The impacts of technology on operational costs: The mediating role of integration

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Abstract
The study aims is to examine the mediating role of integration with respect to the impacts of operations technology on operational costs. A model illustrating the relationship between the research variables is proposed. Structural Equation Modeling (SEM) was employed to test the model, drawing on a sample of 254 respondents comprising of operations managers or equivalent positions employed in the service sectors in Malaysia. Data analysis revealed a statistically significant relationship between the level of integration and operational costs. The results further supported the proposition that integration mediates the impact of technology on operational costs.

Keywords: Operations technology, Integration, Operations costs

Introduction
Technologies have long been established to be able to improve services processes. Banks and other financial institutions that provide Automated Tellers Machine (ATM) services, for example, could offer better quality services to customers and clients. Although initially, banks have to incur some investments in adopting the ATM technology, in the long run, they could reduce operating costs by decreasing the number of staff at counter services. In the service industry, not only technology is important, but the ability of the elements in the system to integrate is also crucial. This is evidenced in various sectors of the industry. In health care, for instance, Li et al. (2002) acknowledged health service network as one of the service quality factors. According to the authors, forging relationship with physicians and other hospitals are deemed crucial in order to improve the health care service quality. Similarly, in the hospitality industry, hotels are being integrated with other industry players such as tour operators, government agencies,

transport and logistics provider and even airline operators.

While technology and integration have been identified by experts as pertinent factors in studies on the structural and infrastructural resources, the 'how' aspect of it; i.e. the nature of the relationship between them and their impacts on operations performances such as operations costs have not been effectively and empirically explored. Additionally, not many studies of this nature have been conducted in a service setting. Hence, this study attempts to address these research gaps. In due course, a model depicting the link between the investment of technology and the improvement of cost operations with integration as the mediating factor is proposed.

Literature Review

Debates on what constitute structural and infrastructural resources in operations paradigm have been in the limelight for several years. With respect to technology and integrations, prominent scholars like Hayes and Wheelwright (1984), and Schroeder (2007) have suggested that both should be recognized as structural resources, along with other resources such as capacities and facilities. To these authors, infrastructures would appropriately be confined to people, information system, organization, production and inventory control, and quality control system. This dichotomy of resources, although was originally designated for the manufacturing industry, should be applicable as well for the service industries.

Resource-based View (RBV)

Theoretically, the relationship between the key research variables i.e., technology, cost and integration could be deduced from the RBV. Managing resources effectively is a fundamental tenet of modern organizations. Resources can be physical, human, and organizational assets (Barney 1991). Firms' resources are the inputs in the production process and can be considered as the most fundamental unit of analysis (Grant 1991). In the past, organizations are more concerned with hard resources in the forms of assets and capital. As of late, given that knowledge and information are becoming more significant, managing human resources is equally pertinent. A company must possess good human resource and human resource development programs. Likewise, it must have the ability to retain these resources through good compensation and reward systems. A successful organization is the one that can manage a balance between the different kinds of resources it possesses. Studies employing RBV as the underlying theory confirm that companies which possess resources that are rare, unique, inimitability overcome their competitors in various performance indicators. This means that resources, which imply company's strength and weaknesses, are related to the firm performances (Barney 1991, Conner, 1991, Mahoney and Pandian, 1992, Teece 1986). Based on these arguments, technology and the investment in it could enhance the overall organizational capability of organizations. And obviously, when complemented with integration, organizations could gain more competitive advantage over their rivals.

Operations costs

As the result of gaining a better competitive advantage, organizations may realize a better performance by achieving the goals and objectives. Managing and controlling costs is

one of objective of operations. Many studies of this nature offer cost measures. For example, Anderson and Sohal (1999) include production and operations costs as one of the performance outcomes. Hendricks and Singhall (1997) include costs as a measure of firms performances besides other measures of productivity and innovation. This study treats costs of operations as the measure for operations performances.

Technology

In Merriam-Webster (2013) dictionary, technology is defined as "the capability given by the practical application of knowledge." Technological developments in general have been attributed to providing plants with competitive weapons (Hofer and Schendel 1978, Itami and Numagami 1992, Li et al. 2000). Among the components of technology, the use of IT gains a more prominent role. This is even true in a service setting where integration with internal and external stakeholders depend on the efficiency and effectiveness of the IT system. Zhang et al. (2011) found fairly consistent results with respect to the positive impact of IT on performance, despite the contextual difference of these studies. While there are variations in the definition of technology, we use investments in technology to measure this construct. In this study, we therefore hypothesize the followings;

H1: Technology positively influence integration

H2: Technology positively influence operations costs

Integration

In the service industry, particularly in health care, the importance of this factor has been often highlighted. Its importance, however, has not been empirically proven in other service industries. In the field of supply chain management, the integration with supplier (Corsten and Felde 2005, Das et al. 2006, Trent and Monczka 2003) and customers (Fynes et al. 2005, Gimenez and Ventura 2005, Sahin and Robinson 2005) has been positively related to supply chain performance. We believe that this is also true in a service environment. On this note, we therefore hypothesize that;

H3: Integration positively influence operations costs

Furthermore, as the outcomes could be relied through integration, this study hypothesized that;

H4: Integration mediates the relationship between investment of technology and operations costs

Method

In this section, we describe the data collection methods, instrument, and respondent's profile

Data collection method

The study employed a survey technique for data collection. The survey instrument contained questions representing the three key research variables or constructs, namely:

investment on technology, the extent of integration implementation, and operations costs. The conceptual definition of the integration construct was adapted from the works of Li et al (2002). While the measure for investment on technology was adapted from Li et al. (2002) and Boyer and McDermort (1999), the measure for cost was adopted from various authors (Anderson and Sohal 1999, Hendricks and Singhall 1997) Modifications were made to some items in the original scale to adjust for semantic meanings and to ensure its validity and appropriateness to the service industries. Scales were based on the seven-point Likert scale, ranging from "least important" to "very important".

Sample size

An ideal sample size depends entirely upon the type of research being conducted. Generally, however, the rule of thumb for determining statistical power is 'five observations for each independent variable' (Hair et al. 2010). To this end, the researcher managed to obtain a moderate yet appropriate sample size of two hundred and fifty (254) respondents from the Hotels, Fast food, Hospitals, Auto repair, Retail store, Retail Bank, Private college, Architect, and Accountant. We identified the population from a sampling frame and selected respondents randomly. For example, we use Malaysian Hotel Directory to identify hotels in Malaysia. In a case where there is no sampling frame, we use our best judgments to identify the appropriate respondents.

Respondents' profile

In Table 1, it is shown that out of the 254 respondents in the study, 170 (66.9%) were national firm. The majority of the respondents (106 or 41.7 %) were managers. Regarding the years firms are in operations, 32 (12.6%) were between (1-3 years), 95 (37.4%) were between (3-6 years), 49 (19.3%) were between (6-10), 78 (30.7%) were more than 10 years.

Table 1: Characteristics of respondents in terms of their Demographic Variables

		Frequency (N)	percent (%)
Firm's market			
	Local / national	170	66.9
	Global / regional	84	33.1
Profession			
	Manager	106	41.7
	Middle Manager	44	17.3
	Top Manager	19	7.5
	Others	85	33.5
Years operation of firm			
	1-3 years	32	12.6
	3-6 years	95	37.4
	6-10 years	49	19.3
	More than 10 years	78	30.7
Type of Service			
	Hotel	31	12.2
	Fast food	30	11.8
	Hospital	24	9.4

	Auto repair	26	10.2
	Retail store	30	11.8
	Retail Bank	30	11.8
	Private college	30	11.8
	Architect	30	11.8
	Accountant	23	9.1

Note: Total number of Respondents = 254

Reliability and validity

Hair et al. (2010) define reliability as an assessment of the degree of consistency between multiple measurements of a variable. Table 2 shows the measures, the descriptive statistics and the Cronbach's alpha score of the constructs. The three factors have yielded alpha coefficients exceeding the acceptable value of 0.70 as suggested by (Hair et al., 2010). Based on the Cronbach's alpha coefficient values obtained, it would be safe to claim that statistically, the measures representing the research variables may well be accepted and admissible, or in other words, proves to be reliable. In order to validate the instrument, this study also considers construct validation using the analysis of moment structures software (AMOS) with maximum likelihood (ML) to analyze the data. This approach is called the confirmatory factor analysis which is more advanced, as the hypotheses are based on the underpinning theory, as discussed in the next section.

Table 2: Measurement of the variables of the hypothesized model

Construct	Item	Measure	Mean	SD	Alpha
Integration	Stl1	Forging a partnership with related agencies	5.13	1.141	.783
	Stl2	Forging alliances with suppliers	5.21	1.006	
	Stl3	Forging a partnership with competitors	5.07	1.129	
	Stl4	Forging relationship with customers	5.69	1.057	
	Stl5	Forging close relationship with local communities	5.50	1.024	
Technology	StT1	ICT systems for firm operations (e-mail system, Intranet system, fax, telephone, etc.)	5.46	1.163	.868
	StT2	Computerized customer information (e.g. customer's database)	5.47	1.100	
	StT3	An integrated information system for tracking customer record	5.41	1.153	
	StT4	Firm's homepage with sufficient information	5.47	1.022	
	StT5	On line system (e.g. booking, registration, appointment, etc)	5.26	1.232	
	StT6	Latest technology relevant for enhancement of the business operations (e.g. latest scanning	5.47	1.136	

		system for hospital or new ATMs for banks)			
Cost	FPC1	Reducing customer/clients costs	4.78	1.146	.798
	FPC2	Attaining high employee productivity	5.30	1.046	
	FPC3	Maintaining high capacity utilization	5.29	1.074	

Results

The measurement analysis was conducted and the results are found to be acceptable. A full-fledged Structural Equation Modeling (SEM) analysis was also performed and the results indicate that the hypothesized model fits and describes the data accurately.

The analysis also reveals some crucial deductions. First, technology has both direct and indirect effects on cost and a direct impact on integration. Second, integration serves as a good mediating variable between technology practices and cost, exerting a direct effect on the cost construct. Detailed evidence of the 'goodness of fit' of the model is presented in Figure 1 and Table 3. In Figure 1, integration constructs represented by Stl1, Stl2, Stl3 and Stl5. the five items of the technology construct are represented by StT1, StT2, StT4, StT5 and StT6; and lastly, the three items of the cost construct are represented by FPC1, FPC2, and FPC3.

Figure 1 shows the full-fledged SEM and the resultant estimations of causal effects among the constructs. The model contains twelve items altogether for the three constructs (four for integration, five for technology, and three for cost). The model indicates a good fit for the data. The goodness of fit statistics are both statistically adequate and practically important — the Root Mean Squared Error of Approximation (RMSEA) = 0.048, and the Comparative Fit Indices (CFI and TLI) are robust (.974 & .967 respectively). Other goodness of fit indices of the model include: a Chi-square (80.994), degree freedom (51), p-value = .005, and a Normed Chi-square (Cmin/ df) = 1.588.

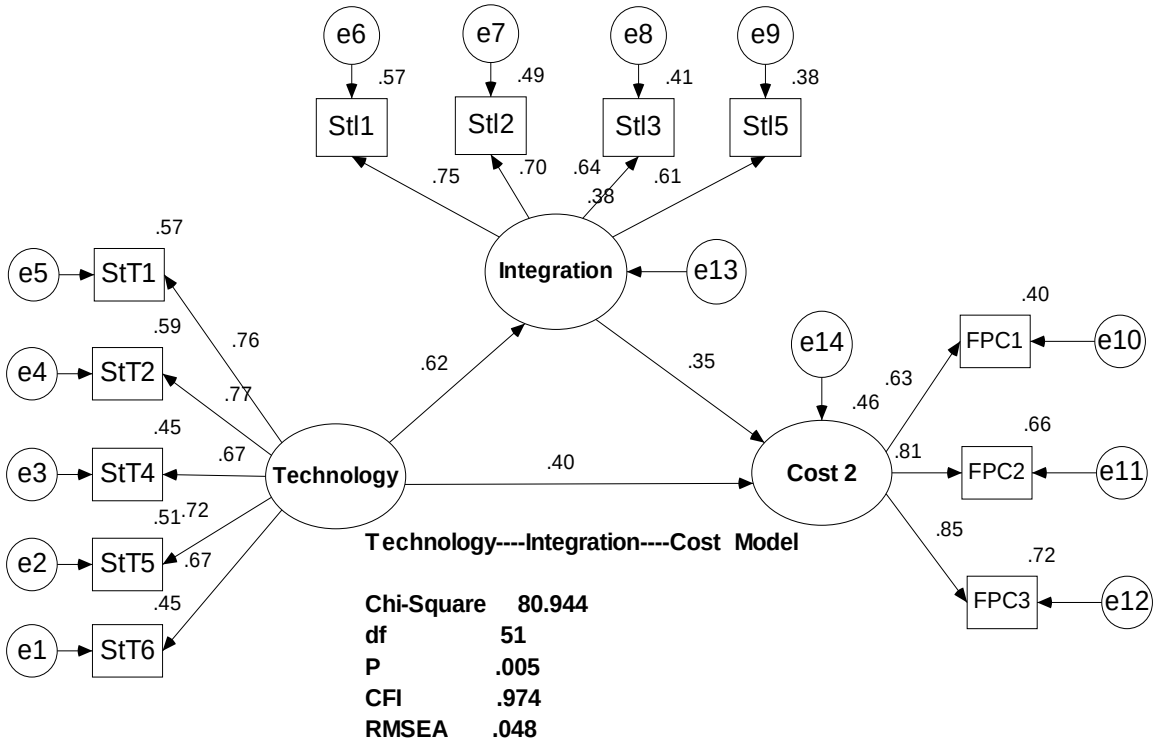

Figure 1: The Full-Fledged Structural Equation Model (SEM)

The summary of the goodness of fit statistics of the model is displayed on the Table 3, below:

Table 3: The Summary of the Fit Statistics for the Full-Fledged SEM Model

Model	X^2	df	P	Cmin/ df	RMSEA	CFI	TLI
Fit Statistics	80.994	51	.005	1.588	.048	.974	.967

The goodness of fit information contained in Table 3 supports the adequacy of the model, as they obtained statistics conform to the recommended values for a satisfactory fit of a model to data. The Norm-Chi-square (Cmin/df) is within the acceptable below of 3 (Bollen 1989, Browne and Cudeck 1993), the RMSEA < .08, and the CFI & TLI > .9 (Browne and Cudeck 1993, Byrne 2010).

All the parameter loadings of the model are practically reasonable and statistically important, implying loading coefficients that range between .61 to .85 — far greater than the recommended threshold of 0.6 (Byrne 2010, Kline 2011,), and without any offending estimates. Inspection of estimate outputs further reveals that the hypothesized relationships among the constructs are all statistically significant. Specifically, the relationships among the three constructs (technology & integration; integration & cost; and technology & cost; and technology to cost through integration) are considered significant, as indicated by the Critical Ratio (CR) values of each of the inter-variable

relationships (Byrne 2010, Kline 2011) greater than 1.96 (the absolute value), at an alpha level of .05.

Also revealed in the model is the evidence of direct and indirect relationships among the constructs of the model. The analysis shows that: technology has a direct effect on cost = 0.40; technology having an indirect effect on cost through integration = 0.217; technology direct effect on integration = 0.62; and integration direct effect on cost = 0.35. All effect estimates are statistically significant and logically acceptable, and their values are of an acceptable standard for evidence of direct and indirect effects (.2) (Byrne 2010, Kline, 2011). Thus, it may be emphatically stated that in this study integration qould be a good mediator between investment of technology and cost.

Discussion and Conclusion

Essentially, this research involves a triangulation of technology, integration, and cost (constructs) within the context of the service industry in Malaysia. Past studies had examined these constructs either discretely or in two-way relationships. As mentioned earlier, the novelty of this research lies in two aspects. Firstly, its inclusion of integration practices as a mediator on the relationship between technology and operations costs. Secondly, it is the fact that it is conducted within a service setting i.e., in service sector.

For the data analysis, the study employed confirmatory factor analyses to produce empirically verified and validated underlying dimensions of technology, integration, and cost. Based on the proposed theoretical model, Structural Equation Modeling (SEM) was applied on the data collected which was represented by a sample of 254 respondents comprising operations managers employed in various service organizations in Malaysia.

The results demonstrated that statistically, technology has a significant impact on the extent of integration practices or implementation. Significant direct impacts on the cost and between the level of integration implementation and cost were registered. Finally, most interesting of all, as hypothesized, the results suggest that indeed integration implementation has a role to contribute on the relationship between technology and cost. This particular finding, attests the success of the triangulation of technology, integration, and cost in providing unprecedented results over all prior studies on the two-way relationship technology and cost.

Given that the model proposed in the study only represents a simple or general model, for future research, an expanded model that could include other variables more specific to the industry would perhaps be more interesting to explore, both for the sake of theoretical as well as empirical contributions to the literature.

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