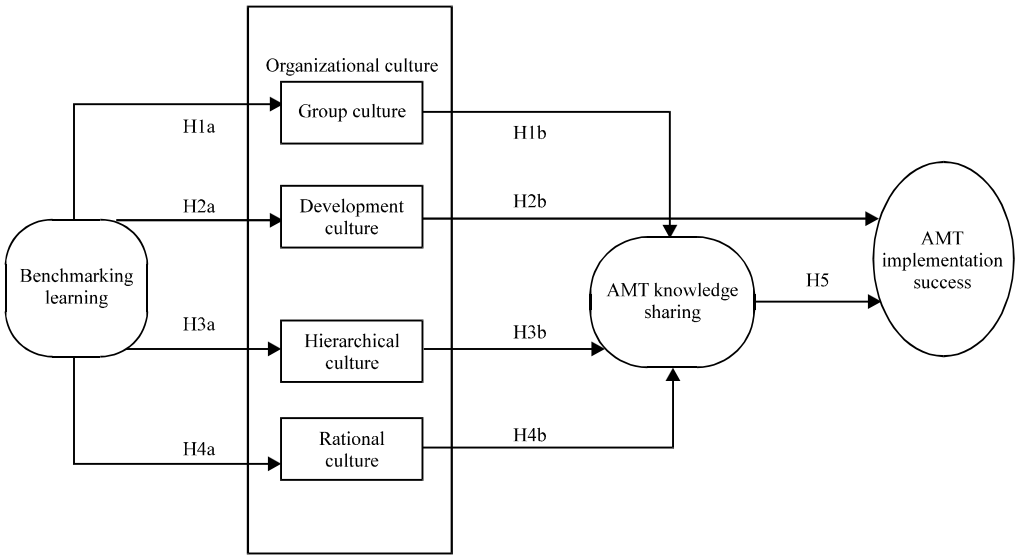

Fig. 1: Framework model of the research

benchmarking learning, organizational culture, knowledge sharing and AMT implementation success, as described in Fig. 1

RESEARCH METHODOLOGY

We used field survey to test the proposed research model. A pretest was initially conducted to examine the content validity of the questionnaire and experts from industry and academics were invited to evaluate the specific items of the questionnaire and find if the items are clear and easy to understand. Several items of benchmarking learning are adjusted since they are too long to read, while three items of organizational culture are also revised in case of their obscurity. 53 firms in Changsha, China were invited to participate in the pilot study to statistically examine the construct validity of the variables. A top executive in charge of AMT systems and his/her direct subordinate were asked to complete two questionnaires in each firm and 76 valid questionnaires from 41 firms were received. PLS analysis results suggest that most of the items load high on corresponding construct and one item of hierarchical culture with factor loading lower than 0.7 was deleted from the questionnaire.

Since our analysis is at organizational level, 386 data from individual respondents was then averaged to match with the 92data from IS executives. After removing the data that has only one valid individual respondent, we finally obtained 87data for analysis at organizational level. Demographics of organizational samples are described in Table 1.

From Table 1 we can see that most of the sample organizations are small and middle sized enterprises (SMEs) from retail industry. This is consistent with the previous findings. In developing countries such as China, the government has launched the policy of using IT technologies to speed up industrialization and SMEs are encouraged to implement AMT systems to support their business operations and achieve market competitive advantage. With the variety of products increases and the retailer size expands, AMT systems have become indispensable for supporting retailers to sell the right product to the right customers at the right time and price. As an emerging market entity, SMEs from retailing industry play a major role in the national economy. The enterprise needs to manage a growing variety of products and a powerful IT such as AMT system was required to satisfy diversification of customer requirements.

Table 1: Demographics of samples

	Category	Percentage
Firm ownership	State owned	10.46
	Joint Venture	4.78
	Private	69.15
	Foreign invested	4.01
	Others	11.60
Revenues (Million Yuan)	<10	31.59
	10-100	38.82
	101-500	13.76
	501-1000	5.05
	>1000	5.14
	Missing	5.64
Number of employees	<150	61.80
	150-500	26.16
	501-1000	4.83
	1001-5000	1.23
	>5000	4.63
	Missing	1.35
Demographics of AMT end users	Employees	60.18
	Business managers	21.86
	Top executives	3.53
	Missing	14.43

DATA ANALYSIS AND DISCUSSION

For analyzing both the measurement and structural models of this study, the Structural Equation Modeling (SEM) method was employed as it was capable of allowing the incorporation of both unobserved (i.e., latent) and observed variables in the same model and being able to handle errors of measurement within exogeno4us variables in a better manner. Additionally, SEM is able to process multiple dependent variables, which is not feasible in a traditional regression analysis method. Two diverse methodological approaches are proposed to calculate SEM. The first one is the covariance structure analysis technique using programs such as, AMOS or LISREL. The other is Partial Least Squares (PLS) technique employing programs; for instance, PLS-Graph and Smart PLS. PLS is appropriate for both reflective and formative construct analysis and is able to accommodate smaller data sample models without requirements of normality distribution of the data. As the sample size collected in this study is relatively small, we chose the PLS approach for data analysis.

The measurement model was assessed to analyze internal consistency reliability, convergent validity and discriminant validity. Internal consistencies are considered as acceptable if each construct's composite reliability, Cronbachs alpha score and item loadings has exceeded 0.7, implying that all the measures consistently represent the same latent construct. Convergent validity was examined by checking the Average Variance Extracted (AVE). AVE was calculated by averaging the percentage of variance extracted of each construct from its indicators and it was reported that AVE should be 0.5 or greater to suggest adequate convergent validity.

Discriminant validity refers to the degree to which items differentiate between constructs and it is assessed by applying the following two criteria: (1) The square root of the average variance extracted of each latent variable from its indicators should exceed that construct's correlation with other constructs; (2) The items should load more highly on constructs they are intended to measure than on other constructs. In this study, we analyzed the correlation between each two latent constructs as well as the cross-loadings, as shown in Table 2 and 3 separately.

As shown in Table 2 and 3, the square root of the average variance extracted (AVE) of each latent construct is greater than that construct's correlation with other constructs. In addition, the items load higher on constructs they are intended to measure than on other constructs. The results suggest good discriminant validity.

Table 2: Correlations between each two constructs

	Benchmarking learning	Develop culture	Group culture	Hierarchical culture	Rational culture	Knowledge sharing	AMT implementation success
Benchmarking learning	0.893						
Develop culture	0.486	0.964					
Group culture	0.364	0.724	0.925				
Hierarchical culture	0.421	0.658	0.752	0.869			
Rational culture	0.397	0.811	0.715	0.758	0.951		
Knowledge sharing	0.325	0.586	0.529	0.637	0.638	0.973	
AMT implementation success	0.683	0.356	0.289	0.365	0.294	0.367	0.896

Bold values represent the square root of the average variance extracted (AVE) of each latent construct

Table 3: Cross-ladings of the constructs

	Benchmarking learning	Develop culture	Group culture	Hierarchical culture	Rational culture	Knowledge sharing	AMT implementation success
Vision	**0.87**	0.34	0.28	0.38	0.24	0.24	0.61
IC	**0.96**	0.36	0.26	0.26	0.29	0.36	0.63
IS	**0.95**	0.35	0.39	0.39	0.31	0.29	0.58
SL	**0.85**	0.39	0.34	0.36	0.34	0.31	0.54
PR	0.93	0.46	0.72	0.34	0.29	0.39	0.65
DEV1	0.42	**0.97**	0.75	0.72	0.71	0.55	0.29
DEV2	0.48	**0.98**	0.74	0.61	0.76	0.63	0.29
DEV3	0.39	**0.89**	0.71	0.68	0.75	0.58	0.18
GRO1	0.34	0.76	**0.93**	0.65	0.68	0.67	0.15
GRO2	0.32	0.72	**0.92**	0.53	0.69	0.65	0.23
GRO3	0.33	0.75	**0.91**	0.79	0.62	0.59	0.29
HIE1	0.42	0.76	0.74	**0.98**	0.75	0.64	0.27
HIE2	0.39	0.71	0.68	**0.96**	0.73	0.59	0.28
RAT1	0.35	0.69	0.69	0.75	**0.93**	0.59	0.25
RAT2	0.32	0.86	0.78	0.72	**0.95**	0.61	0.34
RAT3	0.36	0.78	0.63	0.69	**0.91**	0.71	0.26
EKS	0.38	0.59	0.51	0.76	0.64	**0.98**	0.27
IKS	0.39	0.64	0.64	0.71	0.71	**0.94**	0.33
PS1	0.61	0.34	0.24	0.34	0.26	0.28	**0.93**
PS2	0.69	0.25	0.23	0.30	0.29	0.39	**0.95**
PS3	0.57	0.35	0.27	0.32	0.25	0.35	**0.94**
PS4	0.68	0.31	0.16	0.37	0.27	0.36	**0.96**

Bold values represent the item loadings of the construct that they are intended to measure

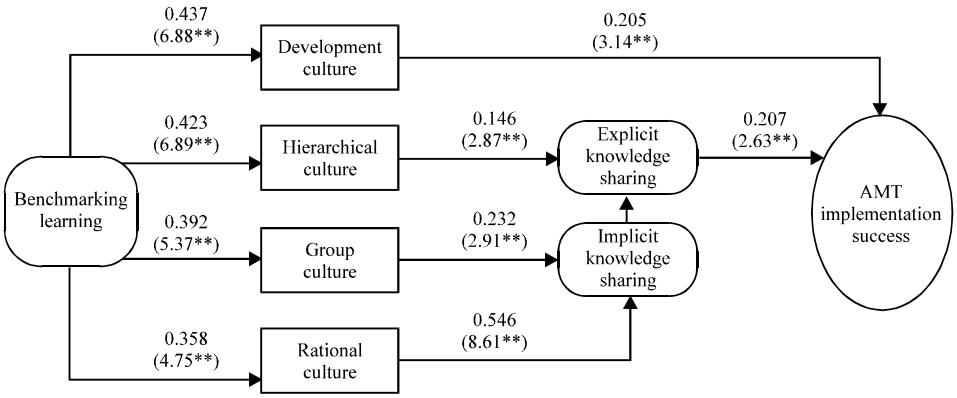

Fig. 2: Result of the Structural equation model analysis

PLS is applied to test the research model in our study since it has a less critical requirement of the sample size to validate the model compared to alternative structural equation modeling techniques. The sample size requirement is either 10 times of the larger measurement number within the same construct or 10 times of the larger construct number affecting the same construct. Since the largest construct number affecting AMT implementation success is three in the research model, our sample size can satisfy the requirements of PLS.

Figue 2 shows the path analysis results of the structural model. Path analysis results show that hierarchical culture is positively related with explicit knowledge sharing, while rational culture and group culture are positively related with tacit knowledge sharing. The path coefficients are all significant at p level of 0.01. The results indicate that trust oriented group culture and achievement oriented rational culture is more likely to foster AMT tacit knowledge sharing by facilitating a communication and participation climate ithin the organization, while control oriented hierarchical culture is more likely to foster AMT explicit knowledge sharing directly.

An interesting finding of the empirical model is that explicit knowledge sharing is positively related with AMT implementation success, yet tacit knowledge sharing has indirect impact on AMT implementation success, mediated by explicit knowledge sharing. The above findings signify the importance of transformation of tacit AMT knowledge into explicit knowledge in achieving AMT implementation success.

CONCLUSIONS

Drawing from benchmarking learning theory, organizational culture theory and knowledge based view, this study developed a theoretical model to examine the joint impact mechanism of benchmarking learning, organizational culture and knowledge sharing on AMT implementation success. PLS analysis indicates that development culture has direct positive impact on AMT implementation success. The empirical results highlight the significance of benchmarking learning in promoting desired organizational culture and facilitating individuals' tacit and explicit knowledge sharing intention, thus to achieve business benefits through the assimilation of AMT systems.

However, there are some limitations in this study, future studies can use the five sub-dimensions of benchmarking learning as independent latent variables and examine their specific impact mechanism on AMT implementation success, to further explore which specific sub-dimension of benchmarking learning is more likely to promote the four types of organizational culture and foster the two types of knowledge sharing.

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