Information Technology and Sales & Operations Planning (S&OP) – An Event Study

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IT has lost its magical power to provide competitive advantages and that corporations would be better off focusing on the risk of IT rather than looking at IT as a strategic asset – such was the conclusion of Carr (Carr, 2003). However, IT champion, Metcalfe, views IT investment as a source of competitive advantage that determines a path of sustainable excellence for a corporation. This paper explores the weight of evidence for both camps using event study and proposes that there is an optimal level investment in IT as a strategic asset beyond which it will cease to be a strategic asset in Sales and operations planning (S&OP).

Keywords: Sales and Operations Planning, Technology Investment, Optimality

INTRODUCTION

There is a debate that is trending that says that IT does not matter. Especially leading this thread of argument is Nicholas G. Carr (Carr, 2003) of Harvard. The contention is that IT has lost its power to provide competitive advantages, and hence, corporations should be better off not to seek opportunities using it as strategic asset. The focus should be on the risk of IT. The argument cites utility industry as a support as follows. A revolution took place between 1905 and 1930, when it became possible to centralize power generation in big utilities and distribute current over a network. Many manufacturers resisted, but lower costs, freed-up capital, enhanced flexibility and fewer headaches made even the largest companies switch. Similarly, advances in networking, hardware virtualization, grid computing and Web services are making IT utilities possible, in which IT will go from being a complex corporate asset to being a simple variable expense. Utility computing today merely hints at coming changes.

The economics of business computing as opposed to the technology of utility computing itself leads one to understand that a much bigger wave of change in today's entire model of business computing is built around fragmentation of basic assets — everyone having to buy what, in many cases, is similar hardware and software. All that stuff will ultimately be centralized outside companies, and that will bring in much greater efficiency, reduced costs and increased reliability for users. Cloud computing is the latest example of Utility computing.

Over the last 50 years, anyone who wanted a sense of the future of business computing could simply look at what the heavy hitters were doing. Building or buying new systems required a lot of capital, and

only the largest and best-funded companies could afford cutting-edge technology. Smaller organizations would wait until costs came down and then follow dutifully in the footsteps of the big guys.

Further, it is hypothesized that ultimately centralizing control over a lot of the basic IT infrastructure will actually increase the level of security over the current highly fragmented and distributed model. Where IT is more distributed, it's more vulnerable in many ways. One of the advantages of a utility model is that the entire success and fate of the utility hinges on its ability to maintain security.

Another stylized fact that is quickly changing: Big companies used to be the earliest to adopt the newest technology. This old pattern is being turned on its head. Today, many of computing's pioneering customers are small or midsize organizations without a lot of cash. They consist not only of businesses but also nonprofits, government agencies, and schools. They still need to pinch pennies, but instead of waiting patiently for the prices of new systems to come down, they're taking an altogether different route. They're inventing a new model of computing built on cheap commodity hardware, free open-source software, and utility services supplied over the Internet.

The IT developments mirror what happened with electricity a century ago. In the early years of industry's electrification, small companies had to stand on the sidelines as larger counterparts constructed expensive private generators to power their machinery. But then, as electric utilities popped up, the smaller outfits purchased kilowatts over the new public grid first. They may not have realized it at the time, but they were defining the future of electricity in business.

Thus, this new view stresses that as we move into the next business-computing era -- that of cheap components and utility supply -- once again, the laggards are leading the way.

On the other hand mainstream IT champion Bob Metcalfe (Metcalfe, 2004) chooses the path of excellence. This view maintains that policy leaders can find competitive advantage using IT. The problem is that if you're breaking a trail, you may not always use the easiest path. That is time-consuming and costly.

Metcalfe and Carr are talking right past each other. Carr's point was simply that IT, in and of itself, might not provide a competitive advantage. Metcalfe's point was that IT innovation and those who skillfully take advantage of it early on will get a competitive advantage.

There's a significant difference between avoiding a competitive disadvantage and providing a competitive advantage. The message to be derived from both views is that any competitive advantage from IT innovation may be short-lived. As a consequence, for a company to maintain an advantage through IT, it will need to continuously invest in new IT capabilities, and this investment will need to be done in the most effective way possible.

Like any highly charged debate, the truth may lie in interactions of both sides' data and positions. This paper will find out whether IT is strategic or infrastructural or both in the supply chain industry.

REVIEW OF THE LITERATURE

In this section we have tried to summarize what leading researchers and practitioners in the area of information technology have mentioned in their publications about strategic values of information technology and their views on Carr's argument of IT no longer is the source of competitive advantage.

According to George Stalk (Stalk,1988), "Like competition itself, competitive advantage is a constantly moving target. For any company in any industry, the key is not to get stuck with a single simple notion of its source of advantage. The best competitors, the most successful ones, know how to keep moving and always stay on the cutting edge. Today, *time* is on the cutting edge. The ways leading companies manage time - in production, in new product development and introduction, in sales and distribution — represent the most powerful new sources of competitive advantage."

In Piccoli & Ives (Piccoli & Ives, 2005), survey of the IT literature they conclude that ″The role of information systems in the creation and appropriation of economic value has a long tradition of research, within which falls the literature on the sustainability of IT-dependent competitive advantage. Based on their research, since the early 1980s, considerable research attention has focused on the strategic role of information technologies and their potential for creating competitive advantage from this work has

emerged the widely accepted conclusion that IT can be used to create competitive advantage through efficiency improvements, differentiation, and channel domination." Paul Samuelson, one of the 20th century's greatest economists, once remarked that the principle of comparative advantage was the only big idea that economics had produced that was both true and surprising.

Kohli and Grover (Kohli & Grover, 2008), in their research argue that "many researchers and Practitioners believe that information technology has now become an essential part of today's modern organizations, but still have difficulty measuring its contribution to business performance. They believe, Nicholas Carr's provocative discourse entitled "IT doesn't matter" ruffled a few feathers. Regardless of the efficacy or scholarship of his arguments, the essay, the attention it drew, and its effect on praxis were disturbing to the IS research community, since it implied our reduced importance. Its innate logic implies to us that if IT is not valuable, then we are engaging in research on something that is not valuable, and hence *we* are not valuable!"

According to Clemons and Row (Clemons & Row, 1986), since the business value of IT has been so difficult to measure, many have classified IT as a strategic necessity, that is, it is necessary but not sufficient for sustainable competitive advantage." They believe information systems are strategic business tools, frequently essential to a firm and central to its competitive strategy. Their importance is now acknowledged. But information technology—equipment and services—is available to all firms, and most applications can be duplicated. The copying firm often enjoys the advantages of newer and better technology, learns from the experience of the innovator, and thus can offer comparable services at lower costs**.**

According to Clemons and Row (Clemons & Row, 1991), Clemons and Kimbrough (Clemons & Kimbrough, 1986), "It has been suggested that many strategic effects of IT applications stem from changing the transactions costs between economic activities. They believe that because IT can improve the cost, timing, and quality of information flows and decision processes, it can radically change the transaction economics with far-reaching strategic results. Monitoring costs and, hence, uncertainty can be decreased." Nicholas Carr, in his 2003 famous paper argued that" but like many broadly adopted technologies—such as railways and electrical power—IT has become a commodity. Affordable and accessible to everyone, it no longer offers strategic value to anyone. Scarcity—not ubiquity—makes a business resource truly strategic. Companies gain an edge by having or doing something others can't have or do. In IT's earlier days, forward looking firms trumped competitors through innovative deployment of IT. Now that IT is ubiquitous, however, we must focus on its risks more than its potential strategic advantages. According to him today, any IT disruption can prove equally paralyzing to your company's ability to make products, deliver services, and satisfy customers. But the greatest IT risk is overspending—putting your company at a cost disadvantage. "Carr (2005) believes that global IT expenditures are about $1 trillion annually and much of that sum is wasted. It's inefficient for each company to create its own computing infrastructure. It leads to massively redundant investments and results in extraordinarily low levels of asset utilization."

Many IT professional and practitioners believe that as technology becomes more and more widely available, it is increasingly going to be how companies make use of their technology that holds the potential for competitive advantage. How they adapt their organizations and business processes to make the best use of technology will be what separates the winners from the losers.

Nevo and Wade (Nevo & Wade, 2010), say most business value of IT research to-date has focused on Information System (IS) resources and capabilities rather than IT assets, which firms must purchase and justify from a cost–benefit standpoint. In part, this scholarly attention was a natural response to works that labeled IT assets as non-strategic or even went so far as to claim that IT does not matter. They instead argue that IT assets derive their business value from the impact they make on the organizational resources (e.g., a customer service department) with which they interact. Thus, the intrinsic capabilities of the IT assets should not be used, or used to a lesser extent, to infer their business value; instead, the emergent capabilities arising from their relationships with organizational resources should be examined and evaluated."

According to Barua, Mani, and Mukherjee (Barua, et.al., 2010), "despite the incredible sums of money that businesses around the world invest in Information Technology, the direct correlation between those investments and the financial performance of the business has eluded senior decision makers." Their study of over 150 Fortune 1000 firms clearly shows that small and even marginal investments in information technology (such as effective and quality data) can have a large positive impact on key financial measures. Based on their findings, the slight investment in IT can increase the return on Equity (ROE) of the average Fortune 1000 by 16%, the Return on Invested Capital (ROIC) by 1.4%, resulting in net income increase of $5.4 million, and the Return on Asset (ROA) by 0.7%, resulting in additional income of $2.87 million. Their study also reveals that in addition to the positive effect the IT investment can have on financial measures, information technology investment can increase employees' productivity, can help the business to grow and innovate, and provide for better planning and forecasting.

MOTIVATION

As indicated earlier that Nicholas Carr's reasoning is similar to what took place a century ago with electricity, when utility companies centralized power generation in big utilities, and they were able to distribute electricity over a network of electrical grid systems. At first, many electric producing/providing companies resisted the change, but lower costs, freed-up capital, more flexibility, and fewer problems made even the larger companies to change their strategies and switch. This transformation helped smaller companies accessed the electricity over the public electrical grid and sell it to their customers. Further, it is hypothesized that over time, centralizing control over the basic IT infrastructure will ultimately increase the level of security and make network grid more reliable, which in turn make the utility model much more successful.

On the other hand Robert M. Metcalfe (Metcalfe, 2004), views IT investment as a source of competitive advantage and determines a path of sustainable excellence for a corporation. Obviously, Carr and Metcalfe are at extreme polar opposites.

We believe that, like any heated debate, the truth may lie in the blend of both views. In this paper, we are motivated to find out whether the reality supports IT as a strategic asset or as infrastructural assets in the supply chain industry, or both. In case of both, it will indicate that there is an optimal level investment in IT as a strategic asset beyond which it will cease to be a strategic asset.

IT as a Strategic Asset – The Case of S&OP

In our previous research, we got mixed results when we applied this approach to Financial Industry and concluded that generally, the level of IT expenditure was not an influential variable on the financial services, however, it leaned more towards the Metcalfe's views of IT as a strategic asset with long term implications. We used multiple regressions to analyze the relationship between IT investments, high or low level of investment and Unexploited Profit Opportunities. Our results indicate that there is optimality of IT investments in financial arbitrage. We have found the amount of money spent on IT by itself is not an influential factor but IT investments offer more room for creativity and innovation that will affect the financial services.

Sales and operations planning (S&OP) is defined by Wikipedia as an integrated business management process developed in the 1980s by Richard Ling (Ling, 1992). Through this process the executive/leadership team continually achieves focus, alignment and synchronization among all functions of the organization. According to Kumar et al (Kumar, et.al., 2014), Ptak and Smith (Ptak & Smith, 2011), Dougherty (Dougherty, 2000), and Wallace (Wallace, 2006), "The S&OP planning includes an updated forecast that leads to a sales plan, inventory plan, production plan, customer lead time (backlog) plan, new product development plan, strategic initiative plan and resulting financial plan. Plan frequency and planning horizon depend on the specifics of the industry. Short product life cycles and high demand volatility require a tighter S&OP planning than steadily consumed products. Done well, the S&OP process also enables effective supply chain management. A properly implemented S&OP process routinely reviews customer demand and supply resources and "re-plans" quantitatively across an agreed

rolling horizon. The re-planning process focuses on changes from the previously agreed sales and operations plan, while it helps the management team to understand how the company achieved its current level of performance, its primary focus is on future actions and anticipated results."

APICS Dictionary, 14th edition defines S&OP as "A process to develop tactical plans that provide management the ability to strategically direct its businesses to achieve competitive advantage on a continuous basis by integrating customer-focused marketing plans for new and existing products with the management of the supply chain. The process brings together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans."

APICS - 2011 Sales and Operations Planning Practices and Challenges

- Lack of strategic coordination among departments - 58%
- Insufficient interaction and involvement among groups - 58%
- Lack of common vision or purpose - 51%
- Lack of commitment from top management - 49%
- Lack of technology and belief in existing business systems - 42%
- Inadequate communication and soft skills - 37%
- Insufficient training or skill in data analysis - 33%

Benefits of S&OP

- Improved Return on Assets
- Improved Gross Profit Margins
- Improved Service Level
- Improved Cash to Cash Cycles
- Improved Forecast Accuracy
- Improved Firm's value

Factors that Affect an Effective S&OP Implementation

According to Larry Lapide (Lapide, 2002, 2004a, 2004b, 2005), research director at MIT center for logistics, "companies spends significant sum of money on S&OP related software applications every year but with little or no expected benefits because they fail to change the process to fully leverage the enabling technology that is needed for building an effective S&OP.

He believes software technology by itself is not very useful, unless it is used to improve the business process. And often, without technology S&OP is cumbersome and cannot support the scale needed to achieve all its benefits. In that case technology becomes necessary but not sufficient.

Practitioners' View on IT Investment in S&OP

We asked CIOs of some midsize firms who implement IT investments in S&OP about the importance of IT investments. Here is their take on it. The following chart describes S&OP at a glance in terms of demand and inventory planning in meeting with the challenges and opportunities.

The typical CapEx is between 20% and 30% of total IT budget/Spend. The CapEx is always an investment in IT world. In general, the total IT CapEx is anywhere between (.5% and .75%) as % of total Revenue and as mentioned above is between 20% and 30% of total IT budget/Spend. These statistics vary from industry to industry. The statistics mentioned here relate to CPG manufacturing industry. Finally, IT OpEx (Operating Expense) plus CapEx (Capital expense) is in between .9% and 1.9% based on Gartner report.

It looks practitioners' view support Metcalfe's point. However, it may be similar to dividend puzzle where we know that practitioners pay dividends yet there are views that dividend payment does not matter. Keeping that in mind, can we say that even when the practitioners make IT investment in S&OP, it may not matter? Thus, clear answer will be sought in data analysis.

Implications of IT in S&OP

The implication of the IT in the above processes is the integration of business processes. Organizations are recognizing the need to develop analytic capabilities that turn data into actionable insights in order to attain a competitive edge and growth. IT is supposed to help solve complex global business problems they are facing globally and across all industries. According to Simchi-Levi et al (Simchi-Levi, et. Al., 2014) technology is supposed to help at three different levels:

1) Strategic – Identifies exposure to risk associated with parts and suppliers, prioritize and allocate resources effectively, develop mitigation strategies, and identify opportunities to reduce risk mitigation cost. Strategic IT allocation starts with a target asset mix based on an S&OP's expected rate of return and risk tolerance, and the long-term performance of different processes. IT Investment portfolios are periodically rebalanced to restore the target asset mix. In other words, rebalancing is done to restore a long-term target, not to respond to market conditions.
2) Tactical: Monitor changes in risk exposure on a daily or weekly basis. Tactical IT allocation involves actively looking for short- and intermediate-term undervalued and overvalued IT assets and moving between IT asset classes to take advantage of these market inefficiencies. Tactical IT asset allocation relies on the fact that markets sometimes tend to overreact and undervalue technology companies, which could represent a good buying opportunity.
3) Operational: Identifies an effective way to allocate resources after a disruption.

This paper will test these advantages through empirical analysis in the light of the general debate about whether IT matters in case of supply chain management.

DATA, METHODOLOGY AND EMPIRICAL FINDINGS

Data and Methodology

We have used Yahoo Finance and NASDAQ.com to obtain information about companies' stock prices and financial statements and key financial ratios. Besides using each company's website, we also used the following sources to obtain the sample companies annual reports, 10Q's: SEC.gov, NASDAQ.com, and AnnualReports.com. Our data was hand collected to test the hypotheses, ANOVA and regression analyses. We went as far back as 1985 to make sure we have not missed any key information about the company's financials and S&OP investment. In order to investigate whether investment in the S&OP technology has an impact on firm's value represented by stock price, we perform an event study around the S&OP technology investment date/s. To that end this paper will investigate the impact of IT investment on stock prices, cumulative abnormal returns and free cash flow using standard event study methodology. Further, it will explore fundamental relationship between IT event in S&OP industry using correlation and regression analysis.

Results

Hypothesis 1

H_0: *S&OP event does not have an impact on the firm's value*

H_a: *S&OP event has an impact on the firm's value*

First, we used the "t" test of hypothesis testing to see if the event (technology investment in S&OP) had any positive impact on the firm's value (stock price). Our analysis, using the significance level of 5% (***$\alpha \leq .05$***), revealed that the technology investment in S&OP had shown positive impact on the stock price of only 9 of the companies in the sample. As a result we concluded that the first hypothesis was partially true and about 35% of the companies in the sample showed the S&OP as having an impact (I) on the firms' value and about 65% of the companies showed that the investment had no impact (NI) at all or a very minimal impact (p value was very close to the significance level of 5%) on the firms' value. For the results please look at Table 1 below.

TABLE 1
RESULTS OF THE "T" TEST TO INVESTIGATE THE IMPACT OF S&OP ON THE FIRM'S VALUE

Firm	***P-value***	***Conclusions ($\alpha \leq .05$)***	***Firm***	***P-value***	***Conclusions ($\alpha \leq .05$)***
SANOFI	.097	No Impact (NI)	DIAGEO	.528	NI
BASF	.026	Impact (I)	LIGHTING SCIENCE	.0098	I
WS ATKINS	.49	NI	SINOPHARM	.01	I
MOHAWK IND.	.045	I	HASBRO	.009	I
CBI	.95	NI	POST	.514	NI
SIGMA IND.	.06	NI	CARLISLE IND	.702	NI
UTC FIRE	.035	I	ANRITSU	.019	I
OLYMPUS	.164	NI	NETGEAR	.884	NI
LENNOX	.385	NI	SAMSONITE	.05	I
GENERAC	.001	I	REDDY ICE	1	NI
UNICHARM	.598	NI	BOART	.422	NI
MASIMO	.085	NI	ARCA	.181	NI
MICHELIN	.765	NI			

Hypothesis 2
H_0: *There are not any cumulative abnormal returns within the event windows.*
H_a: *There are cumulative abnormal returns within the event windows.*

Second, we have used the "t" test of hypothesis testing to investigate whether or not there were any cumulative abnormal returns within the S&OP event windows. Our analysis, using the significance level of 5% ($\alpha \leq .05$), revealed that 17 of the companies in the sample had the p-value of lower than the significance level of 5% which proved that the technology investment in S&OP to have significant impact on the cumulative abnormal returns. As the result we concluded the second hypothesis was true and there were cumulative abnormal returns within the S&OP event windows for the majority (about 70%) of the sample companies in the study. However, the test results also revealed that a few companies, roughly 30%, of the sample companies (with p-value more than the significance level of 5%) showing the S&OP event had no impact (NI) on the Cumulative Abnormal Returns. The results are in Table 2 below.

TABLE 2
RESULTS OF "T" TEST TO INVESTIGATE CUMULATIVE ABNORMAL RETURNS WITHIN THE S&OP EVENT WINDOWS

Firm	*P-value*	*Conclusions ($\alpha \leq .05$)*	*Firm*	*P-value*	*Conclusions ($\alpha \leq .05$*
SANOFI	<. 01	Impact	DIAGEO	.40	NI
BASF	.40	No Impact	LIGHT SCIEN	<. 01	I
WS ATKINS	.02	I	SINOPHARM	<. 01	I
MOHAWK IND.	<. 01	I	HASBRO	.40	NI
CBI	<. 01	I	POST	<. 01	I
SIGMA IND.	<. 01	I	CARLISLE IND	<. 01	I
UTC FIRE	.02	I	ANRITSU	<. 01	I
OLYMPUS	<. 01	I	NETGEAR	.05 - .06	NI
LENNOX	.40	NI	SAMSONITE	.02	I
GENERAC	<. 01	I	REDDY ICE	.05 - .06	NI
UNICHARM	<. 01	I	BOART	.11	NI
MASIMO	<. 01	I	ARCA	<. 01	I
MICHELIN	.20	NI			

Third, we have used the Pearson correlation coefficient to see if there was any positive relationship between the firm's value and the company's technology investment in the S&OP. Our study for the sample companies showed about 50% of the companies with no or negative correlation and the other 50% of the companies showed otherwise (strong $S > 0.75$, moderate $0.51 \leq M \leq .74$, & weak $W \leq 0.50$). Please refer to Table 3.

TABLE 3
RESULTS OF PEARSON CORRELATION TO INVESTIGATE THE RELATIONSHIP BETWEEN S&OP AND FIRM'S VALUE

Firm	*Correlation*	*S > 0.75; 0.51 ≤ M ≤, & W ≤ 0.50*
SANOFI	.84	Strong (S)
BASF	.35	Weak (W)
WS ATKINS	-.08	No (No correlation)
MOHAWK IND.	.85	S
CBI	.03	No
SIGMA IND.	.83	S
UTC FIRE	.84	S
OLYMPUS	-.73	No
LENNOX	.48	W
GENERAC	-.98	No
UNICHARM	-.27	No
MASIMO	.75	S
MICHELIN	.16	W
DIAGEO	.35	W
LIGHTING SCIENCE	.98	S
SINOPHARM	-.98	N
HASBRO	.92	S
POST	.35	W
CARLISLE IND	.21	W
ANRITSU	-.915	N
NETGEAR	-.077	N
SAMSONITE	-.84	N
REDDY ICE	0	N
BOART	-.45	N
ARCA	-.71	N

Fourth, we have used the "t" test of hypothesis testing to see if the event (Newly Implemented S&OP) had any immediate impact on the firm's Free Cash Flow (FCF).

Hypothesis 3
H_0: μ *"FCF - Newly Implemented S&OP" =* ***μ*** *"FCF – Not Implemented S&OP"*
H_a: μ *"FCF - Newly Implemented S&OP" ≠* ***μ*** *"FCF – Not Implemented S&OP"*

The test showed that with the p-value of .93, using the significance level of 5% (***$\alpha \leq .05$***), the null hypothesis (H_0) was true and the "Mean FCF - Newly Implemented S&OP" was not significantly different from the "Mean FCF - Not Implemented S&OP". Our conclusion is that the technology investment in S & OP had no immediate impact on the firm's Free Cash Flow. The findings are in Table 4.

TABLE 4
RESULTS OF "T" TEST TO INVESTIGATE THE IMPACT OF NEWLY IMPLEMENTED S&OP ON FIRM'S FCF

t-Test: Two-Sample Assuming Unequal Variances	FCF - Newly Implemented S&OP	FCF – Not Implemented S&OP
Mean	1,192,581,109	1,149,112,779
Variance	4.10 E+18	3.40 E+18
Observations	31	31
Hypothesized Mean Difference	0	
df	60	
t stat	0.09	
P(T<=t) one-tail	0.46	
t Critical one-tail	1.67	
P(T<=t) two-tail	0.93	
t Critical two-tail	2.00	

Fifth, we have used the "t" test of hypothesis testing to see if the technology investment in S&OP had any positive impact on the firm's Free Cash Flow (FCF) at least 1 year after implementing S&OP.

Hypothesis 4
H0: $\boldsymbol{\mu}$ *"FCF - Newly Implemented S&OP" =* $\boldsymbol{\mu}$ *"FCF – At least 1 year after Implemented S&OP"*
Ha: $\boldsymbol{\mu}$ *"FCF - Newly Implemented S&OP"* $\neq$ $\boldsymbol{\mu}$ *"FCF – At least 1 year after Implemented S&OP"*

The test showed that with the p-value of .76, using the significance level of 5% ($\boldsymbol{\alpha \leq .05}$), the null hypothesis ($H_0$) was true and the "Mean FCF - Newly Implemented S&OP" was not significantly different from the "Mean FCF - At least 1 year after Implemented S&OP". Our conclusion was that the technology investment in S&OP had no impact on the firm's Free Cash Flow (FCF) even at least 1 year after implementing S&OP. For the results, please refer to Table 5.

TABLE 5
RESULT "T" TEST TO INVESTIGATE THE IMPACT OF S&OP ON FIRM'S FCF AT LEAST 1 YEAR AFTER IMPLEMENTED

t-Test: Two-Sample Assuming Unequal Variances	FCF - Newly Implemented S&OP	FCF – At least 1 year after Implemented S&OP
Mean	1,192,581,109	1,372,114,674
Variance	4.10 E+18	6.61 E+18
Observations	31	31
Hypothesized Mean Difference	0	
df	57	
t stat	-0.30	
P(T<=t) one-tail	0.38	
t Critical one-tail	1.67	
P(T<=t) two-tail	0.76	
t Critical two-tail	2.00	

Sixth, the one-way analysis of variance (ANOVA) was used to determine whether there are any statistically significant differences between the "Mean FCF - Newly Implemented S&OP", "Mean FCF – At least 1 year after Implemented S&OP", and the "Mean FCF – Not Implemented S&OP".

Hypothesis 5
H0: $\boldsymbol{\mu}$ *"FCF - Newly Implemented S&OP" =* $\boldsymbol{\mu}$ *"FCF – At least 1 year after Implemented S&OP" =* $\boldsymbol{\mu}$ *"FCF – Not Implemented S&OP"*
Ha: $\boldsymbol{\mu}$ *"FCF - Newly Implemented S&OP"* $\neq$ $\boldsymbol{\mu}$ *"FCF – At least 1 year after Implemented S&OP"* $\neq$ $\boldsymbol{\mu}$ *"FCF – Not Implemented S&OP"*

The ANOVA test showed that with the p-value of .91, using the significance level of 5% ($\boldsymbol{\alpha \leq .05}$), the null hypothesis ($H_0$) was true and the "Mean FCF - Newly Implemented S&OP" was not significantly different from the "Mean FCF – At least 1 year after Implemented S&OP" and the "Mean FCF – Not Implemented S&OP". Our conclusion was that the technology investment in S&OP had no impact on the firm's Free Cash Flow (FCF) neither immediately nor even at least 1 year after implementing S&OP. The Table 6 illustrates the findings.

TABLE 6
RESULTS OF THE ANOVA

ANOVA: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
FCF – Not Implemented S&OP	31	3.56E+10	1.15E+09	3.47E+18		
FCF - Newly Implemented S&OP	31	3.70E+10	1.19E+09	4.10E+09		
FCF – At least 1 year after Implemented S&OP	31	4.25E+10	1.37E+09	6.61E+18		
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8.66E+17	2	4.33E+17	0.09	0.91	3.10
Within Groups	4.26E+20	90	4.73E+18			
Total	4.27E+20	92				

Finally, using the significance level of 5% ($\boldsymbol{\alpha \leq .05}$), we have used the multiple regressions analysis to learn more about the relationship between the dependent variable (FCF- At least 1 year after Implemented S&OP) versus independent variables (FCF - Newly Implemented S&OP, FCF- Not Implemented S&OP, and Technology) to see if technology investment in S&OP was a relevant factor or not. See Table 7 below.

TABLE 7
REGRESSION ANALYSIS TO INVESTIGATE TECHNOLOGY INVESTMENT ON S&OP AS RELEVANT FACTOR ON FCF

SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.95					
R Square	0.91					
Adjusted R Square	.90					
Standard Error	81.67E+7					
Observations	31					
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	3	1.8E+20	6.01E+19	90.12	3.5E-14	
Residual	27	1.8E+19	6.67E+17			
Total	30					
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	1,034,981.87	218,893,602.8	0.00	0.99	-448,097,592	450,167,556
FCF – Not Implemented S&OP	0.30	0.26	1.13	0.27	-0.4	0.85
FCF - Newly Implemented S&OP	0.97	0.24	3.98	0.00	0.47	1.47
Technology	-244,125,094	337,526,383	-0.72	0.47	-936,672,025	44,81,421,837
FCF = Free Cash Flow						

Regression Analysis

Regression Equation - Categorical predictor coding (1, 0)

Technology (1 = high spenders who have invested more than $100,000,000 of their capital expenditures on technology)

FCF – At least 1 year after Implemented S&OP = Y
FCF - Newly Implemented S&OP = X_1
FCF – Not Implemented S&OP = X_2

0.00 $Y = 1{,}034{,}982 + 0.97\ X_1 + 0.302\ X_2$ (1)

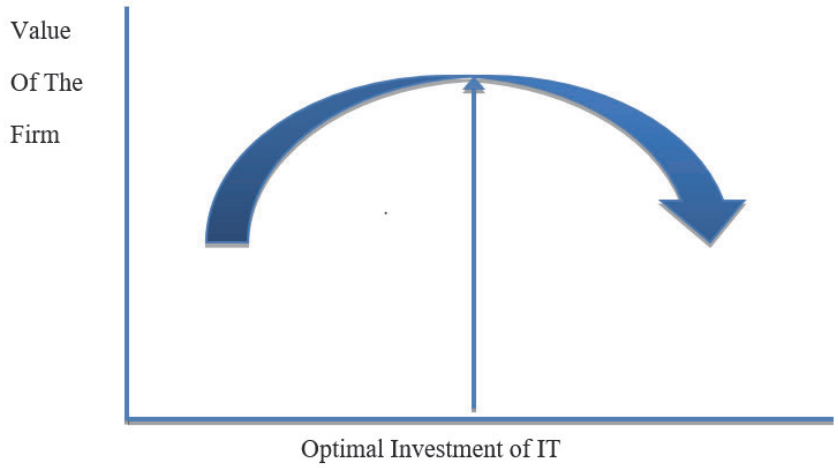
1.00 $Y = -243{,}090{,}112 + 0.97\ X_1 + 0.30\ X_2$ (2)

Our findings seem to be inconclusive at first as our first hypothesis suggests that IT does not matter to S&OP and second hypothesis contradicts the first one and suggest that IT really does matter with a very strong impact for some of the firms in our sample. However, we believe that the implications of our findings would suggest there is an optimal IT level. At the beginning stage the strategic benefits from IT

may far exceeds the risk of IT. At some point the role may reverse and risk and misutilization of IT investment may outweigh the independent and interactive strategic benefits of IT. And as such the Impact of IT on S&OP should be a 2 step process, the first step is to measure the creativity and innovation impact of IT and second step is to investigate how supply chain management processes impacted by the result of step 1.

Our results indicate that there is optimality of IT investments. The following graph explains it well, and the optimal level will maximize the value of the firm

FIGURE 1
OPTIMALITY OF IT INVESTMENTS



CONCLUDING REMARKS

In the introduction we posited that truth might lie in the middle. That is, it is neither 'IT does not matter at all' nor it is 'IT matters all the time'. Our empirical findings indicate such a result when we linked S&OP and IT investment. Our data show that IT investment matters sometime and not always. The implications of our findings suggest that there is an optimal IT investment level. At the beginning stage, the strategic benefits from IT investments far exceed the risk of IT investments. At some point the obverse happens and the risk and misutilization of IT investments outweigh the independent and interactive strategic benefits of IT. The challenge for future research is to clarify and determine the optimal level of IT investments in S&OP.

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