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# Two Studies on The Use of Information Technology in Collaborative Planning, Forecasting & Replenishment (CPFR)

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# TWO STUDIES ON THE USE OF INFORMATION TECHNOLOGY IN COLLABORATIVE PLANNING, FORECASTING & REPLENISHMENT (CPFR)

By

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## ABSTRACT

Two Studies on the Use of Information Technology in Collaborative Planning, Forecasting & Replenishment (CPFR)

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In the 1st study, I seek to determine whether there are trends in the coverage of the use of Information Technology in CPFR in support of Supply Chain Management. I look at the way technology is studied along two dimensions. The first dimension is the function within CPFR—Planning, Forecasting or Replenishment. The second dimension is level at which the study addresses use of the technology, whether at the Operational, Tactical or Strategic level. Within this 3x3 matrix, I seek to prove that studies would primarily fall along a line where the higher the level functions should be served by systems which have a longer-term orientation. This was broadly true, along with an emphasis on studies at the strategic level. Additionally, I find an underrepresentation of Forecasting, especially at the strategic level.

The 2nd study seeks to determine the factors affecting IT system use for CPFR, in the real world. I examine the factors affecting system use along two dimensions.

The first is along the company-level dimension. There are 3 points along the company-level dimension, defined as follows. Strategic use is defined as use by upper level management who are interested in the long term view of the organization and its processes and products. The Tactical use of IT for CPFR includes use by middle

managers at a departmental level for medium term decision making. Operational level IT use covers functions which directly affect individual customers and keep the business running day to day.

The second dimension along which system use is examined, is the functional-dimension. There are 3 points along this dimension and they are defined as follows. Use of IT for Planning, based on the VICS standard, is usually, but not exclusively under the purview of senior managers to determine what products to manufacture and the features they should have. Forecasting is done mainly by middle-managers in order to move enough products at the right time, to the right paces, while avoiding over-stocking each product. The Replenishment function is the actual process of moving items to the customer as they are ordered on-line or bought from the shelf. This is typically the job of operational logistics personnel such as purchasing and, shipping and delivery, as well as front-line staff such as customer service, shop-floor attendants or cashiers who interface directly with customers.

In examining real world IT use for CPFR, I build on Simmonds, Haines & Li (2013) which looks at the trends and gaps in the IT literature as far as use of IT in CPFR was concerned. The aim is to determine whether the literature lines up with reality, or whether researchers are inherently biased when studying how Information Technology is used to support CPFR. A survey instrument was sent to 4000 senior managers in manufacturing and distribution companies.

IT use along the STO dimension (Haines, Hough, & Haines, 2010) and its relationship with Industry characteristics (clock-speed of the industry and technological orientation) will be investigated in the context of the Technology Acceptance Model (TAM) (Fred D.

Davis, 1989). Product factors (such as demand variability & luxury nature of the product) which drive IT use (Attaran & Attaran, 2007) along the PFR dimension will be investigated in the context of Technology Task Fit Theory (Goodhue & Thompson, 1995). Intra-firm trust (Frazier, Johnson, Gavin, Gooty, & Bradley Snow, 2010) and its effect on use on the PFR dimension, will be looked at with managerial influence within Innovation Diffusion theory (Rogers, 2010) as a basis. Trust issues including confidence of management in competence of workers and confidence of employees in dependability of IT.

Members of Dissertation Committee: Ling Xia Li

M. Lance Frazier

This dissertation is dedicated to Lascelles John Simmonds & Alda McCaw who are no longer with us. And my brothers and sisters who raised me to be self-aware.

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# STUDY 1: USE OF INFORMATION TECHNOLOGY IN COLLABORATIVE PLANNING, FORECASTING & REPLENISHMENT (CPFR) - SUMMARY AND PATTERNS OF THE LITERATURE

## INTRODUCTION

In selecting studies on the use of IT in CPFR, Journals were chosen by scanning the Reference list for Papers (L. Li, 2012) and (L. Li, Ford, Zhai, & Xu, 2011). Five categories of journals were searched, including mainstream journals on Information Technology, Supply Chain Management and Operations Research. These journals were searched because a scan of highly cited literature on CPFR and SCM in were identified to come from these areas. Management as well as Marketing literature were also scanned in order to be exhaustive since a few SCM (though not CPFR) studies were noted to have come from these areas as well.

In order to narrow the search by journal, the Google Scholar advanced search was used and this allowed us to narrow our search to one journal at a time. The advantage of Google Scholar is that it ranks articles by citations and author as well in addition to relevance to the search term. For example, by searching for Information Systems, Google Scholar draws on the intelligence of Google Search technology to also search for Information Technology as a synonym. The term Information System was used instead of Information Technology since it is a more commonly used term and captures a wider range of IT use. To ensure the accuracy of the search, several Journals were used to test whether IT results would be capture in an IS search. When the ACM was searched, the use of either term (IS or IT) turned up the exact same 9 results, albeit in slightly different

order. Of note is that fact that the term “Information System” appeared in sequence all 9 times whereas “Information Technology” appeared in sequence only once. Similar results were obtained with International Journal of Production Economics (see below).

**The Studies**

To ensure completeness of the search results, I also compared the results of a Google Scholar search with ODU Library Database Searching for:

Decision Support Systems: (Same 4 + 1 study that the database did not turn up – unable to determine why).

ACM: (Picked up the same 9, but Google Scholar did not pick up 7 conference proceedings papers which were published by the ACM and included in the ACM Digital library).

Decision Sciences: (same 9 plus an extra irrelevant article which was in picked up in the Database because CPFR was mentioned in an author’s areas of expertise).

MIS Quarterly: (1 found in Google Scholar but none in the Database).

International Journal of Production Economics (52 in the journal, 47 in Google Scholar. Of the top 20, 19 matched. Only 1 was missing from Google Scholar, but CPFR only appeared twice in the article, starting on page 10 and the mentions were incidental to the topic). Using the term “Information Technology” instead of Information System reduced the search results to 45 with the same results identified (16 out of 20 matches).

In all, 102 articles were identified as dealing with a topic heavily related to Collaborative use of IT in CPFR or a related area such as Logistics (Replenishment). 89 articles were selected for review. The other studies were left out since they were not primarily IT based, were conceptual on nature or dealt with use of IT in an area that was only remotely

related to CPFR. In reality, many were only partially related to CPFR, looking at such topics as IT in collaborative logistics, Internet use in general Supply Chain and Technology use in product development along supply chains. But they were included so as to err on the side of completeness, preferring Recall over Precision (Zhu & Wu, 2011). Strategic use of IT across the Enterprise was covered by 53 studies, or 60%. This of course makes sense, since CPFR is a cross-organization effort, described by (L. Li, 2007, p. 19) as collaborative activities which are undertaken jointly by partners in a supply chain. The Tactical use of IT accounted for another 26 studies or 29% of the population). 10% of the studies on IT use were at the Operational level. These studies look at the implementation of specific functions.

Aside from the level of organizational use, the other logical dimension along which to categorize the use of IT in CPFR is the function of CPFR. The points along this dimension include planning use - the lion's share with 43 studies or 48% which included general collaborative planning amongst supply chain partners, Forecasting studies account for another 17 studies or 19% while Replenishment studies the surprising second place by function, covering ordering, procurement, and inventory management & warehousing in the studies accounted for 29 studies or 33%. It is important to point out that some technologies were repeated across several organization levels since they were studied in the context of multiple uses within organizations. Our study does not attempt to categorize where a technology used in an organization, but whether it is used.

The technologies identified in the Strategic level included: company-wide packages such as ERP, DSS, CRM, EIS, Supply Chain-Wide systems such as Supply Chain Management Systems, Electronic Marketplaces, Information Sharing /Exchange,

RosettaNet. Strategic systems also included analytical IS like Business Process Management, Business Intelligence/Data-Warehousing Systems and Knowledge Management systems as well.

**Strategic**

The technologies identified in the Strategic level included: company-wide packages such as ERP, DSS, CRM, EIS, Supply Chain-Wide systems such as Supply Chain Management Systems, Electronic Marketplaces, Information Sharing/Exchange, RosettaNet. Strategic systems also included analytical IS like Business Process Management, Business Intelligence/Data-Warehousing Systems and Knowledge Management systems as well.

**Strategic level Planning**

A typical study in this area included L. Li (2012) who studied Enterprise IT to determine the effect of IT on performance & relationship to ownership which achieves market & operational performance. (Rai, Patnayakuni, & Seth, 2006) examined Supply Chain Management (Process Integration) to produce a performance research model for investigating firm performance & revenue growth. (Barratt & Oliveira, 2001) examined Enterprise IT (SAP), POS & Data Modeling to produce a framework for CPFR implementation effectiveness while Skjoett-Larsen, Thernøe, and Andresen (2003) looked at Information Exchange Mechanisms and Business Process Management to produce a framework for analyzing collaboration. Danese (2007) looked at Electronic Marketplaces to produce an analysis of systems implementation rationale. Cassivi (2006) examined Enterprise IT to determine the role of IT tools in CPFR. (Disney, Naim, & Potter, 2004) looked at Business Process Modeling (z-transform analysis and Beer game)

to produce models for e-business impact

Other studies included Yu, Yan, and Cheng (2001) who examined Information Exchange & Sharing Mechanisms to produce optimal inventory policies which achieves reduced inventory levels. (Xu, 2010) examined Enterprise IT (EIS), SOA, RFID, Agent & Workflow Management to produce an information architecture to survey technologies used in CPFR. Grover and Kohli (2012) studied relationship-specific assets, knowledge-sharing routines, complementary resources and capabilities to produce a value creation theory. Kim, Cavusgil, & Calantone (2006) studied Supply Chain communication Systems (SCCS) and RBV to produce a performance measurement for Supply Chain performance. Danese, Romano & Vinelli (2004) looked at Supply Chain Management (SCM) Systems & Inter-firm coordination to produce a theoretical framework. (Danese, 2011) examined Collaboration level & multiplicity (of collaborators) to discover factors in choosing collaboration partners. (Danese, 2006) studied Web (email) and Fax to determine the CPFR & IT implementation differences which show how managerial choice affects CPFR implementation. (Markus & Christiaanse, 2003) examined Electronic Marketplaces vs. B2B to produce a comparative theory of collaborative marketplaces. (McLaren, Head, & Yuan, 2004) looked at Supply Chain Management (SCM), IS competitive strategy & Inter-organizational IT to produce a model of IT capabilities which achieves operational efficiency, operational flexibility, internal planning and analysis. (Bhakoo, Singh, & Sohal, 2012) studied Enterprise IT to produce a list of factors affecting CPFR arrangements (e.g. compatible IS). (Plomp & Batenburg, 2010) studied Supply Chain Management (SCM) Systems to produce a measure for the level of ICT maturity in collaboration/integration to facilitate a roadmap for Supply

Chain digitization. (Davis & Golicic, 2010) looked at Information Exchange & Sharing and Business Process Management to produce a model for performance. Wang and Archer (2004) studied Electronic Marketplaces to produce a framework for collaboration. (Shaw, Meixell, & Tuggle, 2003) examined Knowledge Management and parts promotions to determine the effect of Knowledge Management on CPFR to achieve Supply Chain performance. (E. Lefebvre, Cassivi, Lefebvre, & Léger, 2003) studied Web (e-collaboration tools) to do an assessment of IT based on supply chain position) that supports efficiency & innovation. (Wietrzyk, Wietrzyk, & Grosky, 2005) studied Electronic Marketplaces, e-business, EDI and RosettaNet to produce an architecture of electronic marketplaces which achieves visibility & disruption handling. (L. A. Lefebvre, Cassivi, & Lefebvre, 2001) looked at Enterprise IT, Data warehousing & Groupware to produce an e-commerce Transition Model that supports matching of e-commerce solutions with business needs. (B. Chen, Ip, & Li, 2006) looked at Enterprise IT (SAP & Manugistics) to determine the relationship of CPFR to the enterprise & external actors. (Shu, Chen, Lai, Xie, & Wang, 2006) examined Business Process Management and Information Exchange to produce implementation conditions for AVE-based CPFR which achieves flexibility and market adaptability. (Gelinas & Markus, 2005) examined Supply Chain Management (SCM) Systems to produce a conceptualization of IT in CPFR in order to generate insights on IT use in CPFR. (Tavassoli, Sardashti, & Toussi, 2009) studied Enterprise IT, OPT & Logistics Systems to produce a classification of IT use toward an overview of IT usage (de Paula, Oliveira, de Souza, & Strauch, 2004) looked at Knowledge Management, XML and CSCW to produce a Custom Design Framework which achieves increased customization. (Cassivi, Lefebvre, & Lefebvre,

2000) looked at Electronic Marketplaces to produce a CPFR & IT framework. (Q. Zhang & Liu, 2008) studied Information Sharing and Coordination Mechanism to produce models of information sharing that support improved service quality & cost and reduced lead time. (Chang, Chiang, & Pai, 2012) studied Product Development Systems to produce a cooperative strategy. (Fang & Meng, 2009) examined Information Sharing and Information Flows to produce a tiered model of collaborative structure. (Khan, Silva, & Kandl, 2012) examined Business Process Management (Process Visualization) to effect real time monitoring.

**Strategic level Forecasting**

A typical study in this area included (Zhao & Xie, 2002) who looked at Simulation to produce a model for Information sharing which improves Forecasting. (Viswanathan, Widiarta, & Piplani, 2007) used Simulation of Information Exchange Mechanism to produce a simulation of 4-echelon supply chain which achieves inventory management & cost control.

Other studies included (Valéra, Lagacé, & Bergeron, 2010) who examined Supply Chain Operations Reference (SCOR) model to produce an Inter-Organizational Information System (IOIS) implementation which achieves improved Supply Chain performance & reduced lead time. (Zhou & Hu, 2008) studied Enterprise IT IOIS, POS & EFT to produce information sharing models. (Chan, Chung, & Wadhwa, 2004) studied Genetic Algorithms to produce multi-criteria genetic optimization.

**Strategic Level Replenishment**

Typical studies in this area included (Olorunniwo & Li, 2010) studied Enterprise IT, Internet, Logistics Systems, EDI, RFID, Communication Technologies & Bar Code

Warehouse systems to determine the impact of IT (EDI & RFID) on performance which achieves Supply Chain performance. (Disney & Towill, 2006) studied Enterprise IS, Ordering System Pipeline & Production systems (APIOBPCS) to produce a DSS Design which achieves reduction of Bullwhip Effect & inventory-variance.

Other studies included (Dedrick, Xu, & Zhu, 2008) studied Procurement Systems to produce a theory of relationship between e-procurement and number of suppliers. (Ellram & Zsidisin, 2002) looked at Enterprise IT, EDI & Internet to determine the factors in se of IT which lead to cost reduction. (Muylle & Basu, 2008) examined Electronic Marketplaces (Electronic Intermediaries) to produce a process support framework in EIMs which achieves performance. (Bendavid, Lefebvre, Lefebvre, & Wamba, 2007) looked at RFID to determine Key Performance Indicators. Charalampos and Chang (2008) examined Enterprise IT (CRM), CORBA, XML, J2EE & .NET to produce a framework for customer integration which achieves seamless linking of demand processes with supply processes. M. H. F. Zarandi, M. Pourakbar, and I. Turksen (2006) looked at Artificial Neural networks (back propagation) a Modified Hong Fuzzy Time Series to produce an Agent System which achieves order policy improvement. (Rabin, 2002) examined Web/Internet, EDI and XML to produce an Order Management Life Cycle Theory on IT in CPFR. (Chakraborty, Sehgal, & Pal, 2005) looked at Agents (Intelligent), Negotiation Protocols and Negotiation Process Model to produce privacy preserving algorithms which preserves the anonymity of negotiators and achieves optimal pricing. (Gialelis, Kalogeras, Kaklis, & Koubias, 2006) looked at RosettaNet and Web Services to produce a B2B infrastructure which achieves flexibility and efficiency. (Ronchi, 2011) examined Electronic Market Places, electronic auctions and electronic

catalogs to determine the effect of internet collaboration. (Zhongwen, 2010) studied Logistic Systems aimed at modeling IT support for CPFR in logistics.

**Tactical**

The Technologies which made up CPFR's Tactical IT use included: Procurement / Replenishment Systems, Forecasting Systems, Manufacturing Systems, Category Management Systems, Logistics systems and POS systems.

**Tactical-level Planning**

A typical study in this area included (Petersen, Ragatz, & Monczka, 2005) who studied EDI and e-requisitioning aimed at achieving planning effectiveness. (Pramatari, 2007) studied Web (Internet) technologies to outline the History of IT use in CPFR that supports practitioner choice.

Other studies included (Marien, 1999) who looked at Forecasting Software to produce a review of software. (Chai, Zhou, & Wang, 2008b) examined Collaborative manufacturing execution systems (CMES). (Tingbin, Lina, Yimin, & Fuquan, 2007) looked at Web Services, J2EE, SOAP, WSDL and XML to produce a system design for web-services integrated SCM. (Tong, Shou, Lai, Chi, & Shou-yan, 2006) studied Forecasting Systems to produce models for AVE CPFR integration which achieves market responsiveness.

**Tactical-level Forecasting**

A typical study in this area included (McCarthy & Golicic, 2002) who studied Forecasting Systems to produce guidelines for implementing forecasting which achieves increased product availability, reduced costs and improved earnings. (Caridi, Cigolini, & De Marco, 2005) examined Anonymous Agents and used Simulation to produce Multi-

Agent models which achieve decreased costs, inventory levels, stock-out levels and improved sales. (Rodriguez, Escoto, Bru, & Bas, 2008) studied Forecasting Systems to produce an implementation framework for CFM.

Other studies in this area included (T. Chang, H. Fu, W. Lee, Y. Lin, & H. Hsueh, 2007) examined Simulation, POS, MS-SQL Database and Procurement System to produce an A-CPFR model supporting reduced inventory and improved forecasting. (Ramanathan, 2012) looked at preparatory, progressive & futuristic Forecasting systems (Promocast, Chan4Cast) to produce a Reference Demand Model which achieves increased forecasting accuracy. (Lu, Humphreys, McIvor, & Maguire, 2009) examined Genetic Algorithms and Forecasting Systems (Moving Average) to produce Genetic Algorithms (GAs) which achieves optimal order policy. (Yan-fang & Xin-yue, 2007) studied Forecasting Systems including Time Series Analysis and Push-Pull Inventory Management) to produce a Quick Response Warehouse System. (L. Zhang, Wang, & Chang, 2008a) studied Artificial Neural Networks to produce a forecasting model which improved mid-term forecasting. (Suesut & Mongkhoin, 2004) looked at Automatic Warehousing to produce a Computer Integration Manufacturing System (CIMS) that leads to greater inventory Control. (Lo, Luong, & Marian, 2006) looked at Forecasting Systems, Contract Systems and AI to produce a conceptual Framework which achieves holistic forecasting.

**Tactical-level Replenishment**

A typical study in this area included (Stank, Daugherty, & Autry, 1999) who examined Replenishment Systems (Automatic Replenishment Programs) to model of the effect of IT on CPFR. (Rodrigues, Stantchev, Potter, Naim, & Whiteing, 2008) examined Inventory Systems to produce a supply chain uncertainty model which achieves

flexibility & responsiveness.

Other studies in this area included (Prajogo & Olhager, 2011) who examined Logistic Systems and Production Systems to produce a theory for the effect of Information Integration. (X. Du, S. Leung, J. Zhang, & K. Lai, 2009) studied POS and Procurement Systems to produce a n-tier procurement model that supports increased service levels & reduced inventory variance. (Pramatari & Miliotis, 2008) looked at Web systems, Ordering System, Store System and Replenishment System to produce a Collaborative Store Ordering System. (Cho & Ogwang, 2006) studied principal components variable selection strategy to produce a PMI series. (Liu, Ruan, & Venkatadri, 2009) studied RosettaNet, Web Services, composition rules and sharing process templates to produce a system architecture. (Yuan & Shon, 2008) studied Simulation and Transport Management to produce a Collaborative Transport Model (CTM).

**Operational**

At the operational/departmental level, there were systems such as Web/Internet systems, Groupware, Web Services / XML, EDI and RFID.

**Operational-level Planning**

One of the few studies in this area included (Fliedner, 2003) who examined Web (Internet) Tools to produce a CPFR implementation strategy.

Other studies included (Frayret, 2009) examined Agent Technology and Operations Research to produce a schema for classifying methodologies. (Z. Chen, 2009) looked at Agent Technology, Internet, XML and CORBA to produce a Distributed Production Planning System.

**Operational-level Forecasting**

The only study in this area was (Hou, 2007) who looked at GPS to produce a Cab-Link which achieves increased efficiency, speed & utilization of taxis.

**Operational-level Replenishment**

A typical study in this area included (Mason, Lalwani, & Boughton, 2007) who examined RFID, Telematics & Automatic Identification & Data Capture (AIDC) to determine the collaboration benefits which bring cost minimization & service level improvement. (E. Y. Li, Du, & Wong, 2007) used Simulation to produce replenishment models.

Other studies included (Sepehri, 2012) studied Grid Systems to produce an Ordering Model which supports reduction in costs. (J. J. Lyu, J. H. Ding, & P. S. Chen, 2010) examined Simulation to produce replenishment models. (Bhakoo & Chan, 2011) looked at Bar Coding and Electronic Messaging to produce an e-business implementation framework. (C. Zhang, Yu, & Liu, 2008) examined Web/Internet Systems to produce an ontology for ELMs. (Z. Li, He, Sim, & Chen, 2008) examined Graph Theory to produce a model of a 3-layer cross-docking system which supports lower inventory cost, maximized throughput and increased sorting capacity.

Findings

**General Gaps in the Literature**

Gaps exist in the literature at all levels with respect to the communication hardware that enables CPFR. One glaring gap is the use of mobile communication technology—specifically smartphones and tablet computers—used or potentially useful in various aspects of CPFR at the strategic, tactical and operational levels. The use of Smartphones needs to be studied for use in fine-tuning existing arrangements. At the Strategic level,

mobile computing should be studied as communication tool for fine-tuning the planning process. It will also be studied for used in the Replenishment process using maps relating to logistic routes and multimedia–pictures and videos in support of replenishment-related shelf space and shelf arrangement. Mobile computing use will also be studied at the tactical level related to the forecasting process in order improve the reliability of communications such as to track emails, manage contact lists, and make video calls related to the whole CPFR process. At the Operational levels, mobile computing is expected to be used to share information in Replenishment based on features such as GPS geo-location, pictures, delivery schedules-estimated and actual.

**Authorship**

The most prolific authors alternated between being 1st and 2nd author. Not surprisingly, these authors with multiple studies tend to stick to a particular box in the 3x3 matrix. And in the case of the most influential authors, their studies tend to fall into the Strategic planning box. These authors include Ling Li author of (L. Li, 2007) which is generally one of the most influential texts in SCM. Her study (L. Li, 2012) is on strategic use of IT for the planning function. This list also includes Danese (Danese et al., 2004), (Danese, 2006), (Danese, 2011); Cassivi (Cassivi et al., 2000), (E. Lefebvre et al., 2003), (L. A. Lefebvre et al., 2001) and Markus (Markus & Christiaanse, 2003), (Gelinas & Markus, 2005).

However there are variations to this "rule". For example Disney authored 2 studies, both at the strategic level, but (Disney et al., 2004) is on the planning function while (Disney & Towill, 2006) is on the replenishment function. Pramatari did 2 studies, both at the tactical level, (Pramatari, 2007) focused on the planning function and (Pramatari &

Miliotis, 2008) on the replenishment function.

Matrix of Studies

Below is a table showing what the distribution of studies looks like when placed in the 3x3 matrix of Strategic, Tactical & Operation VS. Planning, Forecasting & Replenishment.

[Insert Table-1 here]

**Distribution of studies in the Matrix**

Figure 1 shows there is an emphasis on strategic studies. In fact strategic planning, despite being just one of the 9 categories, comprises 35 studies or 39% of the total. It also shows that strategic use of IT is decidedly clustered in the planning function, compared to a much smoother climb toward strategy in the case of Replenishment.

[Insert Figure-2 here]

Figure 2 shows that for the planning function, there is a steep climb toward the strategic level, compared to a much smoother climb toward the strategic level in the case of Replenishment function.

## DISCUSSION & CONCLUSIONS

**Trends in the Matrix**

There are three trends in the systems discussed. One is a general conformance to the line which reflects the relationship I suspected: higher level functions go hand in hand with

systems having a longer-term function: studies have a demonstrated affinity for the buckets of Operational-Replenishment, Tactical-Forecasting, and Strategic-Planning. The other trend is a trickle down from strategic systems to operational systems.

Strategic Planning: The Lion's share

The strategic emphasis of the studies is not surprising. CPFR is fairly new and being a strategic initiative, will take time to filter down into the tactical and operational levels of organizations as it gains buy in from senior management and eventually develops traction at the lower levels. IT in CPFR is even newer for the obvious reason that IT would take time to catch up as CPFR itself is rolled out. Not surprisingly, the average publication year of the studies on IT in CPFR is 2007.

The emphasis on the planning aspect is also not surprising since CPFR starts with Planning. Forecasting and Replenishment should also take longer to filter down and permeate the workings of organizations after the planning function is rolled out. Taken together, strategic planning requires the least intimate sharing of knowledge and happens at a very broad level, between a few top executives. Forecasting involves integration of summarized data and Replenishment draws on massive use of detailed data and so corporations will take longer to rollout those functions.

**Replenishment: Operational or Strategic?**

Replenishment seems to be (at least at this point) more of a strategic issue than an operational activity. Covered by 16% of the studies, Strategic Replenishment studies make up the second largest group. This is unexpected but not surprising. It is true that CPFR is a fairly new concept. So that Replenishment (ordering, POS, logistics, shelving, warehousing) should be the last to be implemented of the functions. But this has to be

balanced with the fact that Replenishment is really where the rubber meets the road, which is why the benefits of collaborating on replenishment would be more immediate and more measurable. It is understandable if top managers were eager to 'jump the gun' in implementing collaborative replenishment strategies so as to try to reap some early benefits from CPFR, in order to get their monthly and quarterly reports looking good in a hurry. A follow up study is being undertaken to determine whether this gap in the literature reflects actual gaps in practitioner usage of IT in CPFR. Managers in the Fortune 500 will be surveyed to determine how IT is actually used in their supply chain management activities. IT managers will be asked to coordinate their own responses along with those of Procurement managers along with Manufacturing and Distribution managers.

Collaborative Replenishment should also be a quick and easy function to implement so as to increase engagement, thereby helping the collaborative efforts to reach critical mass at a human and psychological level. Using collaborative strategies, partners can quickly engage with each other and start sharing information in order to get CPFR rolling.

**Glitch in the Matrix: Forecasting**

Theoretically, a perfect forecast would result in no gap between the level of demand and the stock on hand to meet that demand, in which case there would be no bullwhip effect. Considering the fact that CPFR is the latest in a line of policies and strategies designed to solve the bullwhip effect, it is surprising that Forecasting studies are generally under-represented. In terms of the overall emphasis of the studies, forecasting consisted of a paltry 17 or 19% of the studies.

[Insert Figure-3 here]

The single most notable aspect of the study is that forecasting has a surprising hole at the strategic level. I define IT for Strategic Forecasting as use of IT to coordinate inter-firm forecasting by upper managers. I expect them to study senior managers' use of forecasting systems in order to assess the adequacy of data collection at the inter-firm level and firm-levels. Strategic forecasting would then feed into macro-level strategies for production and marketing. I also expect managers at the Strategic forecasting level gather top level data to feed into their forecasting systems, Whereas planning and replenishment functions show a steady increase going from Operational to Strategic levels, Forecasting has a drop from the tactical to strategic level. As mentioned before, Planning makes up the lion's share of studies with 48% of the studies. The overall dearth of forecasting studies with the particularly gaping hole at the strategic level calls into question whether CPFR is being implemented effectively and in the order which it was designed to be implemented. One would expect it to ripple down from the top left of the matrix, spreading down and to the right, with emphasis on the Strategic-Planning to Tactical-Forecasting to Operational-Replenishment diagonal. What I see instead from the literature is that at the strategic level, seems to skip forecasting and "jumps" straight down to the replenishment function.

The "rubber meets the road" value of implementing replenishment quickly could account for the jump from Planning, to Replenishment systems. But the strong representation of Forecasting at the tactical level rules this out. Also, the general trickle down from strategic to operations also refutes that idea. Instead, it is possible that there are issues of

trust at work here. Companies are probably happy to make broad, vague plans together (which do not require so much trust) and even share their replenishment level information (inventory-levels, stock-movement, POS data, logistics-tracking etc.). But they may be less willing to share the guts of their forecasting strategy, since that is probably the most vulnerable to opportunism. Planning looks at how many units you want to move. Replenishment speaks to the number of units actually moved. However forecasting says how much you expect to move.

So whereas Strategic planning and Strategic replenishment are the sweet spots of CPFR, it appears that Forecasting at the operational level and Strategic levels are the sore spots. This is not difficult to believe. A company's forecasting algorithms are a bit like the secret sauce of CPFR. Embedded in this secret sauce is an unknown combination of easy to guess ingredients such as actual units moved in the past and current market share, very intimate ingredients such as the company's product development plans, marketing plans, market analysis and possibly less savory ingredients such as secret deals made to improve market access, bypass regulations, access tax-shelters and holidays. Pulling all these ingredients together is a possibly highly tuned formula which has compared past movements against projected movements. It is not possible to draw useful conclusions without further study of actual use of IT in CPFR within industry. This is something I will also explore in the future study where will pose questions to managers concerning the rational for the distribution of emphasis on various

Two other more likely possibilities should be considered as to why there is a dearth of forecasting studies. One possibility is that companies are not willing to expose their forecasting secrets, simply because there are just not as many as would be expected. It is

possible that companies are embarrassed at how simple and unsophisticated their forecasting really is. It could be that a company plans to produce 10% more every year, with 20% more at Christmas than the yearly mean, and it could be that represents the extent of its forecasting magic. The strongest possibility I believe, which will be explored in a further study, is that forecasting does not represent low hanging fruit for academics publishing studies on IT in CPFR. Forecasting is more detailed and much harder to study and it could be that the availability of data and the effort it takes to gather-data, formulate, simulate, and measure Forecasting efficacy does not lend itself to being studied easily enough for academics to bother with it.

Whatever the explanation for the lack of studies on IT based Forecasting for CPFR, it is disappointing and represents a missed opportunity, either by practitioners who could be missing out on the value of implementing CPFR in a manner endorsed by VICS, or academics who are not connecting the dots of actual IT use in explaining firm performance at operational and financial levels. IT will not make forecasts perfect, but it allows analysis of forecasting performance so as to figure out how much leeway to build into stocking policies. IT driven forecasts are also relatively easy to capture, replicate, simulate and store. Doing sophisticated forecasts using IT will allow a manager to do what-if-analyses, reconfigure forecasts based on changing conditions, and ultimately capture the deeper intelligence applied by an experienced forecaster for posterity in a company's knowledge management systems so that it adds to institutional knowledge and can be used to train other managers. IT driven forecasting represents too much of an opportunity to be simply skipped over by managers or academics for expediency. Jumping a step could come back to haunt practitioners later when they have to redo the

implementation of CPFR to get the full benefits. It could haunt academics later because of gaps in the explanation of firm performance. If IT academics are taking an incomplete approach to studying CPFR, then other fields such as marketing or operations research may be taking more credit than they should, because of gaps in the explanation of IT use. It is also too important to be ignored by academics in general since this will ultimately hurt the relevance of academia's relevance to Supply Chain Management.

# STUDY 2: USE OF INFORMATION TECHNOLOGY IN COLLABORATIVE PLANNING, FORECASTING & REPLENISHMENT (CPFR) – DETERMINANTS OF REAL WORLD USE

## INTRODUCTION

### Supply Chains

According to Min and Zhou (2002), the purpose of a supply-chain is to increase the profitability and efficiency of a company along with its partners in the supply chain, thereby making the whole partnership more competitive. A supply chain behaves as "an integrated system which synchronizes a series of inter-related business processes in order to: (1) acquire raw materials and parts; (2) transform these raw materials and parts into finished products; (3) add value to these products; (4) distribute and promote these products to either retailers or customers; (5) facilitate information exchange among various business entities (e.g. suppliers, manufacturers, distributors, third-party logistics providers, and retailers)". In order to have a smoothly running supply chain, firms must be able to anticipate the needs of their downstream partners so they can supply their needs at just the right time. This means continued forecasting must occur throughout the entire supply chain and sharing of information is very important in supply-chain management (Kwon & Suh, 2004). Because a supply-chain will span many companies, it demonstrates the need for coordination across organizations (H. Lee & Whang, 2002).

### Supply Chain Management

Supply Chain Management is defined by (Castellucci & MacKenzie, 2011) as:
a set of synchronized decisions and activities utilized to efficiently integrate suppliers, manufacturers, warehouses, transporters, retailers and customers so that the right product

or service is distributed at the right quantities, to the right locations at the right time, in order to minimize system-wide costs while satisfying customer service level requirements (p. 5).

The emphasis of supply chain management is generation of optimal overall customer satisfaction through efficient operation of the supply chain with the lowest combined cost for all participants. To achieve this, supply-chain management relies on systematic coordination of typical business functions across enterprises within a supply chain in order to increase the efficiency of movement of goods and supplies (McCarthy & Golicic, 2002). According to Min and Zhou (2002) supply-chain management consists of two main functions including materials management which deals with inbound logistics along with outbound logistics which takes care of physical distribution.

**The Bullwhip Effect**

Supply chains do not always run smoothly. Sometimes there is inadequate flow of information. Spengler (1950) provides early documentation with findings on "double marginalization," where sometimes the retailer does not consider the supplier's optimal operating conditions when making inventory stocking decisions, and therefore orders too little product for system optimization. Forrester (1958) in his seminal study of industrial dynamics in a four channel supply chain, illustrates how rational decision-makers acting independently can cause customer demand information to distort and amplify while moving upstream in the supply chain. This results in a) Inaccurate forecasts b) inefficient asset utilization and c) Poor customer service; causing what has come to be known as the bullwhip effect. This is an inverted Ripple effect where forecasting errors in a supply-chain are increased as you go further down the supply chain. Orders placed with the

upstream supply partner, exaggerate the actual end consumer demand due to the low visibility of information from the immediate downstream partner. This effect then ripples down, exaggerated as you traverse the supply chain (Castellucci & MacKenzie, 2011; J. V. Chen, D. C. Yen, & K. Chen, 2009; Min & Yu, 2008).

With the bullwhip effect there is uncertainty in movements of goods within a supply-chain. These uncertainties create glitches which manifest themselves in unnecessarily high Inventory in some cases, and product shortages in other situations. So that the supply-chain runs inefficiently and there is a constant mismatch between supply and demand (Kwon & Suh, 2004). Both situations are of course undesirable since high inventory means that money remains tied up in goods sitting in a warehouse which is itself expensive to operate. Meanwhile product shortages result in an immediate loss of revenue as well as eventual loss of customer good will, with the possibility of the customer switching to a different brand for life (Boone & Ganeshan, 2007). To deal with the uncertainty in the actual demand along the supply chain:

Suppliers hold extra inventory for the safety stock wholesalers hold. Wholesalers need extra inventory for the safety stock retailers hold. Incongruent information across the supply chain leads to overreact to backlog and building of excessive inventory in order to prevent stock-outs (Castellucci & MacKenzie, 2011, p. 191).

Systems introduced to prevent the Bullwhip effect

In seeking to reduce the Bullwhip effect, several frameworks have been implemented. The objective of these systems has been to increase the visibility of goods moving through the supply chain. One of the early forerunners was electronic data interchange (EDI). This system allowed for movement of business documents between computers in a

machine readable format. This usually took place between partners in a supply-chain over a Value Added Network (Angeles, 2000). EDI suffered from massive levels of expense associated with the effort to connect companies over a purpose built network. The cost of implementing EDI usually meant that there were a few very powerful companies with the cash to develop the network. These companies became known as hubs. Their trading partners which acted as spokes were forced to concede to the terms that the hub companies dictated (Angeles, 2000).

After EDI, several other attempts at collaboration were made. They include vendor managed inventory—VMI (Barratt & Oliveira, 2001). VMI was still inadequate because the movement of goods along the supply-chain was not as visible as required. This was due to the fact that point-of-sale (POS) data was not included, so that replenishment was based only on the customer's stock level in their distribution center or warehouse. This caused the grocery industry to give up on VMI (Barratt & Oliveira, 2001). Continuous replenishment (CR) was another method which came about in the early 90s. It improved on VMI because Point-of-sale data was taken into account in order to produce a forecast. This improved forecasting then drove the inventory policy (Barratt & Oliveira, 2001). However CR which was performed by a manufacturer using history and algorithms, was too highly dependent upon the effectiveness of a replenishment analyst who was exposed to a particular account, whereas the forecast should ideally come from the retailer (Barratt & Oliveira, 2001).

Sahin and Robinson (2002) surveyed the vast literature on supply chain integration and proposed information sharing and coordination among supply chain members as the primary driver of supply chain performance. According to Boone and Ganeshan (2007)

companies came to the realization that in addition to forecasting, they needed to collaborate on procurement and replenishment as well, in order to increase the magnitude and efficiency of the flow of their products. Hence, having tried systems such as EDI, VMI and CR, they have now settled on CPFR since it allows them to leverage many more sources of data than before.

**CPFR**

(Li, 2007, p. 19) describes Collaborative Planning Forecasting and Replenishment (CPFR) as being composed of 3 activities including Planning, Forecasting and Replenishment which are undertaken jointly by partners in a supply chain. CPFR is defined by ECR as "A cross-industry initiative designed to improve the supplier / manufacturer / retailer relationship through co-managed planning processes and shared information" (Skjoett-Larsen, Thernøe, & Andresen, 2003). CPFR started in 1995 with a pilot program comprising Wal-Mart and Warner-Lambert and was called CFAR at the time, or “Collaborative Forecasting and Replenishment” (Castellucci & MacKenzie, 2011, p. 295). By 1997 an organization known as the Voluntary Inter-industry Commerce Solutions Association (VICS) developed a framework which it published in 1998 as the CPFR guidelines (Cederlund, Kohli, Sherer, & Yao, 2007; Skjoett-Larsen et al., 2003).

How CPFR works

Two organizations in a supply-chain, trading forecast data as well as sharing information on their stock levels in order to make production decisions and effect constant replenishment on an collaborative basis (planned and ad-hoc), is a basic example of CPFR at work (Danese, 2007; Skjoett-Larsen et al., 2003). First, partners will execute the planning function which results in a contract that indicates each partner’s responsibilities.

This sets the stage for creation of a business plan to be executed by both partners. This business plan covers demand management, promotions, quantities to be produced, schedules and inventory levels. Next is the forecasting stage where partners calculate expected demand. Differences (exceptions) are used to fine-tune these forecasts so that they will benefit all partners. In the replenishment stage, orders are generated and discrepancies (exceptions) are worked out to everyone's satisfaction. From this comes the schedule of productions and deliveries which will satisfy needs along the supply chain (Castellucci & MacKenzie, 2011, p. 19).

In collaborative forecasting there is a level of decentralization in the information sharing so that forecasting is done on the basis of shared information, not just based on one source, even though each supply-chain partner creates their individual forecasts which can be used in the replenishment process. There is a constant revision of demand forecasts (Aviv, 2001). Several approaches are used in forecasting such as Bayesian updating mechanisms, modeling of demand as a time-series, and also Markov-modulated demand. One other approach uses the Martingale model to forecast (Aviv, 2001). In some CPFR implementations, customers may make their point-of-sale data available to their supply partners who consolidate it into a monthly pattern, comparing it to the previous year in order to attempt to forecast future sales (Barratt & Oliveira, 2001). Suppliers take an active role in the replenishment process, automatically delivering replenishment stock as reports indicate that the stock is reduced through consumption (Holmstrom, Framling, Kaipia, & Saranen, 2002).

**Implementing CPFR**

Before a firm can successfully implement CPFR, it must already have its own working forecasting processes which it can use to compare to its partner's forecasts. CPFR is jointly implemented—between a firm and its supply partners—in a nine step process (Castellucci & MacKenzie, 2011, p. 19). These steps include: 1) developing a front-end agreement 2) creating a joint business plan 3) creating sales forecasts 4) identifying exceptions to sales forecasts 5) resolving/collaborating on exception items 6) creating order forecasts 7) identifying exceptions to order forecasts 8) resolving/collaborating on exception items 9) generating orders (Barratt & Oliveira, 2001; Danese, 2007; Min & Yu, 2008).

When setting up CPFR, a company should start with a narrow focus on a few key processes where it collaborates with supply-chain partners. This allows the company to scale the project strategically, relying on lessons learned during its pilot project to effect improvement in processes across the wider organization (Danese, 2007). Cultural as well as attitudinal changes may need to take place so that employees within the collaborating companies stop interacting with each other on the basis of power-differences and cost cutting and instead treat each other as partners who are ‘in it for the long haul’. Plans to be developed jointly can include marketing, Stock management as well as sales and product changes (Skjoett-Larsen et al., 2003). Firms must decide which technologies they will use, the level of collaboration between themselves and supply-chain partners, how much and what type of information to share, as well as what products to design jointly. They must also decide on the distribution channels they will utilize and also determine how best to measure performance along supply chains (Boone & Ganeshan, 2007).

Before fully implementing CPFR, Motorola launched a major CPFR pilot project with one of its mobile phone retailers. It emphasized the shift across the organization to teamwork with customers as the focus (Cederlund et al., 2007). Motorola established and formalized communication processes at several points in its supply-chain. To support the process they held weekly collaborative planning sessions; in these sessions Motorola and its retailer reviewed the previous week's replenishment, sell-throughs, inventories as well as open-orders (Cederlund et al., 2007).

**Benefits of CPFR**

According to Castellucci and MacKenzie (2011, p. 20) use of CPFR helps to reduce the bullwhip effect. This in turn reduces the need for excessive safety stock throughout the supply chain in order to guarantee product availability. One of the problems encountered before CPFR was that suppliers were forced to make production plans based on their own internal sales forecasts. A worst-case scenario was that the supplier did not know of SKUs being eliminated by the distributor, with the result that distributors would return shipments because they were obsolete by the time they arrived from the supplier (Holmstrom et al., 2002). CPFR helps by bridging the gaps found in previous practices such as VMI and CR. CPFR more comprehensively deals with the effect of promotions on sales forecasts and the resulting effect on inventory management, changing demand patterns and how they affect sales forecasts. It also helps with the synchronization of functional departments within manufacturing by bringing together forecasts across departments such as production planning, sales and distribution, finance, marketing, logistics & purchasing (Barratt & Oliveira, 2001). The more effectively CPFR is used, the more it reduces the bullwhip effect, ensuring the supply chain runs optimally.

CPFR if implemented properly can drastically increase supply-chain performance and so must be a big priority for firms in today's supply-chain (McCarthy & Golicic, 2002). Using CPFR, supply-chain benefits are expected to be derived from four main strategies including efficiency in promotions, efficient replenishment and efficiently introduced products as well as efficiency in store assortment (Barratt & Oliveira, 2001). CPFR is superior to VMI and CR since it allows for systematic planning, forecasting and replenishment processes. Partners meet very frequently and are much more integrated instead of operating at arm's length. Hence, a much greater level of information passes between them based on the shared vision of decreasing costs across the supply chain and increasing value to end-consumers, securing their position in the market (Holmstrom et al., 2002; McCarthy & Golicic, 2002; Sethuraman & Parasuraman, 2005; Sherer, Kohli, & Yao, 2009; Skjoett-Larsen et al., 2003). CPFR has been shown to reduce safety stocks, increase order fill rates, improve sales and decrease customer response times. The disruption of the flow of goods on the supply-chain is prevented, enabling suppliers to increase service levels as well as decrease costs to consumers (Min & Yu, 2008).

Success stories in CPFR

The first pilot program for CPFR involving Wal-Mart and Warner-Lambert also included SAP, Manugistics and benchmark partners. It centered on the distribution of Listerine in 1996. Wal-Mart and Warner-Lambert used CPFR software to jointly develop forecasts using data such as previous sales, promotion plans and weather data. Information was transmitted iteratively to allow them to come to a consensus on the forecasts, in cases where the original forecasts diverged. Listerine sales increased—because of improved fill rates—from 87% to 98%, even though there was less overall inventory. Lead times were

also reduced from 21 to 11 days. Sales volume increased by $8.5 million (Aviv, 2001; Barratt & Oliveira, 2001; Danese, 2007; Min & Yu, 2008)

Another pilot project run in 1999 between Nabisco—a manufacturer of snacks and sweets along with Wegman's—a retailer, created a 13% increase in sales for Wegman's, while non-collaborative retail chains experienced a drop of 8%. Wegman's also experienced an 18% reduction in time spent by goods in the supply chain (Holmstrom et al., 2002). In Germany, Herlitz AG, which makes office supplies, partnered with its retailer called Metro, using CPFR and thereby decreased inventory by 15% as well as decreased stock outs by half and increased its yearly sales by 3% (Min & Yu, 2008). Before Motorola implemented CPFR, mobile phone sales were highly variable and were usually unsynchronized with consumer demand (Cederlund et al., 2007).

Many firms are beginning to recognize that there are great strategic benefits in implementing CPFR in order to increase their control over the supply-chain in which they participate (Min & Zhou, 2002). Several CPFR partnerships have been developed including Liz Claiborne and Dayton Hudson; Procter & Gamble and Wal-Mart; Johnson & Johnson and Eckerd Drug; Compaq and some of its supply chain Partners; New Balance and some of their Retailers; Timberland and some Retailers; Schering Plough and Eckerd Drug; GM and Dealers; Subaru and its dealers; Ford and some of its dealers; Kimberly Clark and Kmart; Wal-Mart and Hewlett-Packard as well as Lucent (Barratt & Oliveira, 2001; Danese, 2007).

**Levels of CPFR implementation**

There are three major levels of collaboration requiring increasingly deeper levels of trust. They include 1) communication about a few processes 2) a limited level of collaboration

which would involve some integration and greater exchange of data and 3) total collaboration. At the introductory stages of CPFR, firms may exchange data or information but may not necessarily synchronize their production or replenishment plans. At the next level firms may collaborate and coordinate their planning by making decisions together or they might collaborate on resolving exceptions to their sales/order forecasts. In the case of full collaboration, there are an increased number of items, relating to many more processes, on which the firms will collaborate. This tends to include coordination and synchronization of sales plans and order forecasts (Danese, 2007; Kolluru & Meredith, 2001; Skjoett-Larsen et al., 2003).

In the later stages of CPFR, partners will collaborate in joint planning sessions which help them to unify their forecasts and policies. They collaborate closely through face-to-face meetings or remotely through technology. The result is that business decisions can be made which increase supply-chain performance. The resulting performance is greater than when any one firm creates forecasts for the supply-chain. Successful CPFR implementation at the highest level involves collaboration between partners who will share information of a strategic and very likely, sensitive and proprietary nature. Examples can be sales data, point-of-sale data, forecasts, inventory status, promotion plans, shipment schedules, production information, capacity plans and lead-time information as well as information about new products. They might also pool data which will be useful for predicting the behavior of consumer demand in the chain. This allows information used in creating the forecast to be of the highest quality and most suitable to the purpose (Aviv, 2001; Boone & Ganeshan, 2007; Kolluru & Meredith, 2001; H. Lee & Whang, 2002; McCarthy & Golicic, 2002; Skjoett-Larsen et al., 2003).

### General Barriers to CPFR

Problems with real-time coordination in the exchange of information, lack of adequate technology infrastructure, along with large amounts of time required to set up the infrastructure, in addition to the process intensive nature of CPFR are all obstacles to its implementation (Cederlund et al., 2007; McCarthy & Golicic, 2002; Min & Yu, 2008). Cultural and attitudinal barriers also exist since some organizations may have seen order processing as a core part of their activity, making it difficult for some people to relinquish it. For example, the CIO of Long's drugstores pointed out that negative cultural attitudes toward sharing of information can be a major obstacle to implementing CPFR since some retailers are just not accustomed to sharing information freely with suppliers—tending to keep it close even when sharing it would obviously be beneficial (Skjoett-Larsen et al., 2003).

## THEORETICAL FOUNDATION

### Trust as a CPFR Enabler

There is increasing recognition among players in supply chains that collaborative forecasting based on pooled information can be very beneficial to all concerned (Min & Yu, 2008). Also, solid relationships between partners will facilitate the success of CPFR; sometimes the same relationships where each party previously tried to squeeze a profit out of the other in a zero-sum game (McCarthy & Golicic, 2002). Company relationships built over long periods, along with trust have been found to be critical to potential collaborators. However companies have also been found to prefer partners who already practice their current purchasing strategies so that they would not have to change very much (Kwon & Suh, 2004; Wang & Archer, 2004). Suitable technologies which support

and facilitate data exchange are also critical to enabling real-time communication. Trust and mutual dependency are also important structures which help develop relationships between participants of inter-organizational collaboration teams (Wang & Archer, 2004). When trust is missing from collaborative partnerships, more time and energy is spent on monitoring these relationships for performance. In contrast when there are great levels of trust, there is free communication and partners will take risks willingly since both parties will freely share information, putting faith in the information which they get in return (Kwon & Suh, 2004).

**Responsiveness Needs**

Response time is an important component in the flexibility of a supply-chain. Response time affects factors such as time-to-market, on-time delivery, order processing time and transit time. The ability to communicate in real-time will have a positive effect as long as it is accompanied by compatible Information and Communications Technology along with high levels of mutual trust (Min & Zhou, 2002). In CPFR, the volume of information transmitted is greatly increased since there is a constant flow of information between supply-chain partners (Pramatari, 2007).

Responsiveness Enablers

The Internet has allowed for a dramatic paradigm shift in the way supply chains operate. The emphasis has gone from a focus on inventory to a focus on information about the movement of goods (Boone & Ganeshan, 2007). The current use of Internet technologies for electronic commerce with its speed and cost effectiveness, has made it easier for small and medium-size enterprises—which were initially unable to afford to use value added networks to participate in EDI—to be able to join in the current collaboration

taking place with CPFR (Angeles, 2000).

Trust requirements

Trust is defined by (Garriss et al., 2006) as the reasonable expectation that an entity will adequately perform its stated purpose and nothing else—creating as few surprises as possible for its partners. Trust is based on the belief that parties engaged in a transaction will behave in a predictable way which is beneficial to all concerned and will not act opportunistically to the detriment of their partners (Karnouskos, Hondroudaki, Vilmos, & Csik, 2004). In order to achieve the required level of integration, objectives of the supply-chain partners must be aligned and they need to practice open communication, share their risks and rewards along with their resources (Büyüközkan, Vardaloglu, & Feyzioglu, 2009). From a transaction cost perspective, when managers are involved in relationships which carry low levels of trust, more legal resources are required to create unbreakable contracts and monitor them for compliance (Dohmen, Moormann, & Rosemann, 2009). If there is an insufficient level of trust to support the required information sharing in CPFR then this can become a major obstacle to the implementation of the program (Kwon & Suh, 2004). In this scenario there is potential for opportunistic behavior between supply-chain partners where one partner may leverage information for their own personal gain, thereby damaging the collaborative relationship between them (Skjoett-Larsen et al., 2003).

**Trust Enablers**

Trust is present when collaborators believe that their partner is acting in an honest and benign manner. It is critical for successful supply-chain management (Kwon & Suh, 2004). While information sharing requires trust, the act of sharing information actually

reduces behavioral uncertainty and as a result ultimately promotes trust as well (Kwon & Suh, 2004).

**Innovation Diffusion Theory**

According to diffusion theory (Rogers, 2010), innovations are products, procedures or concepts which appear new to an individual who seeks to adopt that new product. As adopters in one category learn and understand the benefits and pitfalls of adopting the technology, users who are able to observe them using the technology are able to learn by proxy and this helps them to become more comfortable with the technology when it is introduced to them, allowing for a smoother and quicker adoption of the technology by the second category. So the process of diffusion affects how this innovation is transmitted among new adopters, through a channel, as time passes (Van Biljon & Kotzé, 2007). Innovation Diffusion Theory has been studied and supported widely as an explanation of the adoption or non-adoption of IT innovations in institutions and the society on a whole. It has been shown to be particularly relevant to IT innovations (Urbaczewski, Wells, Sarker, & Koivisto, 2002).

**Innovation Diffusion Theory in SCM**

According to Moore and Benbasat (1991), management affects IT adoption by ordering staff to use it, so management can also play a part in the encouragement of adoption of IT (Leonard-Barton and Deschamps 1988). But (Bayer & Melone (1989) warn that adoption may not be as straight-forward as being used or not. Adopters may engage with the technology at varying levels of use as against simply using it or not (Fichman, 1992). Staff will also affect the extent to which managers uses the systems based on the confidence that management has in the data that staff places in the system. If they believe

that the data has integrity, then patterns in it will be useful for making decisions and use for long term planning.

**Technology Task Fit**

Task Technology Fit theory (Goodhue & Thompson, 1995) predicts that a technology will be considered as useful to a potential user, based on the extent to which it fits the task that the user needs to accomplish. Also companies, despite being in a long standing relationship such as is found in a supply chain, and may be able to switch to another supplier with a better technological fit to changing market conditions. According to (Harland, 1996), creating relationships with new partners may be difficult, but it is easier than changing how systems are used inside the company.

**Technology Task Fit in SCM**

Production Volume and Clock speed require the use of Technology which is appropriate to the demands and pressures of each industry. Depending on the turn-around time for making product changes, product roll-outs, maintaining product quality, tracking production schedules, the information technology which is used to collaborate with supply chain partners will need to be able to sophisticated enough to allow for a deep enough integration necessary to achieve smooth information flows. Systems must be able to track changes and trigger information flows quickly enough and with sufficient integrity so that product can be delivered reliably and efficiently.

**TAM**

F. D. Davis (1986) proposed and developed the Technology Acceptance Model (TAM) which predicts and explains the extent to which individuals will adopt a technology based on factors such as perceived usefulness and perceived ease of use, which in turn drive

their attitude and ultimately their intention to adopt. This model has become broadly accepted both for its parsimony and its generalizability. It has been found to stand up to replications (Adams, Nelson, & Todd, 1992) and has been tested many times against various technologies including Smartphones, Wireless Internet and the World Wide Web (Burdette, Herchline, & Oehler, 2008; Burdette, Trotman, & Cmar, 2012; Chang & Chen, 2005). It has also been successfully applied in several professions including Medicine and Logistics (J. Chen, D. Yen, & K. Chen, 2009; Walter & Lopez, 2008).

ICT as a useful tool of collaboration

Technology is required for virtual teams operating across geographical boundaries will depend heavily upon, in order to overcome time zones and physical separation (Beurer-Zuellig & Meckel, 2008). Some important technologies include communication features such as instant messaging, e-mail and telephony (Patten, Arnedillo Sánchez, & Tangney, 2006).

The likelihood of adoption of ICT will depend on several industry characteristics. These include 1) The general need for collaboration and data sharing 2) industry within which collaborators operate as well as what they actually produce 3) Position of the channel captain 4) whether the channel captain leads … its channel partners 5) the level of collaboration between the supply chain partners 6) Sources of competitive Advantage 7) Professionalism of the ICT Department and IT Diffusion in the organization 8) Executive buy-in, knowledge ability about and involvement with system implementation and

**Relevance of Fast and Responsive collaboration**

In order to remain competitive, most organizations will need to increasingly leverage distributed collaboration (Beurer-Zuellig & Meckel, 2008). I expect this to be universal

for the majority of industries in today's fast paced world. The Internet and technologies which leverage it, such as smartphones, are core components of distributed collaboration efforts such as CPFR since they allow business processes to quickly share electronic data in order to drastically decrease expenses, while at the same time improving service to customers (Kolluru & Meredith, 2001; H. Lee & Whang, 2002; Skjoett-Larsen et al., 2003). At Motorola case, division managers were able to share information in real-time with their retailers. They found this critical to facilitating time-based decision-making (Cederlund et al., 2007)

**Industry Effects**

For high-tech industries with fast product clock speeds (Castellucci & MacKenzie, 2011, p. 15), it is necessary to have constant communication on forecasts related to the end of product life-cycles. For example a high-technology consumer electronics manufacturer can track the movement of their products within distributors' stores by monitoring the steady stream of information coming from the distributor's point-of-sale (Barratt & Oliveira, 2001; Bayus, 1994). High-tech industries are typified by the cellular phone industry. The constant introduction of new products into a market such as the cell phone market makes for a volatile supply chain which is difficult to manage and control. For example, cell phones have an average life-cycle anywhere from six months to a year (Cederlund et al., 2007). This requires a greater level of information sharing on a constant and frequent basis. In the retail industry which deals with durable goods (such as Walmart), functions such as shelf replenishment and stock out alerts can benefit from use of a PDA. This has been suggested as a way of increasing responsiveness and improving customer service. There is also the possibility for suppliers to get real-time updates on

shelf appearance when products and shelves are monitored using RFID (Pramatari, 2007).

**Levels of Collaboration**

As mentioned before, there are three major levels of collaboration including 1) communication about a few processes 2) a limited level of collaboration with some integration and exchange of data and 3) total collaboration (Danese, 2007). Firms start out exchanging data and information. Later on firms may coordinate their planning by making decisions together or collaborate on resolving exceptions to their sales/order forecasts. In later stages of collaboration, firms will collaborate on many of their sensitive processes such as coordination and synchronization of sales plans and order forecasts. They will also make agreements on service levels to be expected. This formalization of exchanges also allows for application of required security measures to guard the increasingly sensitive data shared between partners (Danese, 2007; Kolluru & Meredith, 2001; Skjoett-Larsen et al., 2003). So the level of security and trust needs to also increase with the level of sharing. For example security associated with sharing of product development plans is greater than security required for sharing of shipment notices. Implementing the requisite level of security will facilitate greater trust between partners which will be needed for higher levels of collaboration.

Other factors will come into play, but some of these factors are usually secondary to the aforementioned factors. For example product cycle time is important since the shorter cycle times are, the more frequently collaborators would need to exchange information indicative of where they are in the product lifecycle of a particular product. But product lifecycles would tend to already be related to whether or not it is a high-tech industry or a

retail industry (Bayus, 1994). Similarly, it is expected that trade secrets will be more sensitive in high-tech industries than in low-tech industries.

## METHODS

### Hypotheses

Firms exchange more data about more aspects of their processes as they go to higher levels of collaboration in the CPFR being practiced. (Kolluru & Meredith, 2001; Skjoett-Larsen et al., 2003). Based on Technology Acceptance Model, higher levels of collaboration in CPFR will allow more processes to be captured in a useful way in the data-exchange process, in line with the Technology Acceptance Model (Fred D. Davis, 1989), thereby leading to more consistent and accurate exchange of data among companies as the level of CPFR increases.

Production and replenishments will be synchronized more effectively as collaboration increases with higher levels of CPFR data exchanges. So the ability to use the system creatively for new and innovative purposes (exploratively) will increase as the level of integration deepens and strengthens as each partner increases their understanding of how the other partner stores and processes data. This will allow the data to facilitate imaginative new ways of looking at and accessing data for executives, hence increasing strategic use.

H1: Greater levels of CPFR being practiced with major partner will increase Strategic Use of CPFR systems being used.

In industries which infuse more technology into their products (and have high levels of proprietary designs) companies will be hard pressed to incorporate the latest research and

design innovations and secrets into their products. Constant feedback is necessary in order to ensure that overproduction of obsolete products is not taking place, while making use of the opportunity to produce enough of the high-demand products (Castellucci & MacKenzie, 2011, p. 15). These products have a short shelf life and yet are highly specialized products requiring high levels of R&D capital. Companies developing these products need to maximize the sale potential of the products, but phase them out quickly enough when they become obsolete. So they need constant, highly accurate data which is geared toward their decision making needs (Al-Ubaydli & Paton, 2005; Beurer-Zuellig & Meckel, 2008; J. Chen, et al., 2009; Donner, 2009. Therefore operational level data becomes more useful in high-tech supply chains (in line with Technology Acceptance Model (Fred D. Davis, 1989) and therefore it is expected that CPFR system use will be more strategic use in high-tech supply chains.

H2: Industries which are more Hi-Tech will have Increased Strategic Use of CPFR systems.

The use of IT at the operational level is necessitated by an on-line presence which dovetails with high-volume production since efficiency of order-fulfilment is a key to winning in the on-line markets such as e-bay or Amazon where super-fast shipping, low-cost and high-availability are essential to customer-satisfaction (Gunasekaran, Patel, & Tirtiroglu, 2001). In situations where demand fluctuates tremendously, prediction and planning becomes difficult and then flexible and efficient day-to-day replenishment type activities become the greater competitive imperative as staff deal with stock-outs and unexpected orders. In this type of fire-fighting situation, operational use of IT for CPFR will be most useful (Fred D. Davis, 1989).

H3: Supply chains with higher production-volumes will have increased Operational Use of CPFR systems

In Industries with faster clock speed. The popularity of a product can be short lived, especially depending on its reviews on social media, flaws found in the product or as competitors leap-frogging the model with a superior model as happens a lot in the consumer electronics market (H. L. Lee, 2002). Staff will learn to lean heavily on IT for their day to day operational needs in these situations. Systems become important to the minute-by-minute use for operational use, especially in demanding customer-facing situations. Staff learns to make use (Fred D. Davis, 1989) of IT systems on a constant basis and trust it to be there to back them up as they sell products, deal with inquiries and sort out customer service issues. This is accentuated by management's use of highly detailed, highly accurate reports which reflect the operational reality at the customer service level which shows fluctuations and new trends as they happen, allowing management to review product mix plans where necessary.

H4: Industries with a faster clock-speed will have increased Operational use of IT CPFR.

Planning, Forecasting, Replenishment (P, F, R) - axis

The use of IT in functions of Planning or Forecasting or Replenishment does not represent a continuous spectrum. Rather, use in any one of those functions represents a discrete, compartmentalized occurrence. So unlike the Strategic-to-Operational spectrum where a system can progress along the spectrum from operational to strategic use, it would be inappropriate to say that system use can progress along a spectrum from Replenishment to Planning or vice-versa. I consider a pair of cells in each scenario, Enterprise level systems which should have been used in one cell but instead, gets

implemented in the cell beside it. Specifically, I am interested in the movement of systems from Forecasting to Planning and Planning to Forecasting. I am similarly interested in systems which are launched at Forecasting but get focused in Replenishment as well as systems which should be used for Replenishment but get used mostly for Forecasting. Two types of influence are investigated for each pair of cells. The first type of influence are the factors which cause the ratio to be changed from one cell to the next, meaning the cell draws system use away from the adjacent cell where it was originally expected to be used. The second type of influences are those which allow the system use to be in the expected ratio, or seen another way, factors which allow the systems to spill over from one cell to the next. In other words, instead of one cell taking away system use from the expected use, use of a system in that cell actually causes the system to also be used in the adjacent cell.

**Product Type**

In Hi-Tech industries (which usually have high levels of proprietary designs) companies will be hard pressed to incorporate the latest research and design innovations and secrets into their products. Constant feedback is necessary in order to ensure that overproduction of obsolete products is not taking place, while making use of the opportunity to produce enough of the high-demand products (Castellucci & MacKenzie, 2011, p. 15). These products have a shelf life which is not guaranteed, and yet they are highly specialized products requiring high levels of R&D capital. Companies developing these products need to maximize the sale potential of the products to maximize on their R&D dollars, but phase them out quickly enough when they become obsolete, to minimize inventory management costs and manufacturing costs of products that are not generating revenue.

This makes product mix and product scheduling decisions more critical in these industries, and in line with the Task-technology-fit theory, Planning use will fit product-mix and scheduling demands better, and so be accentuated in High-tech supply chains (Goodhue & Thompson, 1995).

H5: Industries which are more Hi-Tech will have Increased Planning Use of CPFR systems.

In industries with high-product variability, figuring out how many units of products your consumers want, within a future time period, is critical. This allows management to ensure that they are providing an abundance of versions of products that are hot, while avoiding a flood of products which are about to become obsolete (H. L. Lee, 2002). Forecasting becomes the best activity to focus on in such an industry (Goodhue & Thompson, 1995), to keep track of the product life cycle (Barratt & Oliveira, 2001) (Pramatari, 2007), thereby ensuring that the shelf life of products is long enough to allow the company to maximize on the cash-flow stage of the product life-cycle by using current movements of product to figure out how much of a "cash-cow" product will be needed over its remaining product-cycle until the product becomes a "dog"9.

H6: Industries with lower demand variability will have decreased Forecasting use of CPFR systems.

In supply chains where products sell on-line and in high-volumes, efficiency of order-fulfilment is necessary in order to keep customers satisfied. When customers buy these mass marketed products on e-bay or Amazon, super-fast shipping, low-cost and high-availability are essential to customer-satisfaction (Gunasekaran, Patel, & Tirtiroglu, 2001). In these situations, prediction and planning becomes more difficult and so flexible

and efficient day-to-day replenishment type activities become the greater competitive imperative as staff filling these orders deal with stock-outs and unexpected order-volumes. In this type of fire-fighting situation, replenishment use of IT for CPFR will be a better fit for ensuring efficient, responsive delivery of products to customers (Goodhue & Thompson, 1995).

H7: Supply chains with higher production-volumes will have increased Replenishment

**Use of CPFR systems**

Company Trust Configuration

If senior management believes that they have competent workers working for them, who use the systems effectively, they will put more faith in the data coming from order-fulfillment systems (McAllister (1995) and believe it is fit for use in making business plans. This effect is increased if the company operates in a high-tech industry where new product versions come out regularly; forcing them to keep track of what has happened with previous product versions, especially customer complaints as entered by the customer-service reps6. Based on Innovation Diffusion theory, Management will be inclined to positively influence staff who use these systems (Bayer & Melone, 1989) to increase their level of adoption (Rogers, 2010) so that the data is complete, thereby increasing system use for planning.

H8: Increased confidence of Management in (dependability of) workers will cause increased Planning use of CPFR systems.

As workers trust management more (Mayer & Davis 1999), they will be more willing to record replenishment and customer-service activities in the system since they will see the system as a productivity tool, not an automation or labor replacement tool. The problem

occurs if users feel they are going to be replaced by automation which simply captures their quick customer service abilities and institutional memory of problem solving, then they are less likely to use and embed their hard-won knowledge into systems that they perceive to simply be labor replacement tools. If trust of workers in management that they will deal with the workers benevolently, then they will lean heavily on order-fulfilment functionality to keep up. This makes the data a good fit for figuring out demand patterns (Goodhue & Thompson, 1995) and will in turn be encouraged by management (Bayer & Melone, 1989) (Rogers, 2010) since it allows them to leverage the data more effectively to do forecasting . This increased forecasting will replace planning which would normally take place to absorb inefficiencies in forecasting to smooth the inadequacies in the accuracy and precision of forecasting.

H9: Increased trust of workers in (Benevolence of) Management will cause an increase in forecasting use of CPFR systems.

H9 was eventually dropped, because the scale was considered to be problematic and abandoned on questionnaire. This was due to concerns expressed by two sets of people. The IRB committee believed this scale to be potentially damaging and most likely to violate the principle of 'doing no harm' to the respondents. Managers who were asked to critique and validate the questionnaire, thought that the questions were too probing and would very likely cause other managers looking at the questionnaire, to stop responding to it. In fact one manager indicated that top executives at his company would be very likely refuse to allow him to answer the questionnaire at all. One manager felt that many managers who scanned the questionnaire ahead of responding to it, would very likely opt out, upon seeing questions like trust in senior managers. There was a general sense that

these questions could be seen as a trap, to bait middle-managers into revealing their misgivings about higher-level managers.

When customer-service staff have greater confidence in the CPFR systems to process customer orders accurately and efficiently (Cook & Wall, 1980), they will make greater use of the system for replenishment activities since it makes their work day easier. Replenishment use of CPFR becomes a good fit (Goodhue & Thompson, 1995) for their customer service efforts. This will drive up replenishment use of CPFR systems.

H9 (formerly H10): Increased confidence in (reliability/usefulness of) CPFR systems will cause an increase in Replenishment use of CPFR systems.

**Survey procedures**

Before the survey (appendix-B) was launched, it was content-validated by sending it to several managers from who gave several useful suggestions for making it more industry-friendly, answerable, flow more effectively. Most importantly, they gave input on ensuring that the questions were as accurately as possible, capturing the construct they were meant to measure. The questionnaire was edited exhaustively to capture the managers concerns. Please see appendix C.

**Emails**

A list of 3939 managers were emailed and invited to take the survey. Of that number, 900 emails turned out to be invalid, mostly because the manager no longer worked at the company. This was verified in the course of making personal phone calls to the managers to try to convince them to take the survey. After calling around 300 managers, I verified (based on sampling) that the invalid emails belonged to managers who no longer worked at the company. More than 95% of the calls made to the mangers ended with leaving

voicemails after being screened by their secretaries. These high level managers were largely unavailable to anyone who was not directly known to them or their personal secretaries.

As much as 5 waves of reminders were sent out to each group (please see Appendix D). As per the agreement with the email list provider, at least a week was allowed to pass between reminders. Several strategies were attempted in order to appeal to the managers to respond to the survey. An official toned email was sent, shown below. Next I attempted to get them to respond using several incentives, as shown in the next email. After several such tweaks of the previously mentioned approaches, they were sent a very personal email detailing the importance of the

**Response rate**

In the end, the response rate was 2.5% (75 responses from 3000 emails with 57 complete responses).

**Measures**

[Insert Table-2 Here]

[Insert Table-3 Here]

[Insert Table-4 Here]

According to the Technology Acceptance Model (Davis, 1986), the likelihood that users will actively adopt technology is driven by the usefulness of the technology. In the

current study, I examine the use of technology by various levels of the organization, in particular, the operational levels versus the strategic levels. The construct representing Strategic-VS-Operational IT-use in the organization was measured by a scale which incorporated 9 items as shown in the table above. Each measure is represented by an item on the questionnaire, which indicates the usefulness of the system increasing in order from the left-most choice to the right-most choice on the scale. In order to combine them into a single factor, z-scores were computed and then averaged to form a scale score which was used in the regression analysis.

Scale Reliability was calculated was calculated for the scale to measure the intra-class correlation of the variables. The scale had a Cronbach's alpha of .520 which is considered to be unacceptable based on (Peterson, 1994).

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 27.7% of the variance. Only OS4_Structuredness, OS5_NonRoutine & OS6_OpenEnded loaded unto the first factor above the low-level cutoff of .6 (Peterson, 1994). Component-2 accounted for 22.86% of the variance. Only Items ZscoreCS_MutlSrv & ZscoreCS_dailymvmt loaded unto the second factor about the cutoff of .6.

[Insert Table-5 Here]

[Insert Table-6 Here]

The Technology Acceptance Model (Davis, 1986), tells us that the ease of use of a

particular technology will positively affect the adoption by a set of users in an organization. In the current study, I examine how easily technology can be used by organizations practicing various stages of CPFR.

The construct representing the Stage of CPFR was measured by a scale which incorporated 8 variables as shown in the table above. Each measure is represented by an item on the questionnaire, which indicates how easily the system allowed for integrating with the partner's activities. The ease of use increases in order from the left-most choice to the right-most choice on the scale.

In order to combine them into a single factor, z-scores were computed and then averaged to form a scale score which was used in the regression analysis.

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 35.5% of the variance. Only OS4_Structuredness, OS5_NonRoutine & OS6_OpenEnded loaded unto the first factor above the low-level cutoff of .6 (Peterson, 1994). Component-2 accounted for 20.56% of the variance. Only Items ZscoreCS_CollabFrequency, ZscoreCS_CollabIntegration, and ZscoreCS_CollabOngoing loaded unto the second factor above the cutoff of .6 for acceptable loadings.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .71 which is considered to be good.

[Insert Table-7 Here]

[Insert Table-8 Here]

Task Technology Fit theory (Goodhue & Thompson, 1995) says that a technology will be considered as useful to a potential user, if it fits the task the user is working on.

The construct representing the Planning-IT-use was measured by a scale which incorporated 4 variables as shown in the table above. The questionnaire items measured the fit of the technology for planning use, with responses that captured how the technology is used for planning, with fit increasing from left to right.

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 55.2% of the variance. P3_Product & P4_Prodlin loaded unto the first factor above the cutoff of .8 for good fit (Peterson, 1994). P1_ProcPrd loaded unto the first factor above the cutoff of .6 for acceptable loadings. Component-2 accounted for 19.88% of the variance. Only Item P2_ProdMixloaded unto the second factor above .8 for good fit.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .719 which is considered to be good (Peterson, 1994).

[Insert Table-9 Here]

[Insert Table-10 Here]

A technology is considered useful to potential users, when it fits the task they are responsible for, based on the Task Technology Fit theory (Goodhue & Thompson, 1995). The construct representing the Forecasting-IT-use was measured by a scale which incorporated 4 variables as shown in the table above. The questionnaire items capture how well the technology fits forecasting use, with responses that captured the fit, increasing from left to right.

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 65.6% of the variance. As can be seen in the table below, F1_FutrDmd & F4_FrcstDm had excellent loading at .8 unto the first factor while F1_ProdLvl & F3_DetDmnd had good loading at .7. Component-2 accounted for 19.88% of the variance. There were no significant loadings unto the second component.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .824 which is considered to be very good (Peterson, 1994).

[Insert Table-11 Here]

[Insert Table-12 Here]

According to the Task Technology Fit theory (Goodhue & Thompson, 1995) technology which fits the task the user is working on, will be thought to be useful to the user.

The construct representing the Replenishment-IT-use was measured by a scale which incorporated 4 variables as shown in the table above. The questionnaire items measure IT

system's fit for replenishment use, with responses that reflect fitness for replenishment use, increasing from left to right.

A CFA was also done to determine the contribution of each variable to the construct. Component-1 accounted for 45.7% of the variance. As can be seen in the table below, R2_Orderng & R3_Reorder loaded at the recommended level of .7 unto the factor while R4_OrdrQnt loaded acceptably at .6. R1_InvtRdc loaded poorly at .5. Component-2 accounted for 22.0% of the variance and had R1_InvtRdc loaded very strong at .8.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .6 which is considered to be acceptable (Peterson, 1994).

[Insert Table-13 Here]

[Insert Table-14 Here]

Innovation Diffusion Theory (Rogers, 2010), indicates that adoption of innovations tend to be difficult for early adopters. But as they learn and understand the benefits and pitfalls of the technology, users observing them using the technology will gain confidence. This allows for a quicker, more confident adoption of the technology by the observers.

The construct representing the Confidence in I.T. System was measured by a scale which incorporated 5 variables as shown in the table above. The questionnaire items measure the confidence of staff in adopting the IT system, based on IT department's management of the system, with responses that reflect their confidence increasing from left to right.

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 62.3% of the variance. As can be seen in the table below, CI3_MgtCns & CI5_ConfSk had very good loadings unto the factor at .8, while the loadings for CI1_Escala, CI2_MgtPrs & CI4_Carefu were good at .7. Component-2 accounted for only 15.1% of the variance and had no significant variable loadings.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .85 which is considered to be very good (Peterson, 1994).

[Insert Table-15 Here]

[Insert Table-16 Here]

According to Innovation Diffusion Theory (Rogers, 2010), adoption of innovations will take time for early adopters. But as they learn and understand the benefits and pitfalls of the technology, users observing them using the technology will learn by proxy. This allows for a smoother and quicker adoption of the technology by the observers.

The construct representing the Confidence in Junior Staff (workers) was measured by a scale which incorporated 5 variables as shown in the table above. The items measure the confidence of Management in adopting the IT system, based on staff's use of the system, with responses that reflect their confidence increasing from left to right.

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 41.1% of the variance. As can be seen in the table below, CW2_Qualit,

CW3_WrkArd & CW5_ClsTrk had good loadings at .8 unto the factor. Component-2 accounted for 28.1% of the variance. CW1_BackPl & CW4_ChckOn had good loading unto the second component.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .61 which is considered to be acceptable for exploratory research.

[Insert Table-17 Here]

[Insert Table-18 Here]

Technology Acceptance Model (Davis, 1986), says that users will adopt technology based on its usefulness. In the current study, I examine the usefulness of the IT system for increasing operational performance. The construct representing Operational Performance was measured by a scale which incorporated 3 variables as shown in the table above. The items measure how useful the IT system was for improving performance, with responses indicating higher performance, increasing from left to right.

A CFA was done to measure the intra-class correlation of the variables. Component-1 accounted for 79.9% of the variance. As can be seen in the table below, OP1_Invtry OP2_StckOt excellent loading unto the factor, above.9. OP3_LdTime had a very good loading unto the factor, above .8. Component-2 only accounted for 14.3% of the variance and had no significant variable loadings.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the

variables. It showed that the scale had a Cronbach's alpha of .87 which is considered to be very good (Peterson, 1994).

[Insert Table-19 Here]

[Insert Table-20 Here]

According to the Technology Acceptance Model (Davis, 1986), users will adopt technology if it is useful to them. In the current study, I examine the usefulness of the IT system for increasing market performance. The construct representing the Market Performance was measured by a scale which incorporated 3 variables as shown in the table above. The items measure how the IT system was useful in improving performance, with responses indicating better performance, increasing from left to right.

A CFA was done to measure the loading of variables unto each factor. Component-1 accounted for 66.5% of the variance. MP1_NewPrd & MP2_EcnGrw had very good loading unto the 1st factor while MP3_CusRet had good loading. The second component accounted for 20.1% of the variance and only MP3_CusRet loaded marginally unto the second factor.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .747 which is considered to be good (Peterson, 1994).

[Insert Table-21 Here]

[Insert Table-22 Here]

Technology Acceptance Model (Davis, 1986), indicates that technology which is easier to use, is more likely to be adopted. The usefulness of technology for facilitating various product life cycles was measured by the questionnaire. The construct representing the Product Life-Cycle was measured by a scale which incorporated 3 variables as shown in the table above. The items measure how easily the IT system was to use for various product life-cycles, with responses indicating longer life-cycles, going from left to right A CFA was also done to determine the contribution of each variable to the construct. Component-1 accounted for 76.3% of the variance. All 3 variables loaded at a very good .8. Component-2 accounted for just 9.2% of the variance and had no significant variable loadings.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .90 which is considered to be excellent (Peterson, 1994).

[Insert Table-23 Here]

[Insert Table-24 Here]

There was no construct representing Product Technology-Level, because it was represented by a mixture of Likert scale variables (LC4_Obsole & LC5_Techno) and

dummy variables (LC6_EmbedT1, LC6_EmbedT2, LC6_EmbedT3, LC6_EmbedT4 & LC6_EmbedT5):

[Insert Table-25 Here]

According to the Task Technology Fit theory (Goodhue & Thompson, 1995) technology which fits the task the user is working on, will be thought to be useful to the user.

The construct representing the Replenishment-IT-use was measured by a scale which incorporated 4 variables as shown in the table above. The items measure how well the IT system fits the management of high-volume products versus the fit for niche products. Responses to the right indicate the system was a better fit for managing niche products. On the scale for High-Volume-VS-Niche Demand there are two extremes as follows: A high volume, commodity product is a mass-market product with little to no demand variability. At the opposite end of the scale is the niche product which has highly variable demand driven by the market in which it exists. The construct representing the High-Volume-VS-Niche Demand was measured by a scale which incorporated 7 variables as shown in the table above. LP1_CompDm & LP2_ DemPrd& LP6_Niche were found to be reverse coded and so they were inverted to come back in line with the scale.

A CFA was also done to determine the contribution of each variable to the construct. Component-1 accounted for 24.4% of the variance. As can be seen in the table below, only 1 variable (LP3_Loyalty) had excellent loading unto the factor with .8 but the next best loadings were LP5_Features and LP2_DemPrd_REV with unacceptable loadings. Component-2 accounted for 19.7% of the variance and had a good loading of

LP6_Niche_REV at .7 and LP1_CompDm_REV at an acceptable .6.

Scale Reliability was calculated for the scale to measure the intra-class correlation of the variables. It showed that the scale had a Cronbach's alpha of .380 which is considered to be very unacceptable.

[Insert Table-26 Here]

## RESULTS

Hypothesis-One: Hypothesis 1 suggested that as partners deepen their collaboration using CPFR, their Use of CPFR systems would take on a more Strategic nature. This is because more complete, richer data, should end up being shared between partners. So executives would be able to make more creative, freeform use of the data to make executive level decisions.

To test this hypothesis, I ran a regression with Strategic-VS-Operational IT-use (Construct) as dependent variable and Stage of Collaboration (Construct) as independent variable.

The control variables in this (and all subsequent models) were Age-of-System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system is used for. Table-27 summarizes the results of the regression.

[Insert Table-27 Here]

Hypothesis 1 was supported: In the regression having Strategic-VS-Operational IT-use as dependent variable, the coefficient for Stage of Collaboration was positive as predicted, and significant at the .05 level. (B=.392, t=2.148, p=.039).

Hypothesis two: Hypothesis 2 suggested that high-tech products are being sold increasingly on-line, which represents an unpredictable market, and so they need to be managed at the executive level in order to control all aspects of the product's design, manufacturing, marketing and distribution. Hence high-tech products should increase strategic use of CPFR systems.

To test this hypothesis, I ran a regression with Strategic-VS-Operational IT-use as dependent variable. The independent variables were the variables representing product-technology-level. The variables used to measure the product-technology level were mixed (dummy variables and Likert scale) and so they were not combined into a unified scale. So the independent variables in the regression were two Likert scale variables. Time to become obsolete & Age of product-technology. The independent dummy variables were: Embedded: No-Technology, Embedded: Integrated-Circuits, Embedded: Application Specific ICs, Embedded: System-on-Chip and Embedded: Networked-Sub-Systems.

The control variables in this were again: Age of the System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the

main function that the system us used for. Table-28 summarizes the results of the regression.

[Insert Table-28 Here]

Hypothesis 2 was very barely supported, and only at the .1 level of significance. Time to become obsolete had the opposite sign to what was predicted. Embedded: No-Technology had the correct sign to what was predicted (the implication being a double negative: if it had no technology then it had a negative effect on Strategic use. It follows that if it had technology then it should have a positive effect on strategic use. But the other variables were not significant, so you could only conclude that by a stretch of the imagination). The two variables were significant only at the .1 level. (B = -.293 and, -.494) respectively.

The following variables were not significant: Age of product-technology (Likert-scale), as well as the dummy variables: Embedded: Integrated-Circuits, Embedded: Application Specific ICs, Embedded: System-on-Chip and Embedded: Networked-Sub-Systems (B = .074, -.191, -.334, .388, and -.346 respectively).

Hypothesis-Three: Hypothesis 3 suggested that higher production volumes increase the Operational use of Collaborative systems. This is because high production volume products require better day-to-day management, as this is where competitive advantage is gained or lost in these markets.

To test this hypothesis, I ran a regression with Strategic-VS-Operational IT-use as dependent variable and High-Volume-VS-Niche Demand as independent variable.

The control variables were Age of the System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system us used for. Table-29 summarizes the results of the regression.

[Insert Table-29 Here]

Hypothesis 3 was supported: In the regression with Strategic-VS-Operational IT-use as dependent variable, the coefficient for High-Volume-VS-Niche Demand was negative as predicted (negative coefficient indicates increasing Operational use, while positive coefficient would have indicated increasing strategic use), and significant at the .05 level (B=.346, t=2.220, p=.033).

Hypothesis-Four: Hypothesis 4 suggested that a faster product life-cycles would increase the operational use of Collaborative systems. Like higher production volumes, short product-life-cycles mean that competition against another company's product is won or lost in the effective change-over of products (managing operations at the shelf level), in order to maintain customer satisfaction at the point-of-sale.

To test this hypothesis I ran a regression with Strategic-VS-Operational IT-use as dependent variable. Because there were problems with the product-life-cycle scale, I used the following variables as the independent variables: Time-to-Rollout-Products, Time-to-Adopt-Products and Frequency-of-Product-Changes.

The control variables were Age-of-System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system is used for. Table-30 summarizes the results of the regression.

[Insert Table-30 Here]

Hypothesis 4 was not supported. None of the product-life-cycle variables mentioned above, had a significant impact on the Strategic-VS-Operational IT-use.

Hypothesis-Five: Hypothesis 5 suggested that as technology in products increased, planning use would become more strategic. This is because high-tech products require greater levels of planning over their shelf-life in order to ensure customers are getting the latest and best features, using R&D to provide them at competitive prices.

To test this hypothesis, I ran a regression with Planning-IT-use as dependent variable. The independent variables were the variables representing product-technology-level. The variables used to measure the product-technology level were mixed (dummy variables and Likert scale) and so they were not combined into a unified scale. So the independent variables in the regression were two Likert scale variables. Time to become obsolete & Age of product-technology. The independent (dummy) variables were: Embedded: No-Technology, Embedded: Integrated-Circuits, Embedded: Application Specific ICs, Embedded: System-on-Chip and Embedded: Networked-Sub-Systems.

The control variables were Age of the System, Company-Size (Revenue-based),

Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four control variables represent the main function that the system us used for. Table-31 summarizes the results of the regression.

[Insert Table-31 Here]

Hypothesis 5 had no support, as Planning-IT-use showed no significant correlations against any of the product-technology-level variables.

Hypothesis-Six: Hypothesis 6 suggested that higher production volumes decreases forecasting use of Collaborative systems. This is because high production volumes reduce the fluctuation of demand at a market level, creating a smoothing effect on required production levels and reducing the need to forecast.

To test this hypothesis, I ran a regression with Forecasting IT-use as dependent variable. Because the scale had a lot of problems, with some of the items reverse coded, the scale for Volume-VS-Niche Demand did not hold together (with a Cronbach's alpha of .38). And so the regression was run using the individual items: Competition-driven-Demand, Predictability-of-Demand, Customers-Brand-Loyalty, Luxury-product, Niche-market-product, Product-Features and Uniqueness-of-product.

The control variables were once again: Age of the System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System,

Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system us used for. Table-32 summarizes results of the regression.

[Insert Table-32 Here]

Hypothesis 6 was very barely supported, and only at the .1 level of significance. Although Competition-driven-Demand had the correct sign, it was significant only at the .1 level. (B = -.325). Predictability-of-Demand, Customers-Brand-Loyalty, Luxury-product, Niche-market-product, Product-Features and Uniqueness-of-product were not significant (B = .156, -.182, .032, -.021, -.005 and .264 respectively).

Hypothesis-Seven: Hypothesis 7 suggested that higher production volumes (mass market product) increases the Replenishment use of Collaborative systems. This is because high production volumes necessitate better customer-interaction management as this is where competitive advantage is gained or lost in high-volume products. Customer satisfaction in this scenario is less about the product itself and more contingent on smooth order-fulfilment and customer interactions.

To test this hypothesis, I ran a regression with Replenishment-IT-use as dependent variable. As explained for Hypothesis-6 (above) the scale for Volume-VS-Niche Demand did not hold together and so the regression was run using individual items including: Competition-driven-Demand, Predictability-of-Demand, Customers-Brand-Loyalty, Luxury-product, Niche-market-product, and Uniqueness-of-product.

The control variables were the same as above: Age of the System, Company-Size

(Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system us used for. Table-33 summarizes the results of the regression.

[Insert Table-33 Here]

Hypothesis 7 had no support at all, as Replenishment-IT-use showed no significant correlations against any of the Volume-VS-Niche Demand variables.

Hypothesis-Eight: Hypothesis 8 suggested that as Management's confidence in their workers improved, planning use of IT would increase. This is because management would have more faith in the completeness and accuracy of the data coming from their staff and find it more useful for the ultimate use, on which the company could stake its future, i.e. production planning.

To test this hypothesis, I ran a regression with Planning-IT-use as dependent variable and Confidence-in-Workers as independent variable.

The control variables (as in all the previous models) were Age-of-System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system us used for. Table-34 summarizes regression results

[Insert Table-34 Here]

Hypothesis 8 was supported: In the regression having Planning-IT-use as dependent variable, the coefficient for Confidence-in-Workers was positive as predicted, and significant at the .05 level (B=.296, t=2.164, p=.037).

Hypothesis-Nine: Hypothesis 9 suggested that as Confidence-in IT improved, replenishment use of IT would increase. This is because in the rubber-meets-the-road, fire-fighting of order-fulfilment, workers will replace manual record keeping, and instincts with IT system data, only if they have confidence in the system.

To test this hypothesis, I ran a regression with Replenishment-IT-use as dependent variable and Confidence-in-IT as independent variable.

The control variables were (as in all the other models): Age of the System, Company-Size (Revenue-based), Company-Size (# of Employees), Main trading partner (Customer or Supplier), and the dummy variables: Manufacturing_System, Distribution_System, Logistics_system and MarketSales_System. The last four dummy variables represent the main function that the system us used for. Table 35 summarizes the regression results.

[Insert Table-35 Here]

Hypothesis 9 was not supported. Even though Replenishment-IT-use was significant against Confidence-in-IT at the .05 level, the sign was opposite to what was predicted (B=-.280, t=2.151, p=.038).

## DISCUSSION

As firms deepen their collaboration, they increasingly synchronize their operations. This means they will make bigger decisions together, increasing the number of processes on which they collaborate, and deepening their organizational coordination. This will lead to use of collaborative IT at higher levels of the organization and ultimately, to increased strategic use (Danese, 2007; Kolluru & Meredith, 2001; Skjoett-Larsen, et al., 2003). The Stage of Collaboration practiced between partners was found to have a significant effect on the Strategic IT use for Collaborative Planning, Forecasting and Replenishment (CPFR) in the organization. Based on Technology Acceptance Model (Davis 1986), this makes sense, because as collaboration between partners becomes entrenched, supply chain partners will find it useful to deepen the level of information exchange between them. It is expected that the actual data being exchanged will become more meaningful and richer. This will make it increasingly useful to use IT systems at the executive levels for strategy according to TAM (Davis, 1986). Organizations need to leverage every capability at their disposal and so if they are taking the time to exchange data, especially with the concurrent increase of exposure, then it is to be expected that management, fully aware of the downside of exposing confidential data, will want to increase the upside by leveraging the shared data coming from their partner—as well as the overall richness of the information generated in the partnership—to gain insights in order to enrich their decision making.

Products which are prone to obsolescence require constant feedback to ensure that they are not being distributed after their useful shelf life has passed (Castellucci & MacKenzie, 2011, p. 15).The technology within products was expected to affect the

organizational level at which CPFR Information Technology is used. But this effect was found to be minimal-to-non-existent. Of the 7 variables tested, only 2 variables had any effect (at the .1 level of significance). Those variables were a) Time to become obsolete & b) having no embedded technology. The effect of having no embedded technology suggests that having no technology actually has a negative effect on strategic use (suggesting it positively affects operational use?).The other variable which had an effect: Time to become obsolete also had a marginal effect (.1 level of significance), suggesting that what causes an increase in strategic level of IT use—is really the overall useful life of the product—of which technology is just a small part. User needs, perceptions, regulatory environment, awareness, social trends also impact the obsolescence of a product and so it really was not an adequate measure.

High technology products need constant updating to make sure that their features are relevant and tuned to the constantly changing landscape of the consumer markets in which they sell. But the predicted relationship between product-technology-level and use of IT for planning purposes (Castellucci & MacKenzie, 2011, p. 15) also did not hold. It is unsurprising that if the previous relationship did not hold, then this one would not either. Planning and strategic use go hand in hand, since planning is a strategic level endeavor, for the most part. And so anything which affects system use for planning probably should have similarly increased its use at the strategic level. Mind you, the logic is not exhaustive, as many of the aspects of planning could be tactical or operational activities; and a lot of the data and systems used for planning could be shared between the operational and strategic levels. In the current study, there was the problem of the sample coming from senior executives, who attempted to answer very technical questions. This

would require them to possess a depth of technical knowledge, enabling them to estimate such detailed product-technology questions. Executives are not known for their hands-on technical knowledge (when they are too hands on, they are known as micro-managers). So the scale certainly needed to be more developed in order to be more robust at all levels of the organization. Ideally it should have items to capture, in a more general way, the manifestations of product-technology-level. Possible questions for fine-tuning the scale could include: "Our product is seen as the most advanced in its class", "consumers prefer our product because of the technological features", "our products biggest selling point is the advanced technology inside", "R&D contributes to the strength of our product on the market", "Technical qualifications and training is a big part of our product team's success".

In industries where the products have a short life cycle, there is constant phasing out of old products and introduction of new products. So manufacturers need to constantly monitor point of sale data from down-stream partners in order to quickly figure out where their products are in the product-life-cycle (Barratt & Oliveira, 2001). It was predicted that faster Product life cycles would cause greater operational use of IT, since shorter product life cycles would require more day-to-day management of the product distribution to ensure that the product is not taking up valuable production capacity and shelf-space beyond its useful life. This was expected to be a strong relationship, especially with today's reviews on social media, where inadequacies & flaws found in the product or unmet customer expectations as a result of newer & better products, would cause product obsolescence to be even more dramatic (H. L. Lee, 2002). However, product life cycle was not shown to have any effect on operational use of Information

Technology for CPFR. The issue here may be whether life-cycle is being accurately or adequately captured by Time-to-rollout-products, Time-for-customers-to-adopt-products and Frequency-of-Product-Changes.

Although the product-life-cycle scale held up well, with a Cronbach's alpha of .90, it is possible that it may not be capturing the intended construct using this particular sample of senior executives. Also, the dependence on senior executives to answer the questionnaire, may have introduced some noise into the measurement of operational-IT-use. VPs—who were the typical respondents—introduces a definite bias. These executives would tend to use systems at a more strategic level, so would they be capable of answering in a level-neutral way? This is probably reflected in the scale for that construct, being far shy of perfect, with a Cronbach's alpha of .520—which is indicative of serious scale problems. The structured-use, non-routine-use and open-ended-use of the system use loaded together well on the first factor. But other questions indicating the organization level and time-frame affected by decisions made using the system (#-people-system-affects, Time-frame-affected-by-System-use & Financial-level-affected-by-System-use) may bring broader organizational factors to mind when the respondents are answering the questions, aside from just the plain system use. So these questions might have been measuring more than just how strategically or operationally, the system is used. Similarly, Main-users-of-System is very user focused while Specificity-of-system-directives would really vary a lot based on the function that the user is performing in their job; and the options provided by the system would typically be driven by that basic job junction. So they may have been too user-focused to be effective questions (again, heavily influenced by the sample of executives). This means that Main-users-of-System and Specificity-of-system-

directives are not so much bad questions, as they are very highly dependent on who you ask, what they do, and the level at which they operate in the organization. And so for those questions to be answered adequately, the survey needed to get the responses of a broader, much more representative sample.

Consistent with the Task Technology Fit theory (Goodhue & Thompson, 1995), products relying on high-volume production should be managed using operational Information Technology, since efficiency achieved with operational IT would fit the 'rubber-meets-the-road' model critical to successfully selling these products. Order-fulfilment is a key to winning in the low-cost, commodity based on-line markets such as e-bay or Amazon. In these product markets, super-fast shipping, low-cost and high-availability are essential to customer-satisfaction (Gunasekaran, Patel, & Tirtiroglu, 2001). Volume-VS-Niche Demand did indeed have a significant effect on [the negative side of strategic-use] Operational-IT-use (despite suffering from reverse coded items in the scale). There is an adage that 'one simply does not advertise bread' [insert Viggo Mortensen meme, here]; it sells itself! Now companies do have to be careful about underestimating the need for dynamism and fluidity in the marketplace for commodities. Because even basic commodities need to be redesigned from time to time, for various reasons. For one thing, there is the need to make use of new materials and production techniques, which allow them to be more cost effective (a desirable feature of commodities). Also, standards change as more research demonstrates that materials we took for granted are not as safe for human-use, or as environmentally friendly, as previously thought. And then there are new raw-materials (especially plastics) constantly appearing on the market that allow products to be more flexible, stronger, or less toxic (also desirable features of even the

most basic commodity).

Still, the delivery of a commodity, is the primary point at which the consumer interacts with it. With these commodities, the smoothness of product purchase, as well as accessing technical-support & warranty benefits should be more important than the deeper—more long term—product quality issues. So product planning while still important with commodities, is ultimately not as make-or-break as direct customer-level, day-to-day interaction. Hence the need to specialize more in customer-interaction management which is the focus of operationally focused CPFR systems. However, no link was established between High-Volume products and Replenishment-IT-use, which was especially surprising since it did correlate with Operational-IT-use. While it is true that both of the scales for Strategic-VS-Operational IT-use and Volume-VS-Niche Demand were problematic (previous discussion), it is possible that the noise did not interact in a way that nullified the significance of the effect on each other. But the noise in the Replenishment-IT-use scale did seem to be overwhelming enough to suppress any significant effect of the reverse-coding affected Volume-VS-Niche Demand. While the other three Replenishment-IT-use variables loaded well on the factor, the questions asking whether the 'benefit' of the system was lead-time and inventory-reduction seemed not to fit. It likely would have been better if they had a more action (instead of outcome) feeling such as "We make inventory-based decisions while using the system".

The high-volume side of the Volume-VS-Niche Demand scale, also manifested a very bare minimum effect on Forecasting. The number of units of product that your customers want, at any given time, should not be hard to figure out with a high-volume commodity. Hence the prediction that there should be a negative relationship between Volume-VS-

Niche Demand and Forecasting-IT-use. (H. L. Lee, 2002). However, the only variable with a significant effect (0.1 level of significance) on Forecasting-IT-use, was Competition-driven-Demand, indicating that the single biggest predictor of Forecasting-IT-use for CPFR is the dependence of the company's product-demand on the competitor's products. The suggestion here is that a competitor dropping their price, or releasing a slightly better version of their product, would be the main scenarios which would send an organization scrambling to improve their forecasting efforts. In this scenario, efficient forecasting–expertly placing just enough product at the right place and right time at the right price—would hopefully compensate for any deficiencies in the product itself (relative to competitors offering). The other suggestion is that they could be repositioning equivalent products head-to-head with the competitor's current 'hot' or 'marked-down' product.

Confidence-in-Workers and Confidence-in-IT had passable & very-good scales in that order, with Cronbach's alphas of .61 & .85 respectively. And it was expected that confidence in the CPFR systems (allowing workers to process customer orders with confidence) would increase replenishment use of IT (Cook & Wall, 1980). And Confidence-in-IT had the better of the two scales, with a stronger Cronbach's alpha. But while it did produce a significant result against Replenishment-IT-use, the sign was not as predicted. The indication is that Confidence-in-IT reduces use of Replenishment-IT-use. There are two plausible explanation for this. Either confidence in IT increases the use and effectiveness of IT for other purposes such as Planning and Forecasting—to the point of overshadowing the use of IT for replenishment, by comparison. Or, there is a virtuous cycle; in which replenishment-IT is so smooth, that it makes the replenishment process

all but disappear and blend into the background. It could be that in these cases, users are not consciously aware of the full extent to which they use the system (or judge their system use to be minimal relative to what the system accomplishes). This is certainly a future direction for more research.

In order to achieve the required level of integration, objectives of the supply-chain partners must be aligned and they need to share their risks and rewards along with their resources (Büyüközkan, Vardaloglu, & Feyzioglu, 2009). When managers are involved in relationships which carry low levels of trust, more legal resources are required to enforce agreements and monitor them for compliance (McAllister (1995; Bayer & Melone, 1989; Dohmen, Moormann, & Rosemann, 2009). Innovation Diffusion Theory indicates that if management, through observing junior staff's use of IT, gains confidence in the way their staff use IT, then they will achieve confidence in using it themselves (Rogers, 2010) for the purpose of planning. Based on these expectations, Confidence-in-Workers had a significant and positive effect on Planning-IT-use as expected, and in keeping with IDT (Rogers, 2010). As discussed before, if management trusts the work which is being done in the partnership of both companies, particularly at the lower-levels, then they will put more faith in the data coming from the lower levels of the collaborative system shared by both companies (McAllister, 1995) and believe the outputs to be useful. Management will use these outputs increasingly for their planning purposes, instead of reverting to current institutional knowledge, or their gut instincts (Goodhue & Thompson, 1995; Cook & Wall, 1980). However, without basic confidence in the people putting data into the system, managers will not lean on the collaborative systems for making decisions. Hence, as the current study shows, Confidence-in-Workers increases Planning-IT-use in CPFR.

## LIMITATIONS

Sampling issues were the biggest limitation in the current study, the elephant in the room, so to speak. The first problem is that the sample was limited to very senior managers in large companies. 80% of the companies had revenue of 100M or more, with over 58% generating more than 250M. Within these large companies, 50% of the respondents were within 2 levels of the CEO. So the sample was skewed toward people who make big decisions in the normal course of operating within large companies, and would be responsible for millions of dollars, over a time frame of months. This seemed to show up in the technology scale where there were inconsistencies in evaluating the strategic nature of decision-making, the technology within a product, and commodity/niche nature of a product.

The other limitation was directly tied to the nature of the respondents, as the email list that was used, consisted of senior managers who were extremely busy and as a result, very short on spare time. It did not help that the questionnaire was long, requiring 12 – 18 minutes in most cases. Many of the would-be respondents also stated that their company policy was not accommodating of this type of questionnaire. And so it was very difficult to convince them to participate in the study. This had two undesirable spinoffs. First, the sample size was small as a result, with only 70 responses collected. Ideally, I was aiming for 300 respondents in order to ensure there was adequate statistical power. Also more desirably, an initial sample would have been collected, and the scales pre-validated using CFAs and EFAs before finalizing the scales and collecting the final dataset to be used in testing the hypotheses. With the small sample size collected, every single response had to be used to have any chance at statistical power. The other more subtle, but still

undesirable effect, was that I had to beg, plead and cajole the managers to respond to the questionnaire. This took months, and so several managers would have responded to vastly different appeals which were sent in the course of the study. This makes it impossible to do a non-response-bias analysis based on late respondents. More problematically, the effect of the pity-factor (which varied over the course of the study) on the objectivity of the responses, is anyone's guess.

Another important limitation of the current study is that respondents were asked to answer questions based on the main system used to collaborate. There are two obvious problems, the first being that they may use more than one system to collaborate in their supply chain. And so asking them to use their interaction with only one system to represent the way they collaborate with companies, using IT will have some overlap. And even if they only use one system to collaborate with Supply chain partners, they may use several systems in their overall job functions, causing them to think of several unrelated system scenarios when answering questions. This, I attempted to mitigate by using the name of the system they initially chose, to constantly remind them which system they should be thinking of when answering the questions..

## FUTURE RESEARCH

The limited support for Hypothesis 2 and 4 suggests that some more work needs to be done on the Strategic-VS-Operational IT-use scale. It is clear that the study could have benefited from having more respondents as well as a more vertically-diverse sample which represents the perspectives of more levels of the organization. I plan to test this with a relaunch of the survey using a list of 10,000 middle managers (with an initial sample of 1000). What is particularly striking is that that the creative decision making

aspect held together well on the scale, so that at the heart of the support for hypothesis-1 is creative, unstructured decision making. The impacts and effectiveness of strategic decision making are by their very nature, inherently harder to measure based on their wider-scope, longer-time frames and more creative nature. To cope with this, you could aggregate across time and space to measure the other dimensions, but measuring the creativeness of a decision is going to be much harder. And so the big take away for future research, is the need to fine-tune the Strategic-VS-Operational IT-use scale to adequately measure the creative component as well as the development of another scale to isolate the effect of creative decisions within strategic decision making.

The high-technology scale also needs to be developed further to operationalize it, and make it more robust in measuring the levels of product technology from various levels in the company. A future research direction could certainly be the investigation of contrasting views of a construct like product-technology-level, to see how it varies from the operational to the strategic levels of the organization.

The Volume-VS-Niche Demand scale also needs more development as seen in its low Cronbach's alpha, as well as the lack of significant results coming out of the regressions in which it is involved for Hypotheses 6 & 7 (against Forecasting and Replenishment). Although the Strategic-VS-Operational IT scale needs some more development as well, it worked reasonably well in two of the four regressions in which it was used. Still, it did raise questions which need to be answered, concerning the traditional notion of what makes decision strategic as opposed to operational, and whether a decision can be strategic in its nature but operational in its impact in the context of CPFR within Supply Chain Management.

## CONCLUSIONS

Based on support for Hypothesis 1, it can be surmised that as companies collaborate, and depend more on each other for mutual survival, they use their CPFR systems at a more strategic level in the organization. This is very important as it suggests that more creative, longer-term, broader-organizational level decisions are being made using these collaborative CPFR systems as companies deepen their integration. This needs to be verified in future research as the portion of the scale which worked really well, was actually the creative/unstructured decision making aspects. Still, in any half decently managed company, creative decisions are almost never made by junior staff. It is extremely reasonable to believe that staff at lower levels will typically make template-driven, cut-and-dry decisions. It is also very reasonable to believe that junior staff will never make decisions that have a long-term impact, such as which products to develop in time for release two years from now. So as discussed before, since what turned out to be the core of the scale worked, I concluded that there really is a connection between stage of collaboration and strategic system use. So it does have implications for senior managers as it points to the need to guide the ongoing integration between supply chain partners, to make sure that CPFR systems continue to be trustworthy and the data they produce continue to be reliable as weightier, more far-reaching decisions get made with them. It has implications for the relationships between senior managers in partner companies as it becomes harder and harder to "walk away" from relationships in which intimate data is being exchanged. They will need to ensure that their partnership is nurtured in order to create a virtuous cycle of increasing integration which leads in turn to richer data being exchanged and vice-versa. This will result in a stronger supply chain

which is crucial since competition no longer happens at the company level.

Based on support for Hypothesis 3, commodity goods are managed using more operational-IT. The emphasis for commodities are of course, affordability, placement and convenience—in a word, availability. The danger in this type of thinking is that there are hardly any commodities anymore. The cheapest plastic cup, an archetypical commodity, must now meet a plethora of criteria in order to remain on the market. This includes not only being cheap, costing cents per cup (including shipping, packaging and shelf-space). But it must also be recyclable. It also has to be strong enough to be reliable, in a variety of circumstances, especially if hot liquids are to be contained in it. As if those were not enough criteria to meet, plastics must also meet ever evolving standards for non-toxicity and recyclability. So with an increasingly aware customer-base, treating a product as a commodity in today's market of highly demanding consumers could prove risky to the survival of any business. Still, the truth of the situation is that regardless of how educated and aware consumers are, the cost-imperative will always be paramount and cannot be ignored. The fact is, you can only spend the money in your budget. And there are many things competing for that budget. So the value of efficient, low cost replenishment (such as Walmart's EDLP) is still crucial to the business strategy of commodity-producers. After-all, no matter how sophisticated a product becomes, the fact that all products are becoming more sophisticated, means there will always be categories of products that are more commodified relative to others and hence more availability sensitive (it's either there on the shelf at Walmart, or it isn't). If you are picking up party supplies, then surely you will put much more thought into the snacks to be served, than the paper-plates in which they will be served. Because even though a lot more thought is going into plastic

cups, even more thought is going into what makes a good snack (being non-GMO, pesticide-free, low-sugar, trans-fat-free, nutritionally-balance and so on).

Since companies are forging deeper partnerships in supply chains in order to compete at the supply-chain level, it means that prospective partnerships, and power in their current partnerships—are critical to today's globally operating organization. Therefore, in order to compete effectively, a company must present an organizational strategy which is very attractive to potential partners. So one contribution of the current study is that for a company operating in the commodities market, attractiveness as a partner must include efficient and robust IT processes, people, and data—at the operational level. High-volume, commodity producing companies looking to forge new partnerships, and those evaluating their current business partnerships, will be interested in the sharing of data and the development of information management processes which get the operational aspects right. Walmart's winning EDLP concept is typical of this. It means that if you want to do business with Walmart, a commodity heavy distributor, then you have to have your customer-facing, rubber-meets-the-road Operational-IT based CPFR, running tight.

Hypothesis 9 was a surprise, since the regression was significant, but moving in the opposite direction than expected. Hypothesis 8 suggests that Replenishment use of IT decreases in the face of greater confidence in the system. Replenishment processes are the last stage in the CPFR rollout, according to the VICS standard. In fact, Replenishment is where the rubber meets the road in fulfilling customer demand. So the alternative and preferable explanation is that Confidence-in-IT increases the effectiveness of IT use for replenishment so much, that processes improve, as well as busy-work/re-work dramatically reduce, resulting in a seamless replenishment process which makes the

system's contribution fade into the background. The net effect would be to make it appear that less effort is being made in replenishment, relative to the productivity. This is a question to be explored in further research in order to confirm whether the finding holds up to greater scrutiny, but also in which cases. Ideally, the hypothesis could be further expanded to see whether this decrease in Replenishment use occurs in scenarios where Operational IT use is also decreasing. If this is the case, then there may be plausibility to the idea that it is the perception of IT use which is reducing, and not the actual use itself. On a high note, hypothesis 8 was well supported and represents one of the unique contributions of the current study, despite having some problematic reverse coding in the scale. The implication from hypothesis-8 is that as management trusts their workers more, they will use the system for increased planning purposes. The takeaway is similar to hypothesis 3's Strategic-IT-use (but focused on Planning-IT-use). In supply chains where there is an emphasis on effective planning, management must ensure HR policies are in place to attract and keep staff who are expert in in Supply Chain Management, and who can give strong support to the CPFR processes and data. This will facilitate high levels of confidence in staff, allowing planning processes to run efficiently. This will in turn allow the company to present an attractive partnership to current and future partners. Hypothesis 9 may also provide a direction in the remediation of collaborative planning processes which are dysfunctional or underperforming. The suggestion of Hypothesis 9 is that if planning processes are weak, a lack of confidence in workers and the data they are contributing, should be something to look at. And if that turns out to be the fault, it should be attended to hastily before permanent damage is done to the partnership, especially since confidence is very hard-won, easily damaged, and difficult to repair.

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# TABLES

## Table-1: 3 x 3 Matrix

| | Strategic | Tactical | Operational |
|---|---|---|---|
| Planning | (Shaw et al., 2003) (Chang et al., 2012) (Khan et al., 2012) (Markus & Christiaanse, 2003) (Grover & Kohli, 2012) (Cassivi et al., 2000) (E. Lefebvre et al., 2003) (Danese, 2006) (de Paula et al., 2004) (M. Chen, Zhang, & Zhou, 2007) (Danese, 2011) (Bhakoo et al., 2012) (Barratt & Oliveira, 2001) (Cassivi, 2006) (B. Chen et al., 2006) (Danese, 2007) (Danese et al., 2004) (Davis & Golicic, 2010) (Fang & Meng, 2009) (Gelinas & Markus, 2005) (Kim et al., 2006) (L. A. Lefebvre et al., 2001) (L. Li, 2012) (McLaren et al., 2004) (Plomp & Batenburg, 2010) (Shu et al., 2006) (Skjoett-Larsen et al., 2003) (Tavassoli et al., 2009) (Wang & Archer, 2004) (Q. Zhang & Liu, 2008) (Wietrzyk et al., 2005) (Xu, 2010) (Yu et al., 2001) (Rai et al., 2006) (Disney et al., 2004) | (Chai, Zhou, & Wang, 2008a) (Petersen et al., 2005) (Marien, 1999) (Tingbin et al., 2007) (Pramatari, 2007) | (Z. Chen, 2009) (Frayret, 2009) (Fliedner, 2003) |
| Forecasting | (Zhou & Hu, 2008) (Viswanathan et al., 2007) (Valéra et al., 2010) (Zhao & Xie, 2002) | (McCarthy & Golicic, 2002) (Suesut & Mongkhoin, 2004) (Lo et al., 2006) (T. H. Chang, H. P. Fu, W. I. Lee, Y. Lin, & H. C. Hsueh, 2007) (Yan-fang & Xin-yue, 2007) (Rodriguez et al., 2008) (Lu et al., 2009) (Ramanathan, 2012) (Tong et al., 2006) (Caridi et al., 2005) (Thomassey & Fiordaliso, 2006) (L. Zhang, Wang, & Chang, 2008b) | (Hou, 2007) |
| Replenishment | (Chakraborty et al., 2005) (Gialelis et al., 2006) (Zhongwen, 2010) (Olorunniwo & Li, 2010) (Ellram & Zsidisin, 2002) (Disney & Towill, 2006) (Ronchi, 2011) (Muylle & Basu, 2008) (Rabin, 2002) (Bendavid et al., 2007) (Charalampos & Chang, 2008) (Chan et al., 2004) (M. F. Zarandi, M. Pourakbar, & I. Turksen, 2006) (Dedrick et al., 2008) | (Stank et al., 1999) (Pramatari & Miliotis, 2008) (X. F. Du, S. C. H. Leung, J. L. Zhang, & K. Lai, 2009) (Yuan & Shon, 2008) (Rodrigues et al., 2008) (Cho & Ogwang, 2006) (Holmström, Främling, Kaipia, & Saranen, 2002) (Prajogo & Olhager, 2011) (J. Lyu, J.-H. Ding, & P.-S. Chen, 2010) | (Mason et al., 2007) (C. Zhang et al., 2008) (E. Y. Li et al., 2007) (Z. Li et al., 2008) (Sepehri, 2012) (Bhakoo & Chan, 2011) |

**Table-2: Company and Respondent - Descriptive Statistics**

| Variable | Questionnaire Item | Choices | Opt-1 (%) | Opt-2 (%) | Opt-3 (%) | Opt-4 (%) | Opt-5 (%) |
|---|---|---|---|---|---|---|---|
| System Age Variable | The length of time the system has been in use (months/years) is: | < 6 months, 6 months - 2 years, 2 - 5 years, 5 - 10 years, over 10 years | < 6 months (0%) | 6 months - 2 years, (8.8%) | 2 - 5 years (24.6%) | 5 - 10 years (21.1%) | over 10 years (45.6%) |
| Revenue Company Size | Company (Division) Size (Number of Employees): | < 50, 50 - 250, 250 - 1000, 1000 - 5000, > 5000 | < 50 (3.0%) | 20-250 (4.5%) | 250 - 1000 (43.3%) | 1000 - 5000 (22.4%) | > 5000 (26.9%) |
| Employee Company Size | Company (Division) Annual Revenue (Millions USD) | < 25 M, 25M - 100M, 100M - 250M, 250M - 1B, > 1 Billion | < 25 M (4.9%) | 25M - 100M (16.4%) | 100M-250M (19.7%) | 250M - 1B (29.5%) | > 1 Billion (29.5%) |
| | | | | | | | |
| Levels from CEO | How many levels are you away from your / President/CEO? | 1, 2, 3, 4, 5 | 1 (30%) | 2 (21%) | 3 (10%) | 4 (18%) | 5 (21%) |

**Table-3: CPFR - Information Technology System's Main Purpose**

| Variable | Questionnaire Item | Choice-1 | Choice-2 |
|---|---|---|---|
| Design_System | The primary functions this system supports in our organization are: | Design (Y=12%) | (N=88%) |
| Manufacturing_System | The primary functions this system supports in our organization are: | Manufacturing (Y=26%) | (N=74%) |
| Distribution_System | The primary functions this system supports in our organization are: | Distribution (Y=33%) | (N=67%) |
| Logistics_system | The primary functions this system supports in our organization are: | Logistics (Y=44%) | (N=56%) |
| Retail_system | The primary functions this system supports in our organization are: | Retailing (Y=5%) | (N=95%) |
| Services_System | The primary functions this system supports in our organization are: | Services (Y=14%) | (N=86%) |
| MarketSales_System | The primary functions this system supports in our organization are: | Marketing/Sales (Y=26%) | (N=74%) |
| **Partner_Supplier** | **Main partner which we collaborate with is a** | **Supplier (=56%)** | **Customer (=44%)** |

## Table-4: CONSTRUCT: Strategic VS Operational-IT-use (CPFR systems)

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| OS1_DcsBrt | Decisions made using the system affect: | 1-5 | individuals | the whole organization |
| OS2_ActTim | Activities guided by the system affect the company's position | 1-5 | within hours | after years |
| OS3_MnUsrs | The main users of the system are: | 1-5 | Front line staff | C-Level officers |
| Os4_Structuredness | Users can utilize the system in ways that are: | 1-7 | Structured | Unstructured |
| Os5_NonRoutine | Users can utilize the system in ways that are: | 1-7 | Routine | Need-driven |
| Os6_OpenEnded | Users can utilize the system in ways that are: | 1-7 | Inflexible | Open-ended |
| OS7_CusSat | The Purchasing system use has an impact on the customer satisfaction of: | 1-5 | specific customers | whole market |
| OS8_FinImp | The lowest level at which the financial impact of the system use can be observed is: | 1-7 | Individual Transaction | Quarterly Financial Statement |
| OS9_UsrInt | When interacting with the system, users are provided with | 1-5 | specific, structured directives | general recommendations |

**Table-5: CONSTRUCT _ CFA: Strategic VS Operational-IT-use (CPFR systems)**

**Component Matrix[a]**

| | Component | |
|---|---|---|
| | 1 | 2 |
| Zscore(OS1_DcsBrt) | .404 | -.428 |
| Zscore(OS2_ActTim) | -.335 | ***.574*** |
| Zscore(OS3_MnUsrs) | .463 | .235 |
| Zscore(Os4_Structuredness) | **.776** | .037 |
| Zscore(Os5_NonRoutine) | **.815** | .358 |
| Zscore(Os6_OpenEnded) | **.794** | -.031 |
| Zscore(OS7_CusSat) | .239 | ***-.686*** |
| Zscore(OS8_FinImp) | .205 | ***.743*** |
| Zscore(OS9_UsrInt) | .076 | -.361 |
| **% Variance Extracted** | **27.70** | ***20.56*** |

**Table-6: CONSTRUCT: Stage of CPFR Practiced**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| CS_MutlSrv | Our company's mutual survival depends on the quality of data sharing between us: | 1-7 | Strongly Disagree | Strongly Agree |
| CS_Dailymvmt | Our supply chain related activities are based on the data shared between us for ... daily product movement: | 1-5 | 0 - 20% of the time | 81 - 100% of the time |
| CS_MnthlySched | Our supply chain related activities are based on the data shared between us for ... monthly scheduling: | 1-5 | 0 - 20% of the time | 81 - 100% of the time |
| CS_QrtlyPlanng | Our supply chain related activities are based on the data shared between us for ... quarterly product planning: | 1-5 | 0 - 20% of the time | 81 - 100% of the time |
| CS_CollabFrequency | Collaboration between us can be described as: | 1-7 | limited level of collaboration | frequent communication about product needs |
| CS_CollabIntegration | Collaboration between us can be described as: | 1-7 | arms-length negotiations | tightly integrated operations |
| CS_CollabOngoing | Collaboration between us can be described as: | 1-7 | per-transaction basis: | continuing |
| CS_CollabRelationship | Collaboration between us can be described as: | 1-7 | contractually enforced | :relationship based |

**Table-7: CONSTRUCT _ CFA: Stage of CPFR Practiced**

**Component Matrix[a]**

| | Component | |
|---|---|---|
| | 1 | 2 |
| Zscore(CS_MutlSrv) | .251 | ***.671*** |
| Zscore(CS_dailymvmt) | .244 | ***.576*** |
| Zscore(CS_DrtlyPlanng) | .457 | ***.604*** |
| Zscore(CS_CollabFrequency) | **.857** | -.153 |
| Zscore(CS_CollabIntegration) | **.833** | -.284 |
| Zscore(CS_CollabOngoing) | **.670** | -.381 |
| Zscore(CS_MnthlySched) | .551 | **.507** |
| Zscore(CS_CollabRelationship) | **.572** | -.421 |
| **% Variance Extracted** | **35.48** | **22.86** |

**Table-8: CONSTRUCT: Planning Use of Information Technology System**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| P1_ProcPrd | Process and product improvements are main benefits of the system | 1-5 | Strongly Disagree | Strongly Agree |
| P2_ProdMix | Creating product mix plans is the primary purpose of the system | 1-5 | Strongly Disagree | Strongly Agree |
| P3_Product | The system's main use is helping us to determine what to produce | 1-5 | Strongly Disagree | Strongly Agree |
| P4_Prodlin | The output of the system influences the choice of product lines and production methods | 1-5 | Strongly Disagree | Strongly Agree |

**Table-9: CONSTRUCT _ CFA: Planning Use of Information Technology System**

| | Component | |
|---|---|---|
| | 1 | 2 |
| P1_ProcPrd | **.682** | -.338 |
| P2_ProdMix | .574 | ***.802*** |
| P3_Product | **.868** | -.153 |
| P4_Prodlin | **.812** | -.119 |
| **% Variance Extracted** | **55.18** | ***19.88*** |

**Table-10: CONSTRUCT: Forecasting Use of Information Technology System**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| F1_FutrDmd | Understanding future demand for current products is the main benefit of the system | 1-5 | Strongly Disagree | Strongly Agree |
| F2_ProdLvl | Figuring out production levels for current products is the primary purpose of the system | 1-5 | Strongly Disagree | Strongly Agree |
| F3_DetDmnd | The system is mainly used to determine customer demand | 1-5 | Strongly Disagree | Strongly Agree |
| F4_FrcstDm | The output of the system is a forecast of product demand | 1-5 | Strongly Disagree | Strongly Agree |

**Table-11: CONSTRUCT _ CFA: Forecasting Use of Information Technology System**

| | Component | |
|---|---|---|
| | 1 | 2 |
| F1_FutrDmd | **.835** | -.395 |
| F1_ProdLvl | **.783** | -.489 |
| F3_DetDmnd | **.771** | .528 |
| F4_FrcstDm | **.847** | .361 |
| **% Variance Extracted** | **65.56** | ***20.09*** |

**Table-12: CONSTRUCT: Replenishment Use of Information Technology System**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| R1_InvtRdc | Lead time and inventory reduction are the main benefits of the system | 1-5 | Strongly Disagree | Strongly Agree |
| R2_Orderng | Making ordering decisions is the main purpose of the system | 1-5 | Strongly Disagree | Strongly Agree |
| R3_Reorder | We use the system mostly to reorder the products we use | 1-5 | Strongly Disagree | Strongly Agree |
| R4_OrdrQnt | The output of the system is order-quantities | 1-5 | Strongly Disagree | Strongly Agree |

**Table-13: CONSTRUCT _ CFA: Replenishment Use of Information Technology System**

| | Component | |
|---|---|---|
| | 1 | 2 |
| R1_InvtRdc | .572 | ***.710*** |
| R2_Orderng | **.728** | .145 |
| R3_Reorder | **.749** | -.205 |
| R4_OrdrQnt | **.641** | -.559 |
| **% Variance Extracted** | **45.71** | ***21.99*** |

**Table-14: CONSTRUCT: Confidence in Information Technology**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| CI1_Escala | We rarely have to escalate problems to IT management to get IT tasks performed | 1-7 | Strongly Disagree | Strongly Agree |
| CI2_MgtPrs | The IT staff we work with do their work even if IT management is not around. | 1-7 | Strongly Disagree | Strongly Agree |
| CI3_MgtCns | Once an IT person is assigned to my task, we don't have to consult with the IT manager to get i... | 1-7 | Strongly Disagree | Strongly Agree |
| CI4_Carefu | We can rely on IT staff to not to make our jobs more difficult through careless work. | 1-7 | Strongly Disagree | Strongly Agree |
| CI5_ConfSk | We have full confidence in the skills of the Information Technology staff | 1-7 | Strongly Disagree | Strongly Agree |

**Table-15: CONSTRUCT _ CFA: Confidence in Information Technology**

| | Component | |
|---|---|---|
| | 1 | 2 |
| CI1_Escala | **.750** | .517 |
| CI2_MgtPrs | **.772** | -.518 |
| CI3_MgtCns | **.800** | -.201 |
| CI4_Carefu | **.769** | .396 |
| CI5_ConfSk | **.852** | -.154 |
| **% Variance Extracted** | **62.30** | ***15.12*** |

**Table-16: CONSTRUCT: Confidence in Junior Staff**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| CW1_BackPl | Rather than needing a backup plan, my colleagues and I can depend on our staff to complete tasks | 1-7 | Strongly Disagree | Strongly Agree |
| CW2_Qualit | The quality of the work that my colleagues and I receive from subordinates is only maintained by our diligent monitoring **(Rev)** | 1-7 | Strongly Disagree | Strongly Agree |
| CW3_WrkArd | My colleagues and I sometimes find it necessary to work around our lower level employees in ord... **(Rev)** | 1-7 | Strongly Disagree | Strongly Agree |
| CW4_ChckOn | My colleagues and I trust our employees to get things done without constantly checking up on them | 1-7 | Strongly Disagree | Strongly Agree |
| CW5_ClsTrk | My colleagues and I keep close track of interaction with my subordinates, taking note of instances where they do not deliver as they should. **(Rev)** | 1-7 | Strongly Disagree | Strongly Agree |

**Table-17: CONSTRUCT _ CFA: Confidence in Junior Staff**

**Component Matrix[a]**

| | Component | |
|---|---|---|
| | 1 | 2 |
| CW1_BackPl | .141 | ***.837*** |
| CW2_Quality_REV | **.799** | -.273 |
| CW3_WrkArd_REV | **.809** | -.025 |
| CW4_ChckOn | .299 | ***.781*** |
| CW5_ClsTrk_REV | **.807** | -.141 |
| **% Variance Extracted** | **41.07** | ***28.12*** |

**Table-18: CONSTRUCT: Operational Performance**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| OP1_Invtry | Inventory performance has improved due to use of the system | 1-5 | Strongly Disagree | Strongly Agree |
| OP2_StckOt | Safety stock and stock-out have been reduced due to use of the system | 1-5 | Strongly Disagree | Strongly Agree |
| OP3_LdTime | Lead time has been reduced due to use of the system. | 1-5 | Strongly Disagree | Strongly Agree |

**Table-19: CONSTRUCT _ CFA: Operational Performance**

| | Component | |
|---|---|---|
| | 1 | 2 |
| OP1_Invtry | **.917** | -.232 |
| OP2_StckOt | **.911** | -.270 |
| OP3_LdTime | **.836** | .549 |
| **% Variance Extracted** | **79.03** | **14.26** |

**Table-20: CONSTRUCT: Market Performance**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| MP1_NewPrd | We created new products and/or entered markets as a result of using the system | 1-5 | Strongly Disagree | Strongly Agree |
| MP2_EcnGrw | We discovered new economic growth opportunities and developed new business opportunities as a result of using the system | 1-5 | Strongly Disagree | Strongly Agree |
| MP3_CusRet | We improved customer retention and attracted new customers as a result of using the system | 1-5 | Strongly Disagree | Strongly Agree |

**Table-21: CONSTRUCT _ CFA: Market Performance**

| | Component | |
|---|---|---|
| | 1 | 2 |
| MP1_NewPrd | **.841** | -.319 |
| MP2_EcnGrw | **.848** | -.267 |
| MP3_CusRet | **.754** | .656 |
| **% Variance Extracted** | **66.50** | ***20.11*** |

**Table-22: CONSTRUCT: Product Life-Cycle**

| Variable | Questionnaire Item | Choices |
|---|---|---|
| LC1_RO | How long does it take your company to roll out new products | D,W,M,Q,Y |
| LC2_Adopt | How long does it take your customers to adopt new products | D,W,M,Q,Y |
| LC3_PF&Mix | How often does your company change the product features or product mix | D,W,M,Q,Y |

**Table-23: CONSTRUCT _ CFA: Product Life-Cycle**

| | Component | |
|---|---|---|
| | 1 | 2 |
| LC1_RO | **.890** | -.118 |
| LC2_Adopt | **.868** | -.405 |
| LC3_PF&Mix | **.862** | .421 |
| **% Variance Extracted** | **76.31** | ***9.17*** |

**Table-24: CONSTRUCT: Product Technology-Level**

| Variable | Questionnaire Item | Choices |
|---|---|---|
| LC4_Obsole | How long does it take for your company's product(s) to become obsolete? | D,W,M,Q,Y |
| LC5_Techno | The core technology in our product(s) was developed: | More than 3 years ago. Less than 3 years ago, less than 1 year ago, less than 6 months ago, is under development |
| LC6_EmbedT1 | Our product(s) have imbedded integrated circuit technology such as: | None: (Y, N) |
| LC6_EmbedT2 | Our product(s) have imbedded integrated circuit technology such as: | Integrated Circuits: (Y, N) |
| LC6_EmbedT3 | Our product(s) have imbedded integrated circuit technology such as: | App Specific ICs: (Y, N) |
| LC6_EmbedT4 | Our product(s) have imbedded integrated circuit technology such as: | System on a chip (Y, N) |
| LC6_EmbedT5 | Our product(s) have imbedded integrated circuit technology such as: | Networked sub-systems (Y, N) |

**Table-25: CONSTRUCT: Mass-Market Product**

| Variable | Questionnaire Item | Scale Range | Leftmost-Choice | Rightmost-Choice |
|---|---|---|---|---|
| LP1_CompDm | Demand for our product depends on our competitors' latest offering **(Rev)** | 1-7 | Not at All | To a Great Extent |
| LP2_ DemPrd | Demand for our product-line is? **(Rev)** | 1-7 | Totally Predictable | Erratic |
| LP3_Loyalt | The customers who buy our products are: | 1-7 | Not at all Brand Loyal | Extremely Brand Loyal |
| LP4_Luxury | Our average consumer considers our products to be a: | 1-7 | Staple | Luxury Item |
| LP5_Featur | Our products compete on: | 1-7 | Price alone | Features alone |
| LP6_Niche | Customers who buy our products represent a market which is a: **(Rev)** | 1-7 | Niche Market | Mass Market |
| LP7_Unique | Uniqueness and customization of our products are important to our customers: | 1-7 | Strongly Disagree | Strongly Agree |

**Table-26: CONSTRUCT _ CFA: Mass-Market Product**

**Component Matrix[a]**

| | Component | |
|---|---|---|
| | 1 | 2 |
| LP1_CompDm_REV | .082 | **.667** |
| LP2_DemPrd_REV | .541 | .412 |
| LP3_Loyalt | **.863** | -.185 |
| LP4_Luxury | .400 | -.390 |
| LP5_Featur | .588 | .171 |
| LP6_Niche_REV | -.076 | **.742** |
| LP7_Unique | .387 | -.017 |
| **% Variance Extracted** | **24.37** | ***19.73*** |

**Table-27: OLS Regression Analysis – The dependent variable is Strategic-VS-Operational IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | -.186 | -1.137 |
| Revenue CompanySize | -.247 | -.861 |
| Employee_CompanySize | .366 | 1.293 |
| Partner Supplier | .074 | .447 |
| Manufacturing System | .253 | 1.433 |
| Distribution System | .037 | .191 |
| Logistics system | .004 | .018 |
| MarketSales System | .230 | 1.354 |
| Collaboration_Stage | .392* | 2.148 |
| **f-statistic** = 1.767 | | |
| $R^2$ = .332 | | |
| Adj $R^2$ = .144 | | |

t - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-28: OLS Regression Analysis – The dependent variable is Strategic-VS-Operational-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System_Age | -.057 | -.352 |
| Revenue_CompanySize | -.563 | -1.800 |
| Employee_CompanySize | .656 | 2.054 |
| Partner_Supplier | .058 | .322 |
| Manufacturing_System | .193 | 1.162 |
| Distribution_System | -.041 | -.202 |
| Logistics_system | .158 | .773 |
| MarketSales_System | .181 | 1.006 |
| LC4_Obsole | -.293† | -1.713 |
| LC5_Techno | .074 | .431 |
| LC6_EmbedT1 | -.494† | -1.909 |
| LC6_EmbedT2 | -.191 | -.703 |
| LC6_EmbedT3 | -.334 | -1.331 |
| LC6_EmbedT4 | .388 | 1.414 |
| LC6_EmbedT5 | -.346 | -1.433 |
| f-statistic = 1.363 | | |
| $R^2$ = .422 | | |
| Adj $R^2$ = .113 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-29: OLS Regression Analysis – The dependent variable is Strategic-VS-Operational-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | -.021 | -.146 |
| Revenue CompanySize | -.554† | -1.869 |
| Employee CompanySize | .647* | 2.248 |
| Partner_Supplier | .156 | .997 |
| Manufacturing System | .133 | .912 |
| Distribution System | .012 | .068 |
| Logistics system | .153 | .822 |
| MarketSales System | .053 | .325 |
| VolumeVSNiche Demand | -.346* | -2.220 |
| **f-statistic** = 1.879 | | |
| $R^2$ = .332 | | |
| Adj $R^2$ = .155 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-30: OLS Regression Analysis – The dependent variable is Strategic-VS-Operational-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | .004 | .028 |
| Revenue CompanySize | -.277 | -.890 |
| Employee CompanySize | .412 | 1.278 |
| Partner_Supplier | .195 | 1.073 |
| Manufacturing System | .114 | .687 |
| Distribution System | -.063 | -.306 |
| Logistics system | .326 | 1.502 |
| MarketSales System | .079 | .425 |
| LC1 RO | -.110 | -.402 |
| LC2 Adopt | .201 | .811 |
| LC3 PFMix | -.212 | -.847 |
| **f-statistic** = 1.056 | | |
| **$R^2$** = .272 | | |
| **Adj $R^2$** = .014 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-31: OLS Regression Analysis – The dependent variables is Planning-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | -.086 | -.520 |
| Revenue CompanySize | -.055 | -.159 |
| Employee CompanySize | -.073 | -.216 |
| Partner_Supplier | -.367* | -2.076 |
| Manufacturing System | -.251 | -1.534 |
| Distribution System | .347 | 1.596 |
| Logistics system | -.090 | -.447 |
| MarketSales System | .197 | 1.100 |
| LC4 Obsole | -.049 | -.290 |
| LC5 Techno | .093 | .549 |
| LC6 EmbedT1 | -.111 | -.399 |
| LC6 EmbedT2 | -.330 | -.994 |
| LC6 EmbedT3 | .013 | .042 |
| LC6 EmbedT4 | .411 | 1.142 |
| LC6 EmbedT5 | .046 | .193 |
| **f-statistic** = 1.490 | | |
| $R^2$ = .444 | | |
| Adj $R^2$ = .146 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-32: OLS Regression Analysis – The dependent variable is Forecasting-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System_Age | -.143 | -.947 |
| Revenue_CompanySize | -.330 | -.943 |
| Employee_CompanySize | .026 | .079 |
| Partner_Supplier | -.253 | -1.482 |
| Manufacturing_System | .082 | .454 |
| Distribution_System | .417* | 2.212 |
| Logistics_system | .020 | .104 |
| MarketSales System | -.033 | -.192 |
| LP1_CompDm_REV | -.325† | -1.976 |
| LP2_DemPrd_REV | .156 | .716 |
| LP3_Loyalt | -.182 | -.824 |
| LP4_Luxury | .032 | .192 |
| LP5_Featur | -.021 | -.121 |
| LP6_Niche_REV | -.005 | -.026 |
| LP7_Unique | .264 | 1.520 |
| **f-statistic** = 1.493 | | |
| $R^2$ = .444 | | |
| Adj $R^2$ = .147 | | |

† - Significant at .1 level

* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-33: OLS Regression Analysis – The dependent variable is Replenishment-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | .057 | .442 |
| Revenue CompanySize | .401 | 1.347 |
| Employee CompanySize | -.867** | -3.080 |
| Partner_Supplier | -.293* | -2.018 |
| Manufacturing System | -.012 | -.078 |
| Distribution System | .537** | 3.345 |
| Logistics system | -.369* | -2.202 |
| MarketSales System | -.017 | -.118 |
| LP1 CompDm REV | -.021 | -.153 |
| LP2 DemPrd REV | -.171 | -.927 |
| LP3 Loyalt | -.093 | -.496 |
| LP4 Luxury | -.107 | -.759 |
| LP5 Featur | -.136 | -.926 |
| LP6 Niche REV | .005 | .034 |
| LP7 Unique | .124 | .842 |
| **f-statistic** = 2.780 | | |
| $R^2$ = .598 | | |
| Adj $R^2$ = .383 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-34: OLS Regression Analysis – The dependent variables is Planning-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | -.137 | -1.046 |
| Revenue CompanySize | -.330 | -1.222 |
| Employee CompanySize | .103 | .375 |
| Partner_Supplier | -.287* | -2.054 |
| Distribution System | .38* | 2.459 |
| Logistics system | -.050 | -.319 |
| Confidence-in-Workers | .296* | 2.164 |
| f-statistic = 3.242 | | |
| $R^2$ = .368 | | |
| Adj $R^2$ = .254 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

**Table-35: OLS Regression Analysis – The dependent variable is Replenishment-IT use**

| Independent Variables | Beta | t |
|---|---|---|
| System Age | -.137 | -1.046 |
| Revenue CompanySize | -.330 | -1.222 |
| Employee CompanySize | .103 | .375 |
| Partner_Supplier | -.287* | -2.054 |
| Distribution System | .38* | 2.459 |
| Logistics system | -.050 | -.319 |
| Confidence-in-Workers | .296* | 2.164 |
| f-statistic = 3.242 | | |
| $R^2$ = .368 | | |
| Adj $R^2$ = .254 | | |

† - Significant at .1 level
* - Significant at .05 level
** - Significant at .01 level
*** - Significant at .001 level

## FIGURES

**Figure 1: Percentage distribution of studies by organizational level**

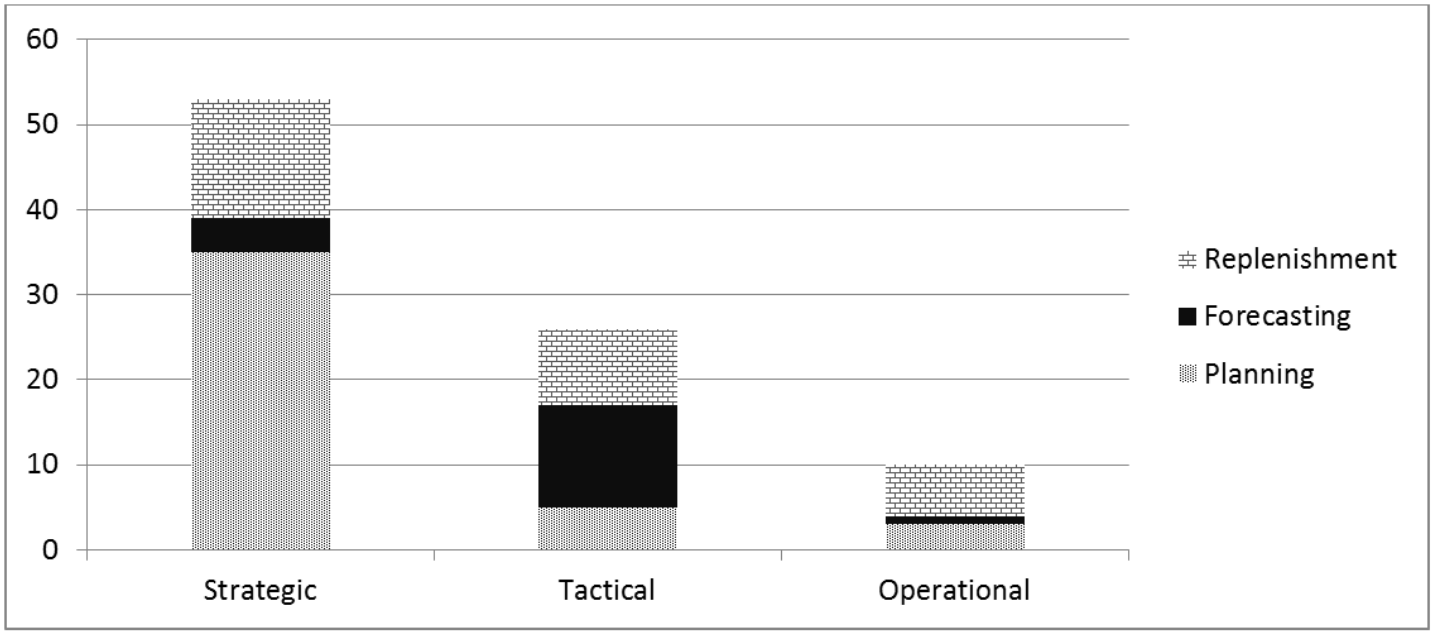


**Figure 1: Distribution of Studies along the OTS/PFR dimensions**

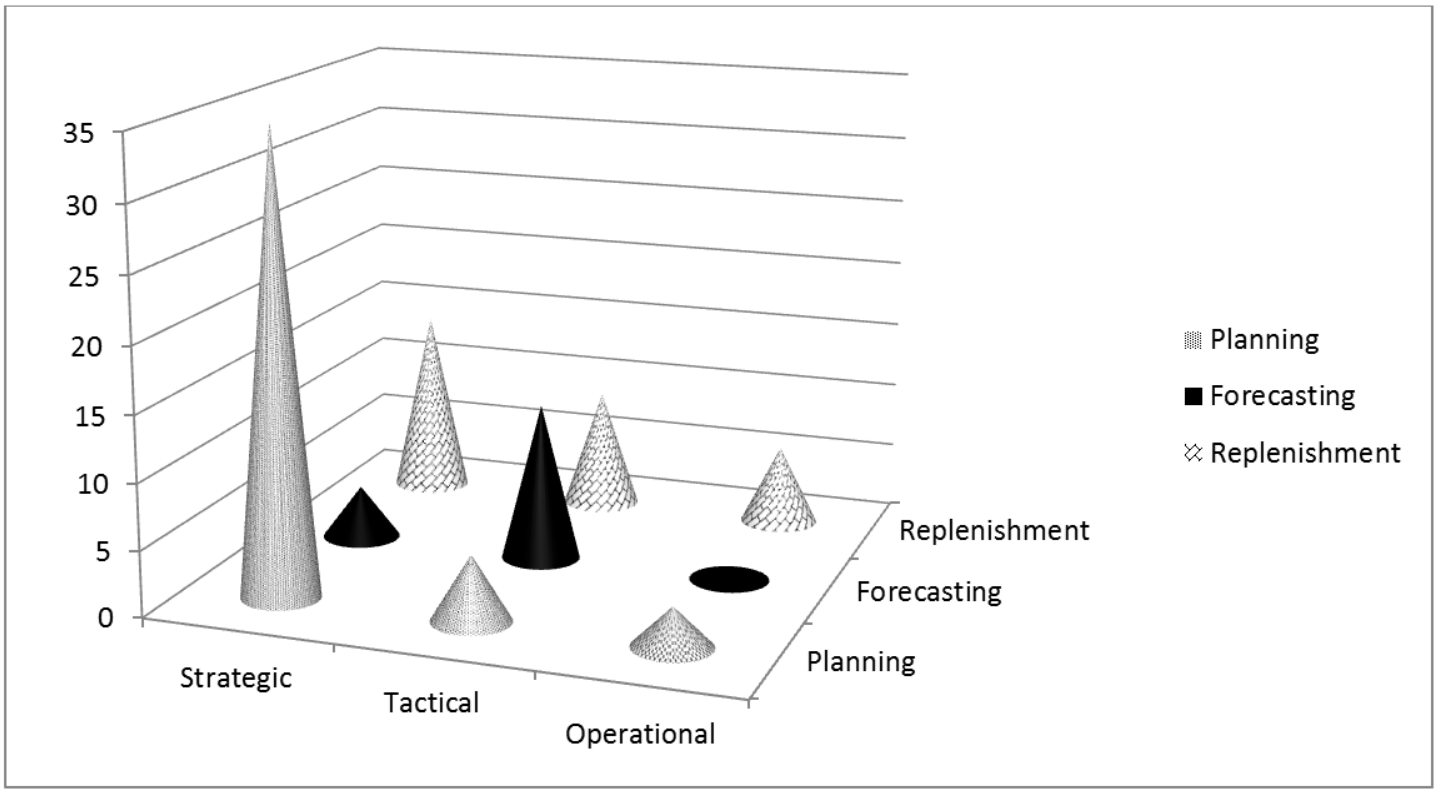


**Figure 3: Numerical distribution of Studies along the PFR/OTS dimensions**

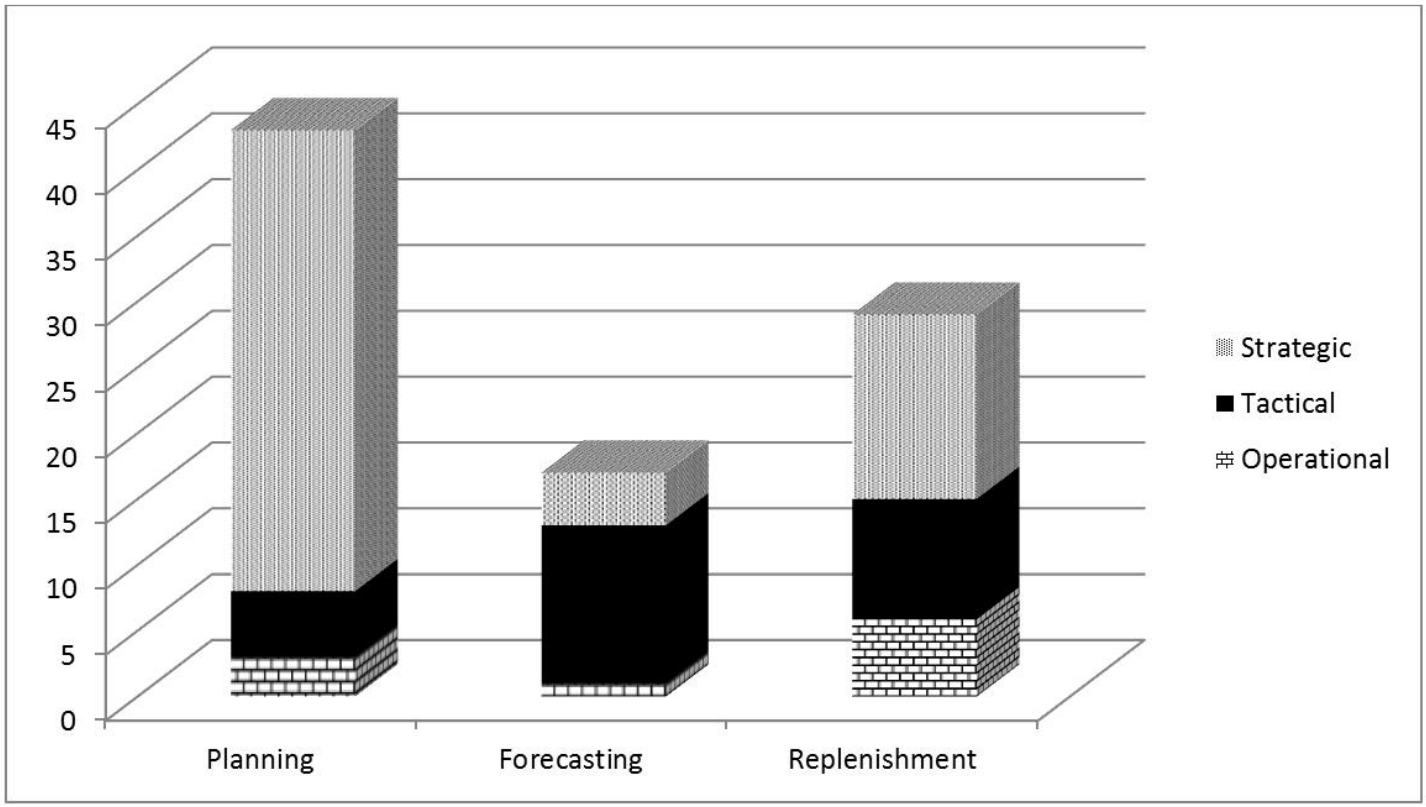


**Figure 4: Technology Acceptance Model (TAM)**

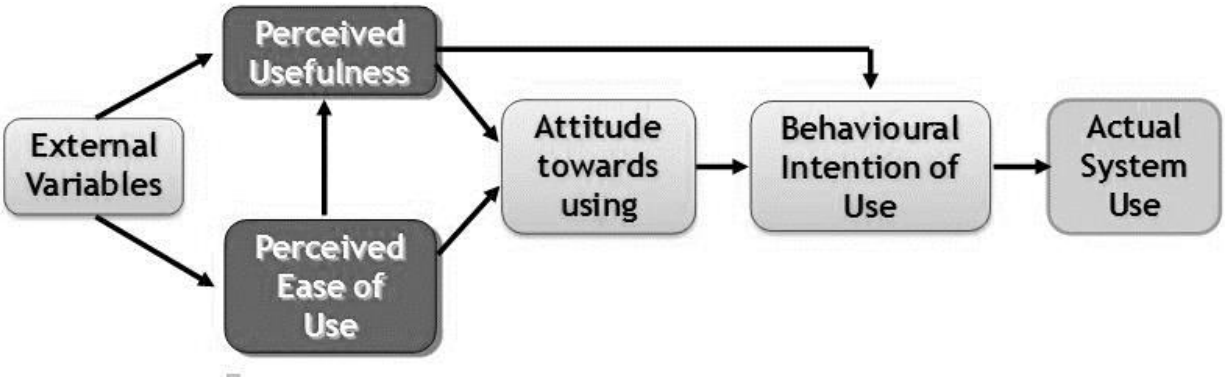


**Figure 5: Task Technology Fit**

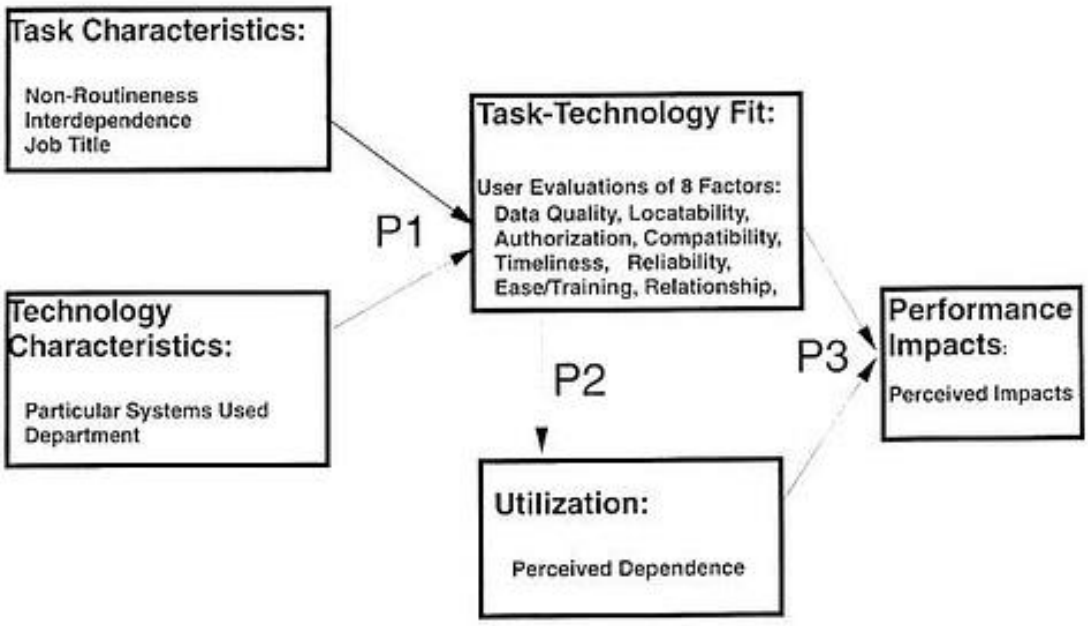



Figure 4. Measurements and Analyses to Be Conducted
(Measures are shown in small type below each construct. Regressions were run for each of 8 Factors of TTF, for Perceived Dependence; and for Perceived Impacts.)

**Figure 6: Innovation Diffusion Theory**

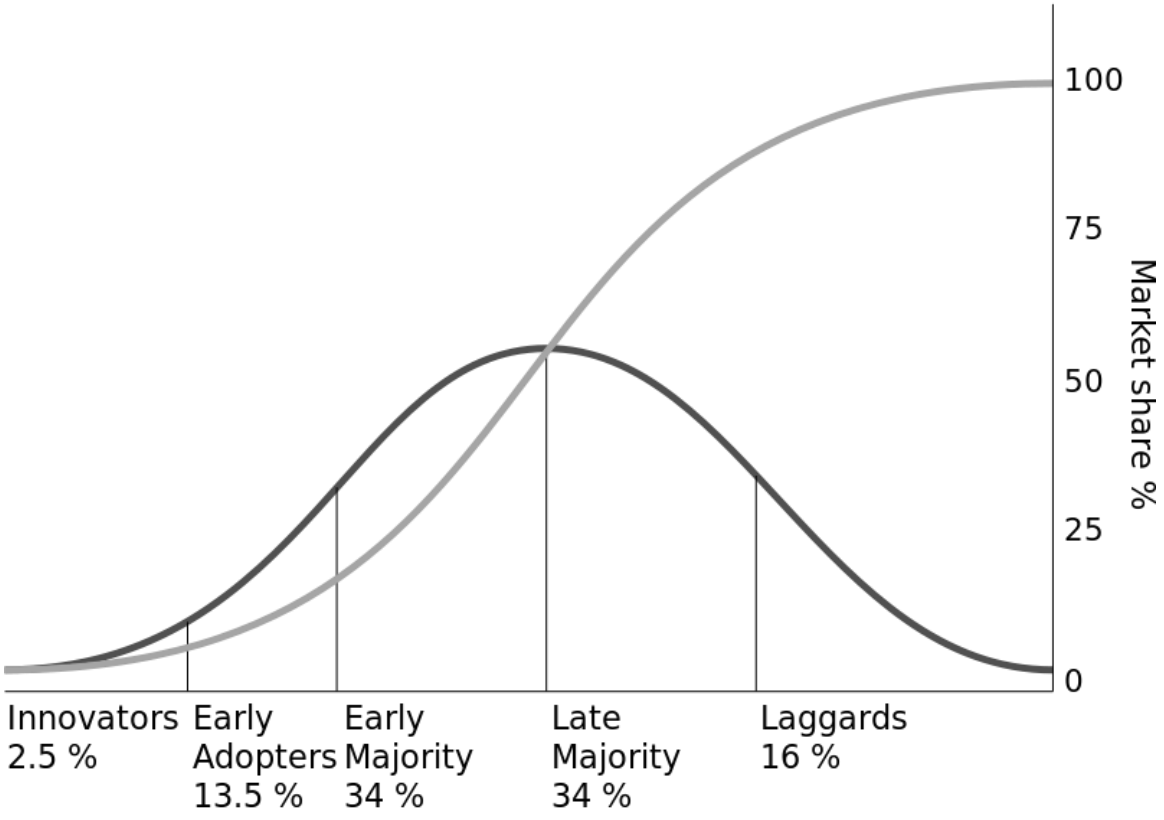
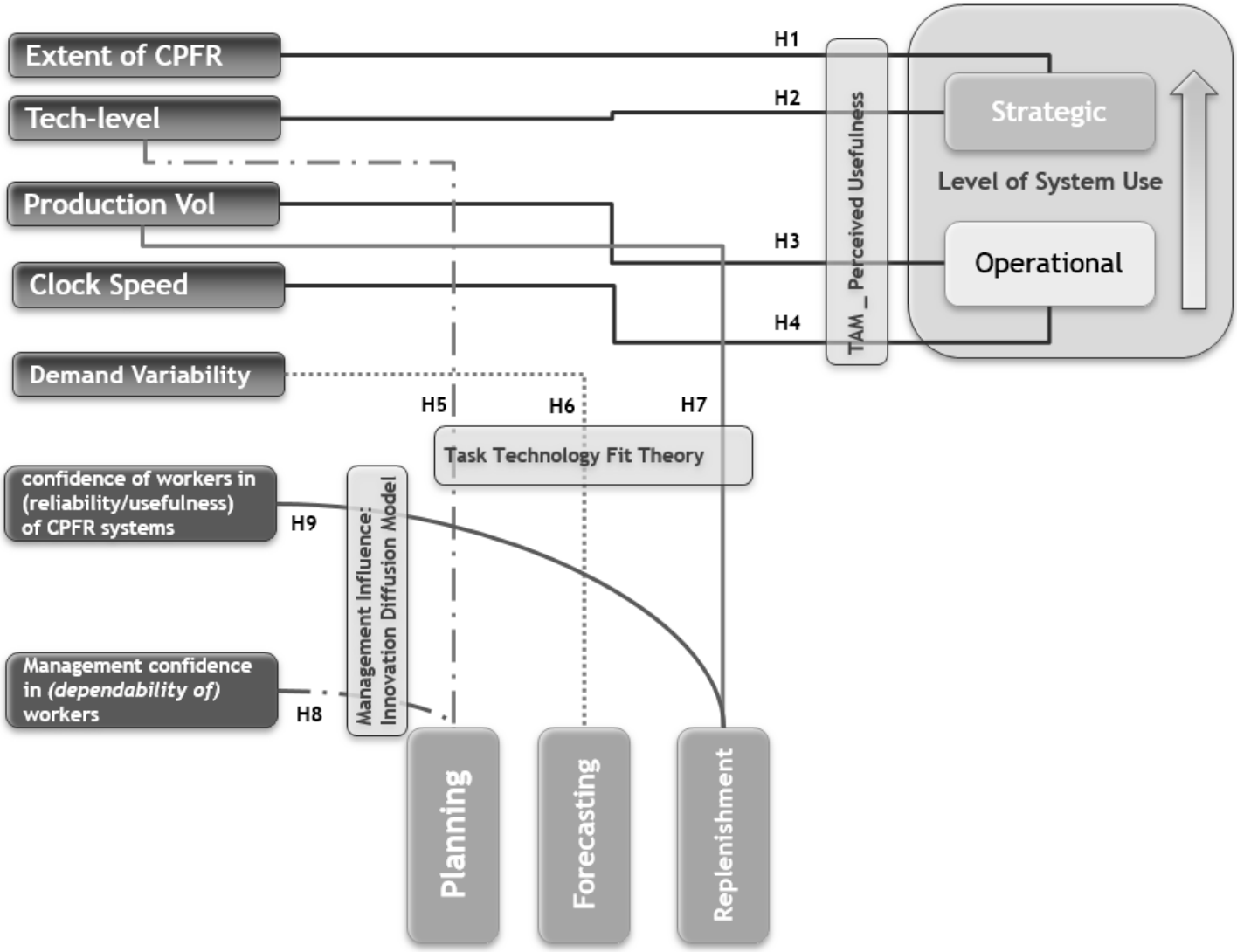


**Figure 7: Model of Hypotheses**



# APPENDICES

## Appendix-A: Survey Instrument

**These questions deal with the life-cycle of your product(s) and the time-frame for designing and launching them. The questions also look at how long they remain profitable on store shelves and in the general marketplace.**

**How long does it take your company to roll out new products?**

Days ○ Weeks ○ Months ○ Quarters ○ Years ○

**How long does it take your customers to adopt new products?**

Days ○ Weeks ○ Months ○ Quarters ○ Years ○

**How often does your company change the product features or product mix of your products?**

Days ○ Weeks ○ Months ○ Quarters ○ Years ○

**How long does it take for your company's product(s) to become obsolete?**

Days ○ Weeks ○ Months ○ Quarters ○ Years ○

**The core technology in our product(s) was developed:**

More than 3 years ago ○ Less than 3 years ago ○ Less than 1 year ago ○ Less than 6 months ago ○ is under development ○

**Our product(s) have imbedded integrated circuit technology such as:**

None ☐ Integrated Circuits ☐ App Specific ICs ☐ System On a Chip ☐ Networked sub-systems ☐

**These questions deal with the major target market for your products. The questions also focus on how the products are viewed by the market.**

**Demand for our product depends on our competitors' latest offering:**

Not at All — Somewhat — To a Great Extent

**Demand for our product-line is?**

Totally Predictable — Erratic

**The customers who buy our products are:**

Not at all Brand Loyal — Extremely Brand Loyal

**Our average consumer considers our products to be a:**

Staple — Luxury Item

**Our products compete on?:**

Price alone — Features alone

**Customers who buy our products represent a market which is a:**

Niche Market — Market Segment — Mass Market

**Uniqueness and customization of our products are important to our customers:**

Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

**The questions in this section ask you to consider the company as a whole. You should not focus on individual product lines, or a particular system.**

**These next questions deal with the confidence that members of your staff have in the overall functioning of Information Technology support in your company.**

**We rarely have to escalate problems to IT management to get IT tasks performed**

Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

**The IT staff we work with do their work even if IT management is not around.**

Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

**Once an IT person is assigned to my task, we don't have to consult with the IT manager to get it done.**

Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

**We can rely on IT staff to not make our jobs more difficult through careless work.**

Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

**We have full confidence in the skills of the Information Technology staff**

Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

**These questions deal specifically with the confidence that you and your colleagues (the people at your level of management) have in the staff who report to them.**

**Rather than needing a backup plan, my colleagues and I can depend on our staff to complete tasks**

Strongly Disagree | Neither Agree nor Disagree | Strongly Agree

**The quality of the work that my colleagues and I receive from subordinates is only maintained by our diligent monitoring.**

Strongly Disagree | Neither Agree nor Disagree | Strongly Agree

**My colleagues and I sometimes find it necessary to work around our lower level employees in order to get things done the way we would like them to be done.**

Strongly Disagree | Neither Agree nor Disagree | Strongly Agree

**My colleagues and I trust our employees to get things done without constantly checking up on them**

Strongly Disagree | Neither Agree nor Disagree | Strongly Agree

**My colleagues and I keep close track of interaction with my subordinates, taking note of instances where they do not deliver as they should.**

Strongly Disagree | Neither Agree nor Disagree | Strongly Agree

**Please think about your main supply chain partner (customer or supplier) with whom you regularly exchange information about orders, shipments, inventory, etc.**

**The main partner which we collaborate with is a ...**

Supplier ◉ Customer ○

**Now think about the way you work with this partner. Visualize one important system you use to manage the Supply Chain activities between your organization and the partner chosen above. The system should be a core part of your Supply Chain Management efforts, and used to to exchange information with this partner.**

**You will be asked several questions later about the system you select here.**

**The main focus of our Supply Chain Management system is:**

Purchasing ▼

**The length of time the system has been in use (months/years) is:**

< 6 months ○ | 6 months - 2 years ○ | 2 - 5 years ○ | 5 - 10 years ○ | over 10 years ○

**The primary functions this system supports in our organization are:**

design ☐ | manufacturing ☐ | distribution ☐ | logistics ☐ | retailing ☐ | services ☐ | marketing/sales ☐

**Options were:**

*Production*
*Forecasting*
*Purchasing*
*Logistics*
*Sales/Marketing*
*Inventory Management*
*Point of Sale*

**These questions address the level of integration between you and your main supply chain partner, the Supplier you selected earlier.**

From option chosen on last screen

**Our companys' mutual survival depends on the quality of data sharing between us:**

| Strongly Disagree | | | Neither Agree nor Disagree | | | Strongly Agree |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**Our supply chain related activities are based on the data shared between us for:**

| | 0 - 20% of the time | 21 - 40% of the time | 41 - 60% of the time | 61 - 80% of the time | 81 - 100% of the time |
|---|---|---|---|---|---|
| ... daily product movement: | ○ | ○ | ○ | ○ | ○ |
| ... monthly scheduling: | ○ | ○ | ○ | ○ | ○ |
| ... quarterly product planning: | ○ | ○ | ○ | ○ | ○ |

**Collaboration between us can be described as:**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| limited level of collaboration | ○ | ○ | ○ | ○ | ○ | ○ | ○ | frequent communication about product needs |
| arms-length negotiations | ○ | ○ | ○ | ○ | ○ | ○ | ○ | tightly integrated operations |
| contractually enforced | ○ | ○ | ○ | ○ | ○ | ○ | ○ | relationship based |
| per-transaction basis | ○ | ○ | ○ | ○ | ○ | ○ | ○ | continuing |

## The questions in this section pertain to the Purchasing system that you use with your Supplier.

**Decisions made using the Purchasing system affect:**

individuals | teams | departments | divisions | the whole organization

**Activities guided by the Purchasing system affect the company's position:**

within hours | after days | weekly | over months | after years

**The main users of the Purchasing system are:**

Front line staff | Department Managers | C-Level officers

**Users can utilize the Purchasing system in ways that are:**

| | | |
|---|---|---|
| Structured | | Unstructured |
| Routine | | Need-driven |
| Inflexible | | Open-ended |

**The Purchasing system use has an impact on the customer satisfaction of:**

specific customers | many customers | specific demographics | market segments | whole market

**The lowest level at which the financial impact of the Purchasing system use can be observed is?:**

Individual Transaction | Weekly Performance Report | Monthly Profit/Loss Report | Quarterly Financial Statement

**When interacting with the Purchasing system, users are provided with:**

specific, structured directives | a list of options | general recommendations

**The next set of questions deal with the benefits gained in using the Purchasing system to collaborate with your Supplier.**

**Process and product improvements are main benefits of the Purchasing system:**

Not at all — To a great extent

**Understanding future demand for current products is the main benefit of the Purchasing system:**

Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree

**Lead time and inventory reduction are the main benefits of the Purchasing system:**

Not at all — To a great extent

**The next set of questions deal with the purpose that the Purchasing system serves in supporting collaboration with your Supplier.**

**Creating product mix plans is the primary purpose of the Purchasing system:**

Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree

**Figuring out production levels for current products is the primary purpose of the Purchasing system:**

Strongly Disagree | Disagree | Neither Agree nor Disagree | Agree | Strongly Agree

**This next section also relates to the Purchasing system which you use with your Supplier.**

**The next set of questions deal with the benefits gained by using the Purchasing to collaborate with your Supplier.**

**The Purchasing system's main use is helping us to determine what to produce:**

Strongly Disagree ○ | Disagree ○ | Neither Agree nor Disagree ○ | Agree ○ | Strongly Agree ○

**The Purchasing system is mainly used to determine customer demand:**

Strongly Disagree ○ | Disagree ○ | Neither Agree nor Disagree ○ | Agree ○ | Strongly Agree ○

**We use the Purchasing system mostly to reorder the products we use/sell:**

Strongly Disagree ○ | Disagree ○ | Neither Agree nor Disagree ○ | Agree ○ | Strongly Agree ○

**The next set of questions deal with outputs from the system which help to support collaboration with supply chain partners.**

**The output of the Purchasing system influences the choice of product lines and production methods:**

Strongly Disagree ○ | Disagree ○ | Neither Agree nor Disagree ○ | Agree ○ | Strongly Agree ○

**The output of the Purchasing system is a forecast of product demand:**

Strongly Disagree ○ | Disagree ○ | Neither Agree nor Disagree ○ | Agree ○ | Strongly Agree ○

**The output of the Purchasing system is order-quantities:**

Strongly Disagree ○ | Disagree ○ | Neither Agree nor Disagree ○ | Agree ○ | Strongly Agree ○

**These questions deal specifically with the results of system use and what the company has been able to start, improve and achieve as a result of using the Purchasing system which you use with your Supplier.**

**Inventory performance has improved due to use of the Purchasing system.**

Not at all ○ ○ ○ ○ ○ To a great extent

**Safety stock and stock-out have been reduced due to use of the Purchasing system.**

Not at all ○ ○ ○ ○ ○ To a great extent

**Lead time has been reduced due to use of the Purchasing system.**

Not at all ○ ○ ○ ○ ○ To a great extent

**We created new products and/or entered markets as a result of using the Purchasing system.**

Not at all ○ ○ ○ ○ ○ To a great extent

**We discovered new economic growth opportunities and developed new business opportunities as a result of using the Purchasing system.**

Not at all ○ ○ ○ ○ ○ To a great extent

**We improved customer retention and attracted new customers as a result of using the Purchasing system.**

Not at all ○ ○ ○ ○ ○ To a great extent

# Appendix-B: Old Dominion University - IRB Documentation

## Appendix Bi: Application for Exempt Research

**Proposal Number:_____**
(To Be Assigned by the College Committee or IRB)

### APPENDIX B
### OLD DOMINION UNIVERSITY
### APPLICATION FOR EXEMPT RESEARCH

Note: For research projects regulated by or supported by the Federal Government, submit 10 copies of this application to the Institutional Review Board. Otherwise, submit to your college human subjects committee.

| **Responsible Project Investigator (RPI)**<br>The RPI must be a member of ODU faculty or staff who will serve as the project supervisor and be held accountable for all aspects of the project. Students cannot be listed as RPIs. | | |
|---|---|---|
| **First Name: Russell** | **Middle Initial: P** | **Last Name: Haines** |
| **Telephone: 757-683-5841** | **Fax Number: 757-683-3258** | **E-mail: rhaines@odu.edu** |
| **Office Address: 2078 Constant Hall** | | |
| **City: Norfolk** | **State: Virginia** | **Zip: 23529** |
| **Department: IT/DS** | **College: Business & Public Administration** | |
| **Complete Title of Research Project: Use of Information Technology in Collaborative Planning, Forecasting & Replenishment (CPFR) – Determinants of Real world use** | **Code Name (One word): ITCPFR** | |
| **Investigators**<br>Individuals who are directly responsible for any of the following: the project's design, implementation, consent process, data collection, and data analysis. If more investigators exist than lines provided, please attach a separate list. | | |
| **First Name: David** | **Middle Initial: M** | **Last Name: Simmonds** |
| **Telephone: 757-770-8143** | **Fax Number: 757-683-3258** | **Email: dsimmond@odu.edu** |
| **Office Address: 2159 Constant Hall** | | |
| **City: Norfolk** | **State: Virginia** | **Zip: 23529** |
| **Affiliation:** __Faculty _X_Graduate Student __ Undergraduate Student __Staff __Other_____ | | |
| **First Name: Michael** | **Middle Initial: L** | **Last Name: Frazier** |
| **Telephone: 757-683-3547** | **Fax Number: 757-683-3258** | **Email: mlfrazie@odu.edu** |
| **Office Address: 2052 Constant Hall** | | |
| **City: Norfolk** | **State: Virginia** | **Zip: 23529** |
| **Affiliation:** _X_Faculty __Graduate Student __ Undergraduate Student __Staff __Other_____ | | |
| List additional investigators on attachment and check here: __ | | |

**Type of Research**

**1. This study is being conducted as part of (check all that apply):**

| | | | |
|---|---|---|---|
| _ | Faculty Research | _ | Non-Thesis Graduate Student Research |
| X | Doctoral Dissertation | _ | Honors or Individual Problems Project |
| _ | Masters Thesis | _ | Other_____ |

**Proposal Number:_____**
(To Be Assigned by the College Committee or IRB)

**Funding**

**2. Is this research project externally funded or contracted for by an agency or institution which is independent of the university? Remember, if the project receives ANY federal support, then the project CANNOT be reviewed by a College Committee and MUST be reviewed by the University's Institutional Review Board (IRB).**

___Yes **(If yes, indicate the granting or contracting agency and provide identifying information.)**
_ **X** _No

**Agency Name:**
**Mailing Address:**
**Point of Contact:**
**Telephone:**

**Research Dates**

**3a. Date you wish to start research (MM/DD/YY)** 10/01/2014
**3b. Date you wish to end research (MM/DD/YY)** 10/01/2015

**Human Subjects Review**

**4. Has this project been reviewed by any other committee (university, governmental, private sector) for the protection of human research participants?**
___Yes
_ **X** _No

**4a. If yes, is ODU conducting the primary review?**
__Yes
__No (If no go to 4b)

**4b. Who is conducting the primary review?**

**5. Attach a description of the following items:**

__Description of the Proposed Study
__Research Protocol
__References
__Any Letters, Flyers, Questionnaires, etc. which will be distributed to the study subjects or other study participants
__If the research is part of a research proposal submitted for federal, state or external funding, submit a copy of the FULL proposal

Note: The description should be in sufficient detail to allow the Human Subjects Review Committee to determine if the study can be classified as EXEMPT under Federal Regulations 45CFR46.101(b).

**Proposal Number:**_____
(To Be Assigned by the College Committee or IRB)

**Exemption categories**

**6. Identify which of the 6 federal exemption categories below applies to your research proposal and explain why the proposed research meets the category. Federal law 45 CFR 46.101(b) identifies the following EXEMPT categories. Check all that apply and provide comments.**

SPECIAL NOTE: The exemptions at 45 CFR 46.101(b) do not apply to research involving prisoners, fetuses, pregnant women, or human in vitro fertilization. The exemption at 45 CFR 46.101(b)(2), for research involving survey or interview procedures or observation of public behavior, does not apply to research with children, except for research involving observations of public behavior when the investigator(s) do not participate in the activities being observed.

____(6.1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
**Comments:**

_**X**_(6.2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; AND (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.
**Comments:**
**A survey instrument will be used to collect data anonymously. Respondents will not provide their names or the names of their companies. There will be no way of identifying the person who filled in the questionnaire. The most personal demographic to be collected will be job-title & formal-education. The most detailed corporate demographic to be collected include company-size, gross-sales & products sold. Of the 2000 people to be surveyed, there will be no way to identify the person who provided the answers to the survey.**

____(6.3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if:
(i) The human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
**Comments:**

____(6.4) Research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.
**Comments:**

**Proposal Number:_____**
(To Be Assigned by the College Committee or IRB)

| |
|---|
| ___ (6.5) Does not apply to the university setting; do not use it |
| ____(6.6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.<br>**Comments:** |
| |
| **PLEASE NOTE:**<br>1. You may begin research when the College Committee or Institutional Review Board gives notice of its approval.<br>2. You MUST inform the College Committee or Institutional Review Board of ANY changes in method or procedure that may conceivably alter the exempt status of the project. |
| |
| **Responsible Project Investigator** (Must be original signature) **Date** |

**Proposal Number:_____**
(To Be Assigned by the College Committee or IRB)

**Attachment**

| | | |
|---|---|---|
| **First Name: Ling** | **Middle Initial: L** | **Last Name: Li** |
| **Telephone: 757-683-6455** | **Fax Number: 757-683-3258** | **Email: lli@odu.edu** |
| **Office Address: 2064 Constant Hall** | | |
| **City: Norfolk** | **State: Virginia** | **Zip: 23529** |
| **Affiliation:** _X_Faculty __Graduate Student __ Undergraduate Student __Staff __Other_____ | | |

## Appendix-Bii - Informed Consent

**Informed Consent Statement**

Thank you for agreeing to participate in this survey. This survey is part of a research study that is being conducted by David M. Simmonds of Old Dominion University, Department of Information Technology/Decision Sciences. The questions address your professional situation, relationships in your company, problem-solving, information use, industry and products, supply chain collaborations, information technology use and demographics. The survey takes about 15 minutes to complete. Neither your identity nor the identity of the organization in which you work is being tracked. Any information provided by you in the survey will be afforded professional standards for protection of confidentiality. Your participation is voluntary and you can stop taking the survey at any time.

Completing this survey will help us to better understand the ways in which Information Technology is used in Supply Chain Management, specifically within Collaborative Planning, Forecasting and Replenishment (CPFR). We are interested in determining how companies within various industries are using Information Technology to collaborate with their supply chain partners. We also want to find out what management, organizational and technical factors within companies contribute to efficient use of Information Technology in a manner which support the company's operating and market profitability. By filling out this survey, you will be contributing to the understanding of supply chain IT practices which contribute to efficiency and profitability, based on factors existing inside and outside of companies.

By completing this survey, you are consenting to the terms of this research as stated above. You are welcome to print a copy of this consent agreement.

If you have any questions about the study or survey, please contact the Principal Investigator:

Dr. Russell Haines - Principal Investigator

IT Department - Old Dominion University - Norfolk

rhaines@odu.edu - 757-683-5841

If you have any questions regarding your rights as a research subject, please contact Adam Rubenstein, Old Dominion University Director of Compliance Research at arubenst@odu.edu or 757-683-3686.

**At the end of the survey, a link will be displayed which you can click on if you want to be entered into a drawing for a grand-prize of a $25 Amazon gift card and 4 consolation prizes of $10 iTunes gift cards.**

## Appendix-Biii: Research Protocol

David M. Simmonds (PhD Candidate)
Russell P. Haines (Chair)
M. Lance Frazier
Ling Xia Li

**Research purpose:** This Research seeks to determine how IT systems are used for CPFR in the real world. We measure two dimensions of system use. In examining real world IT use for CPFR, I build on Simmonds; Haines & Li (2013) which looks at the trends and gaps in the IT literature as far as use of IT in CPFR was concerned. Here I seek to determine whether the literature lines up with reality, or whether researchers are inherently biased when studying how Information Technology is used to support CPFR. In the second part, the hypotheses which are supported will be used to do a cluster analysis. In this part, I will demonstrate that there are clusters of companies which use CPFR systems in the expected way (such that their industry, product and trust configuration supports the ten hypotheses) and also have high Return on Investment for Operational and Market performance in the use of CPFR systems.

**Procedure overview:** We will send emails to 3000 managers within industry who are interested in supply chain management. The cover letter (attached) will ask them to fill in the survey (attached). They will be directed to the website link (ODU _ IT CPFR Study _ Questionnaire) where they will be asked to fill in the online survey hosted in Qualtrics. Emails will be sent in 3 waves, each wave being 2 weeks after the previous wave of emails. These emails will serve as reminders to the potential respondents to fill in the survey if they have not already done so.

The first page of this online survey will be an opt-in/out notice (attached) where they are informed of the purpose of the survey and given the opportunity to opt out at that point or any point thereafter, or to continue.

**Incentives:**
On the consent page (attached) there will be a message indicating that respondents who complete the survey, can further opt to be entered into a drawing for a grand-prize of a $25 Amazon gift card and 4 consolation prizes of $5 iTunes gift cards. On the last page of the survey: a message (attached) will be displayed indicating the link which respondents can click on in order to be entered into the drawing. They will also be given a link allowing them to request a copy of the survey results/paper produced from the survey (also included):

**Email List:**
We will pay for an email with a list of 3,000 managers. We will send 3 email blasts to the managers who are in charge of procurement, manufacturing, design, sales & marketing, and

production. Because this survey has 3,000 potential respondents with hundreds of respondents in each category of company-size and product, the data does not allow the investigators to guess at which company the respondent is from.

**Data Collection:**
A survey instrument will be used to collect data anonymously. Respondents will not provide their names or the names of their companies. There will be no way of identifying the person who filled in the questionnaire. The most personal demographic to be collected will be job-title & formal-education. The most detailed corporate demographic to be collected include company-size, gross-sales & products sold. Of the 3,000 people to be surveyed, there will be no way to identify the person who provided the answers to the survey

**Data Storage:**
Data will be captured in Qualtrics in a manner which preserves the anonymity of the respondent and there will be no way to tie the respondent to the data they submitted in the survey. The data will be downloaded into a spreadsheet and stored on secure computers without any identifying information. No personally identifiable information will be collected. The most intimate details to be collected will be optional data such as job-title & formal-education. The most detailed information about the company will be company-size, gross-sales & products sold.

**Post Survey Follow-up:**
As can be seen in the opt-in notice, the at the end of the survey, respondents may-if they desire-click on a link which generates an email which comes back and allows them to be entered into a grand drawing for a $25 Amazon gift card with 4 consolation prizes of $10 iTunes gift cards. They will only be able to send that email when they get to the last page of the survey. There is still no way to connect their email address to the data they submitted in the survey.


**Informed Consent Statement**

Thank you for agreeing to participate in this survey. This survey is part of a research study that is being conducted by David M. Simmonds of Old Dominion University, Department of Information Technology/Decision Sciences. The questions address your professional situation, perceptions, problem-solving, information use, Industry & products, supply chain collaborations, information technology use and demographics. The survey takes about 25 minutes to complete. Neither your identity nor the identity of the organization in which you work is being tracked. Any information provided by you in the survey will be afforded professional standards for protection of confidentiality. Your participation is voluntary and you can stop taking the survey at any time.

Completing this survey will help us to better understand the ways in which Information Technology is used in Supply Chain Management, specifically within Collaborative Planning, Forecasting, & Replenishment (CPFR). We are interested in determining how companies within various industries are using IT to collaborate with their supply chain partners. We also want to find out what factors within companies contribute to efficient use of Information Technology in a manner which support the company's operating and market profitability. By filling out this survey, you will be contributing to the understanding of supply chain IT practices which contribute to efficiency and profitability, based on factors existing inside and outside of companies.

By completing this survey, you are consenting to the terms of this research as stated above. You are welcome to print a copy of this consent agreement.

If you have any questions about the study or survey, please contact the Principal Investigator:

Russell Haines - Principal Investigator
IT Department - Old Dominion University - Norfolk
rhaines@odu.edu - 757-683-5841-

If you have any questions regarding your rights as a research subject, please contact the Old Dominion University Human Subjects Research Committee Administrator, Katrina Miller-Stevens, at klmiller@odu.edu or 757-683-5109.

**At the end of the survey, a link will be displayed which you can click on if you want to be entered into a drawing for a grand-prize of a $25 Amazon gift card and 4 consolation prizes of $10 iTunes gift cards.**

Continue

Survey Completion
0% 100%


**You are now at the end of the survey. Thank you for your time!!**

But before you click out ...

... If you want a copy of the survey results or the paper which is produced from it, then please send an email to dsimmond@odu.edu with the subject-line: **SendCopySurveyResults.** If you have Microsoft Outlook installed, then you can if you choose to instead, click on the following link: SendCopySurveyResults and it will automatically create a new email for you.

... If you would like to be entered into a drawing for a grand-prize of a **$25 Amazon gift card** and 4 consolation prizes of **$10 iTunes gift cards**, then please send an email to dsimmond@odu.edu with the subject-line: **EnterCPFRSurveyDrawing**. If you have Microsoft Outlook installed, then you can instead, click on the following link: EnterCPFRSurveyDrawing and it will automatically create a new email for you. Then just hit the send button and you will be automatically entered in the grand drawing. Sending of eitheremail does not compromise your anonymity. Your responses will still not be linked to your email address.

Back Continue

Survey Completion
0% 100%

Survey Powered By Qualtrics

## Appendix-C: Survey-invitations

### Formal Invitation (November 2014):

Dear Supply Chain Manager,

I am a PhD candidate at Old Dominion University in International Business (Information Technology). I am inviting you to participate in a research study by completing the attached survey. It is the core of my dissertation on the use of Information Technology in Supply Chains and your assistance would be deeply appreciated in completing it.

The survey looks at your professional role, perception of company relationships, Industry & products, supply chain collaborations, and information technology use. It takes about 15 minutes to complete and any information provided will be afforded professional standards for protection of confidentiality.

You were selected as an operations-focused manager in a short-list of companies that are industry leaders, demonstrating leadership and excellence in Supply chain Management. Proficient managers such as yourself help to steer your company to dominant positions within your industry, using advanced Supply chain Management collaboration and Information Technology.

This study hopes to draw on the depth of your experience to understanding how Information Technology is used in Collaborative Planning, Forecasting, & Replenishment (CPFR). By making your insights available, you will be making invaluable contributions to the advancement of supply chain IT practices. This will, in the future, manifest in results driven IT systems which support effectiveness in company's supply chain operations and overall profitability.

On completion of the survey, you can enter a drawing for a grand-prize of a $25 Amazon gift card and 4 consolation prizes of $10 iTunes gift cards.

I do hope you will make time in your busy day to do this survey, and I thank you in advance.

Sincerely,
David Simmonds

**Follow this link to the Survey:**
Take the Survey

**Incentive-laden Survey-invitation (December 2014):**

Dear ${m://FirstName},

I would deeply appreciate if you could share some of your expert insights into Supply Chain IT use, which is the basis of my PhD in Information Technology.

As you are aware, with the realities of IT driven Supply Chain companies like eBay & Amazon, FedEx & UPS, mastery of supply chains are critical to success in a globalized world of customers and suppliers. The benefit to your company, is access the aggregated results. You will be able to see how your company's IT use compares--to your industry, as well as to overall best practices--for Supply Chain Management.

Executives at your level--in American companies that interact heavily with their Supply Chain--can provide invaluable insights into the use of advanced Information Technology for optimizing interactions with customers and suppliers. I am inviting you to participate in the attached survey. Your assistance would be deeply appreciated and your responses are anonymous.

The survey asks about your professional role, perception of relationships, Industry & products, supply chain collaborations, to determine their effect on your company's IT use and its effectiveness. It takes 10 - 15 minutes to complete. On completion of the survey, you can choose to enter a drawing for a $100 Amazon gift card and four $25 iTunes gift cards.

I hope very much, that you will take time out of very your busy day to take the survey. And I thank you in advance.

Sincerely,
David Simmonds

**Benchmarking (You will learn from it) invitation (February 2015):**

Dear ${m://FirstName} ${m://LastName},

The Old Dominion University Department of Information Technology and Decision Sciences has chosen your company from among several, select cutting-edge supply chain involved companies, to participate in the 2014-2015 benchmarking study of Collaboration in Supply Chains. We are gathering the input of key decision makers who influence planning, forecasting, or replenishment among their customers and suppliers. As a benchmarking participant, you will eligible to receive the results of the study, aggregated by industry.

The study will reveal the current best practices for leveraging IT to optimize end-to-end Supply Chain product planning, forecasting and replenishment. By participating, you will gain insights into your company's standings in key IT/SCM performance areas. You will also see areas in which to focus your IT/SCM process improvement efforts in order to retain and enhance global competitiveness.

Below is a link to an online questionnaire to enter data about your organization on a confidential basis. It takes less than 15 minutes to complete.

--
Dr. Russell Haines
Old Dominion University

${l://SurveyLink?d=Take%20the%20Survey}

${l://OptOutLink?d=Click here to unsubscribe}

**Personalized with Jamaican flavor (March 2015):**

Dear ${m://FirstName} ${m://LastName},

I am a Jamaican student, months away from fulfilling my life-long dream of earning my PhD, at Old Dominion University in Norfolk, Virginia. I have been an adjunct instructor for the last seven years and I need one more thing to complete my dissertation. This will allow me to remain in the United States, teaching as a qualified assistant professor.

Attached is a brief survey, and this is where I desperately need your help. I am caught in a chicken-and-egg situation as my dissertation requires the real-world understanding of highly experienced senior managers like you … who are by nature, extremely busy. And so far, I have been getting a lower than 2% response rate.

CNN, in ***"8 things you might not know about Jamaica",*** says our food is reason enough to visit. So unsurprisingly, we explain everything using food. And as we say in Jamaica, **"one-one coco full basket"** (a basket of coco-beans is made up of individual beans). Each expert manager like you, who completes the survey, takes me one data-point closer to the PhD. It will take you 15 minutes to "add a coco-bean to my basket", and your participation will literally make a world of difference to how ... and where I continue my career.

**Please follow this link to the Survey:**

${l://SurveyLink?d=Take the Survey}

# Appendix-D: Email reminders – History

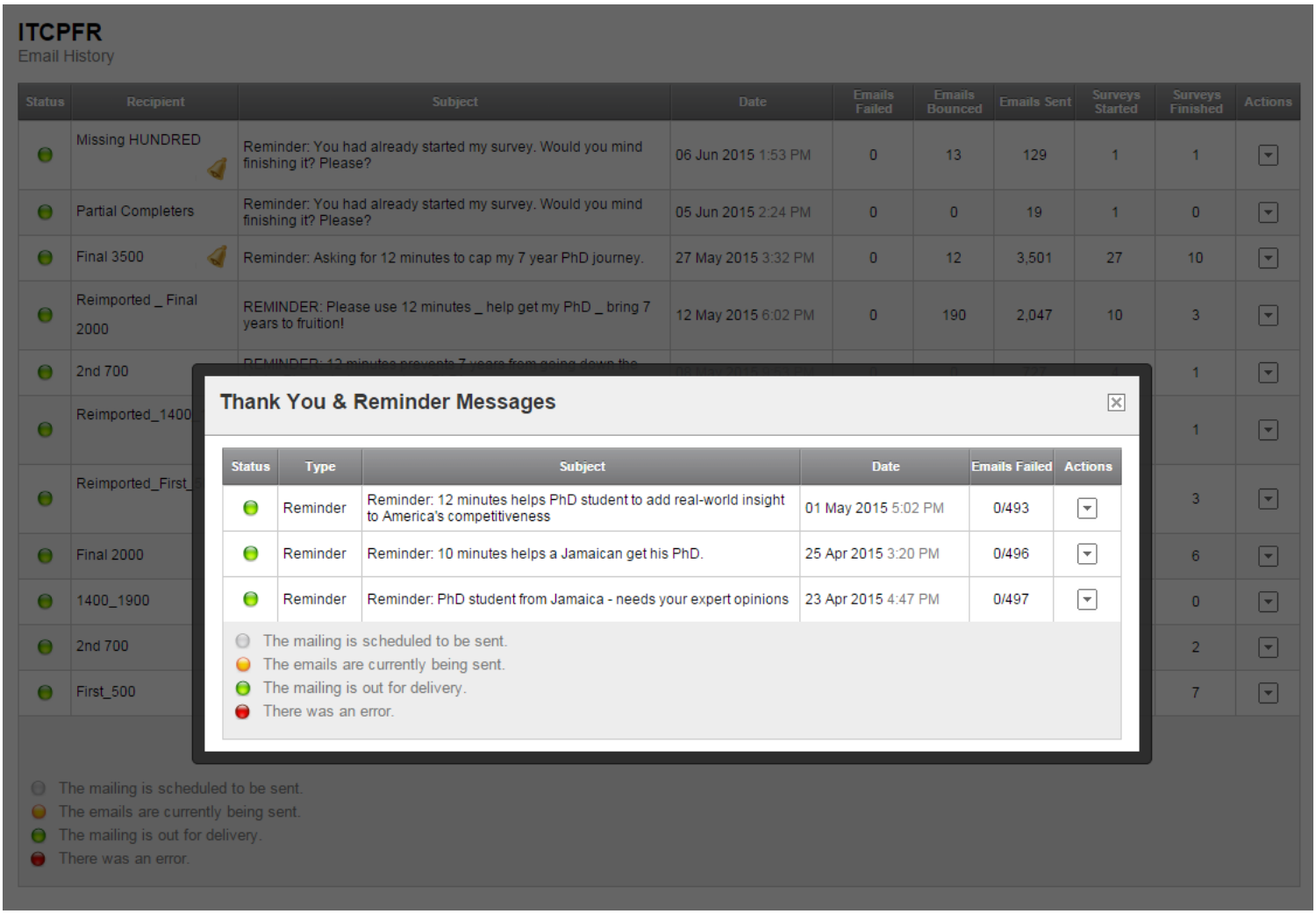
**ITCPFR**

Email History

| Status | Recipient | Subject | Date | Emails Failed | Emails Bounced | Emails Sent | Surveys Started | Surveys Finished | Actions |
|---|---|---|---|---|---|---|---|---|---|
| | Missing HUNDRED | Reminder: You had already started my survey. Would you mind finishing it? Please? | 06 Jun 2015 1:53 PM | 0 | 13 | 129 | 1 | 1 | |
| | Partial Completers | Reminder: You had already started my survey. Would you mind finishing it? Please? | 05 Jun 2015 2:24 PM | 0 | 0 | 19 | 1 | 0 | |
| | Final 3500 | Reminder: Asking for 12 minutes to cap my 7 year PhD journey. | 27 May 2015 3:32 PM | 0 | 12 | 3,501 | 27 | 10 | |
| | Reimported _ Final 2000 | REMINDER: Please use 12 minutes _ help get my PhD _ bring 7 years to fruition! | 12 May 2015 6:02 PM | 0 | 190 | 2,047 | 10 | 3 | |
| | 2nd 700 | REMINDER: 12 minutes prevents 7 years from going down the drain. Please help me get my PhD! | 08 May 2015 9:53 PM | 0 | 0 | 727 | 4 | 1 | |
| | Reimported_1400_1900 | 12 minutes prevents 7 years from going down the drain. Please help me save my PhD! | 07 May 2015 3:45 AM | 0 | 60 | 528 | 3 | 1 | |
| | Reimported_First_500 | 12 minutes stops 7 years from being wasted. Please help a desperate Jamaican PhD student | 07 May 2015 3:06 AM | 0 | 0 | 495 | 5 | 3 | |
| | Final 2000 | PhD student - desperately needs ten minutes of your expert, real-world insights | 05 May 2015 5:24 PM | 0 | 176 | 2,057 | 16 | 6 | |
| | 1400_1900 | PhD student from Jamaica - begs for 12 minutes of your expertise | 30 Apr 2015 5:27 PM | 0 | 57 | 532 | 4 | 0 | |
| | 2nd 700 | PhD student from Jamaica - needs 10 minutes of your expertise | 23 Apr 2015 7:02 PM | 0 | 0 | 734 | 8 | 2 | |
| | First_500 | Reminder: Jamaican PhD student needs your help | 07 Apr 2015 4:51 PM | 0 | 0 | 505 | 10 | 7 | |

Showing 1 - 11 of 11

- The mailing is scheduled to be sent.
- The emails are currently being sent.
- The mailing is out for delivery.
- There was an error.


ITCPFR
Email History
Status
Recipient
Subject
Date
Emails Failed
Emails Bounced
Emails Sent
Surveys Started
Surveys Finished
Actions
Missing HUNDRED
Reminder: You had already started my survey. Would you mind finishing it? Please?
06 Jun 2015 1:53 PM
0
13
129
1
1
Partial Completers
Reminder: You had already started my survey. Would you mind finishing it? Please?
05 Jun 2015 2:24 PM
0
0
19
1
0
Final 3500
Reminder: Asking for 12 minutes to cap my 7 year PhD journey.
27 May 2015 3:32 PM
0
12
3,501
27
10
Reimported _ Final 2000
REMINDER: Please use 12 minutes _ help get my PhD _ bring 7 years to fruition!
12 May 2015 6:02 PM
0
190
2,047
10
3
2nd 700
1
Reimported_1400
1
Reimported_First_
3
Final 2000
6
1400_1900
0
2nd 700
2
First_500
7
Thank You & Reminder Messages
Status
Type
Subject
Date
Emails Failed
Actions
Reminder
Reminder: 12 minutes helps PhD student to add real-world insight to America's competitiveness
01 May 2015 5:02 PM
0/493
Reminder
Reminder: 10 minutes helps a Jamaican get his PhD.
25 Apr 2015 3:20 PM
0/496
Reminder
Reminder: PhD student from Jamaica - needs your expert opinions
23 Apr 2015 4:47 PM
0/497
The mailing is scheduled to be sent.
The emails are currently being sent.
The mailing is out for delivery.
There was an error.
The mailing is scheduled to be sent.
The emails are currently being sent.
The mailing is out for delivery.
There was an error.

# VITA

**DAVID MCCAW SIMMONDS**

**Department of Information Technology**

**Strome College of Business**

**Old Dominion University, Norfolk, VA 23529**

**Email: dsimmond@odu.edu**

## Education

2000 University of the West Indies - Kingston, Jamaica

MSc in Management Information Systems: Focused on IT with Management subjects: Economics, Marketing, Finance, Accounting and Organizational Behavior. Focused on helping Jamaican Information Technology professionals to rise to senior management.

1992 University of the West Indies - Kingston, Jamaica

B.Sc. (Hons) Computer Science & Electronics.

**Conference Papers**

Effect of Hofstede Culture on Adoption of Smartphones

IT Trends in Collaborative Planning Forecasting & Replenishment

**Web-Site Tutorial Series:**

Series of articles on Gang of Four (GoF) Design Patterns for two websites - Programmers Heaven.com and ASPAlliance.com. These design patterns allow software to be robust, adaptable and maintainable. The 16 completed articles were written solely by me. They re-conceptualized and used everyday language to simplify understanding of the software design patterns from the GoF. They included 4 introductory articles, the 5 Creational

Patterns and the 7 Structural patterns. Also started work on 5 of the Behavioral patterns. http://aspalliance.com/author.aspx?uId=59827

**Career Highlights - Academic**

Adjunct Professor - Old Dominion University – Norfolk Virginia (5 years):
Taught Business Intelligence (IT410) for IT majors, which shows how Business Intelligence solutions are designed, developed and implemented in organizations (1 semester). Also taught principles of Information Technology (IT360T – Online) which is designed to give non-IT majors a fundamental understanding of how IT is used in organizations to achieve efficiencies and competitiveness (1 semester). Collaboratively developed and currently teaching Basic Information Literacy and Research (IT150G) for four years. Taught Business Productivity Software (BUS135) which was focused on use of Microsoft Office software.

Lecturer, Information Technology – VTDI – Kingston, Jamaica (2 years). Researched, developed course materials for, and taught Information Technology courses. Developed exams and course-work, assessed exam scripts.

External Examiner (IT) – Council of Community Colleges of Jamaica (3 years – Part time). Second marked scripts and performed statistical analysis of student performance to measure first marker's consistency and accuracy.

**Career Highlights - Industry**

Information Technology Manager–Office of Disaster Preparedness/TouchPoint Call-Centers/Jamaica General Insurance (4 years): Supervised staff, ensuring smooth

operation of the companies MIS resources and processes. Developed strategic IS objectives for the Organizations. Managed performance and development of IS Staff (ODPEM, TPCI, JGI). Procured network equipment and software. Administered the organization's network infrastructure. Developed a comprehensive IT Disaster Recovery Plan. Developed an RFP and implementation road map for a Hot Site (ODPEM). Developed and implemented solutions for tactical information needs using Visual Basic programming. Spearheaded development of user-focused IT processes (TPCI). Guided selection an enterprise wide General Insurance System through systems analysis using company-wide fact-finding and industry surveys, culminating in production of a Request for Proposal. Guided system evaluation and scoring process by the IT Steering Committee (JGI).

Database Administrator - Life of Jamaica Limited (2 years): Managed the mission critical Databases using DB2, Ingres and SQL Server. Implemented Database design changes, pertaining to Life Insurance Application. Performance tuned the databases. Trained programmers and power-users in use of reporting tools and SQL-queries. Developed and documented database disaster recovery procedures.

Senior Systems Analyst/Programmer Analyst - Cable & Wireless Jamaica/National Housing Trust (4 years): Performed systems analysis and programming for the data conversion of a Customer Information System (CWJ). Performed systems analysis and programming for implementation of the mission critical Mortgage system. Performed User Training. Conducted User Acceptance Testing and volume testing for the mortgage system (NHT).