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Modeling a multi-supplier framework on cloud computing for inducing flexibility in Supply Chain Management

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Abstract: The multi-supplier multi-buyer framework agreements are designed to ensure cost effective purchasing and faster deliveries of products. The EU directives 2004/17/EC and 2004/18/EC define the rules of framework agreements signed in the entire Europe. In practice, framework agreements are not effective because of poor collaboration, communications, and information sharing. The model of pre-agreed lock-in prices is not successful in modern markets because the market prices fluctuate significantly. The suppliers feel that they carry all the risks and buyers just want to play safe given the lack of volume commitments. This study presents an integrated collaborative model of framework agreements using cloud computing. At the core of the model, an automated process framework with automated request-response tasks is designed that ensures automatic PO preparation, automatic ordering, automatic delivery tracking, and automatic issuing of replenishment instructions. The performance is excellent given the adoption of cloud computing e-marketplace design. The model is expected to solve the problems of poor collaboration, communications, and information sharing in existing framework agreements.

Highlights:
1. The framework agreements are not effective because of poor collaboration, communications, and information sharing.
2. Framework agreements can be made highly collaborative with excellent performances using cloud computing.
3. The framework agreement operators can use published information on prices, discounts, stocks-in-hand, and delivery lead-times to automate the ordering, delivery tracking, invoicing, and replenishment tasks.
4. In automated collaboration mode, framework agreements can make use of collaborative inventory games theory, user-centered procurement theory, and collaborative supply chain theory partially but with adequate effectiveness.

1. Introduction:

This research is focused on implementing supply chain capacity in a multi-supplier framework under a “multi-user multi-supplier” model. Framework agreement is the latest concept of multi-supplier model in which, the orders are placed using a process called “call-offs” amidst uncertainties in demands of items, their quantities, their prices, and schedule of their ordering (Cartlidge, 2006). It can be established between two cartels of suppliers and buyers for avoiding repetitive procurement processing for each ordering (Cartlidge, 2006). It helps in managing continuous and uninterrupted procurements creating value for both the suppliers and the buyers (Cartlidge, 2006). The suppliers can get consolidated volume commitments from multiple coordinating buyers and the buyers can get price discounts from multiple coordinating suppliers during the call-off events (Cartlidge, 2006). In practice, there have been multiple difficulties in implementing multi-supplier framework agreements. Suppliers cannot plan for inventory and price commitments amidst lack of advance purchasing and volume commitments (Cartlidge, 2006; Arrowsmith, 2009). New suppliers offering enhanced products and services cannot get entry in an existing framework agreement (Arrowsmith, 2009). This may lead to consumption of outdated or obsolete products in public departments (Arrowsmith, 2009). In practice, multi-user multi-supplier frameworks can be made effective by integrating information from the participating suppliers and buyers through a common global information systems platform, like cloud computing. New suppliers should be given chance by introducing the concept of updatable master list of products and their specifications. This research presents a cloud-based information integration model for effective implementation of multi-user multi-supplier framework agreements. The model is designed using OPNET showing a multi-party integration framework using cloud computing theories. The simulation results show how the interactions between the buyers and suppliers can be automated during the “call-off” events and what performance levels and lead-times can be achieved. This model can be useful in implementing the multi-party framework agreements for continuous uninterrupted procurements achieving agility, short lead-times, and high procurement performance levels. The next section presents a theoretical review of multi-supplier frameworks and of information systems integration through cloud computing.

2. Theoretical review:

Framework procurement agreements emerged through the EU directives 2004/17/EC and 2004/18/EC defining the provisions for establishing and operating framework agreements for public procurements (OGC, 2008a). Framework agreements help in establishing a framework of contractual terms applied to all subsequent orders (called call offs) made by the buyers to the sellers participating in the framework (OGC, 2008a). Similar agreements are operational in other countries of the world, like the indefinite delivery and quantity frameworks in the US, panel procurement frameworks in Australia, and supply arrangements under umbrella contracts in Canada (Procurement Lawyers Association, 2012). In the European Union, framework agreements are considered as contracts in which, the EU procurement directives are defined for periodic purchase of goods and for awarding periodic works and services assignments (OGC, 2008a). Framework agreements are different from regular procurement contracts because neither the price, nor quantities, nor the delivery schedules are agreed (OGC, 2008a). A framework agreement is established for a master list of products with vast varieties of specifications defined in a master database (OGC, 2008a). The end customers may choose the products needed at a time and issue a call-off to all suppliers participating in the framework (OGC, 2008a). Thereafter, the purchase order may be placed to the lowest bidder among the participating suppliers (OGC, 2008a). The call-offs may be viewed as individual purchase contracts that downloads the terms from the parent framework agreement (OGC, 2008a). The only details added are the products and their specifications taken from the master database and the pricing, quantities, and delivery schedules as agreed with the chosen supplier (OGC, 2008a).

Framework procurement agreements are based on the key principles of repeatability, management of complexity, value, risk management, and commonality (OGC, 2008b). The EU directives require equal opportunities, equal treatment, non-discrimination, mutual recognition, proportionality, and transparency during call-off events (OGC, 2008b). As further stated in the EU directives, the framework agreement should serve as the tool to mitigate risks because of uncertainties in time of purchasing, quantity, delivery schedules, products and technical advancements, obsolescence, market prices, and availability (Beuter, 2005). The procurement principles need to be interpreted correctly driven by pre-defined economic and non-economic criteria (Beuter, 2005). The World Bank assessment model for national procurement frameworks can be used for assessing the execution capacity of suppliers, tools and procedures employed, anticorruption and other governance controls, public-private participation, contract governance, and grievance addressing system of framework agreements (Thai, 2009).

Public procurement process using frameworks comprises of two stages – tactical stage and operational stage (Caldwell & Bakker, 2009). In the tactical stage, the products and their specifications are finalized, proposals are invited, suppliers are chosen, and contracts are signed (Caldwell & Bakker, 2009). In the operational stage, individual orders are placed, deliveries are expedited, and supplier performances are evaluated (Caldwell & Bakker, 2009).

Framework agreements can be analyzed through multiple theoretical and methodical models. The possible theories and methods linked with framework agreements could be the cooperative games theory (Meca, 2007; Meca & Timmer, 2007; Nagarajan & Sosis, 2006), inventory games theory (Meca, García-Jurado, & Borm, 2003; Meca & Timmer, 2007; Meca *et al.*, 2004; Chen, 2008), procurement as a shared service (Murray, Rentell, & Geere, 2008), user-centered procurement process (Lif, Goransson, & Sandback, 2005), minimum commitment contracts (Bassok & Anupindi, 1997, 2008), and collaborative supply chain theory (Simatupang & Sridharan, 2008; Ramanathan, 2014; Holweg *et al.*, 2005; Fu & Piplani, 2004; McLaren, Head, & Yuan, 2002). The mapping between these theories and framework agreements is presented in the subsequent sections.

2.1 Mapping cooperative and inventory games theories with framework agreements

Cooperative game theory is based on the assumption that the participants do not act individually to meet personal objectives albeit they act as a team to meet collective objectives (Meca, 2007; Meca & Timmer, 2007). Cooperation may be achieved through a suitable mechanism, through commitments, or through binding agreements (Meca, 2007; Meca & Timmer, 2007). The stability of the framework of a cooperative game depends upon the individual benefits abstracted from the cooperation assuming that the cost of cooperation levied upon each individual is worth for each of them to remain in the framework (Cachon & Netessine, 2004; Meca, 2007; Meca & Timmer, 2007). Cooperative game theory is based on at least one stable allocation to the total worth of the game that denies incentives for leaving the game (Cachon & Netessine, 2004; Meca, 2007; Meca & Timmer, 2007). Further to this, cooperation game theory also defines merging coalitions (Meca &

Timmer, 2007; Nagarajan & Sosis, 2008). A merger of two coalitions may be super-additive or sub-additive depending upon whether the larger coalition is beneficial for the two coalitions or not, respectively (Meca & Timmer, 2007; Nagarajan & Sosis, 2008). A super-additive game can be made convex by permutations if there exists a mechanism by which, the incentives of joining the coalition increases as the coalition grows (Meca & Timmer, 2007; Nagarajan & Sosis, 2008). If such a game is played cooperatively and there is no restriction on how many coalitions can join the larger coalition, the game may grow like a snowball (Meca & Timmer, 2007; Nagarajan & Sosis, 2008). Every convex game by permutations is balanced by virtue of a worth allocation rule that allocates individual worth of each player to the grand coalition through a proportionality factor (Granot & Huberman, 1982).

An inventory game is a special form of cooperative game in which, multiple retailers share storage space, inventory costs, and holding costs (Meca, García-Jurado, & Borm, 2003). The individual agent's worth is determined through the individual economic ordering quantity problem solved through cooperation and joint order placements (Meca, García-Jurado, & Borm, 2003; Meca & Timmer, 2007; Meca *et al.*, 2004). Sharing of ordering costs produce convex games by computation because addition of new agents increases the incentives of remaining within the grand coalition (Meca, García-Jurado, & Borm, 2003; Meca & Timmer, 2007; Meca *et al.*, 2004). The demands faced by the agents can be allocated to the coalition proportionately through the core allocation system of the coalition and profits are shared through a stable allocation (Chen, 2008). The grand coalition can be extended to multiple items with multiple specifications required for assembling before delivery if an optimization game is added to the core allocation system (Guardiola, Meca, & Puerto, 2006). In this model, new costs like setup, assembly, finalization, and special packaging needs to be shared among the agents (Guardiola, Meca, & Puerto, 2006). The allocations require a proportionality factor calculation in a balanced combinatorial optimization game that is mathematically a multi-objective linear programming problem using linear programming duality (Guardiola, Meca, & Puerto, 2006).

In a multi-party framework agreement there is a grand coalition between two separate coalitions – the coalition of buyers and the coalition of suppliers (Cartlidge, 2006; OGC, 2008a). The grand coalition shall behave like a super-additive complex game if its formation is beneficial for both the buyers' and suppliers' coalitions. The permutations are needed to derive at least one stable configuration of the interests of the two coalitions. For example, the supplier' coalition would be interested in meeting their volumes and profitability objectives whereas the buyers' coalition would be interested in their pricing, delivery, and quality objectives. The grand coalition should act like an effective system enabling optimum achievements of objectives of the buyers' and suppliers' coalitions. However, the grand coalition may not grow like a snowball because the current framework agreements as per the EU directives do not allow new suppliers or buyers to join the framework (Arrowsmith, 2009; OGC, 2008a). As per the existing EU laws, new suppliers and buyers can join a new framework advertised through the public sector tendering process (Arrowsmith, 2009; OGC, 2008a).

In their current form, the framework agreements are not fully compliant with the inventory game theory and cooperative game theory. In the current form, the call-offs invoke a competition among the suppliers registered in a framework agreement. Every call-off leads to a price and order winning war. The only benefits suppliers enjoy are reduced order processing costs, and licensed access to a mini market of customers. The framework agreements appear to benefit only the buyers and not the suppliers because there are no commitments from the buyers on orders, quantities, and prices (Procurement Lawyers Association, 2012). However, a potential exists in framework agreements to achieve such levels of cooperation if there are slight changes in the directives and a framework of real-time information sharing is implemented. The EU directives do not allow formation of cartels thus disallowing inventory and cooperative games in their pure forms. However, a framework of healthy competition through automated ordering process can be implemented if an information integration platform (like, cloud computing) is employed. The details are discussed further in the proposed solution.

2.2 Mapping procurement as a shared-service with framework agreements

Procurement as a shared service is a system in which, the procurement needs of multiple users are combined and serviced through a consortia formed for consolidating processes, methods, and benefits (Murray, Rentell, & Geere, 2008; Khalfan, McDermott, and Kyng, 2006). Procurement as a shared service helps small councils to gain access to professional procurement services and execute a centralized or decentralized structured procurement system for making purchases of any volume (Murray, Rentell, & Geere, 2008). This theory derived that procurement as a shared service helps in developing an effective centralized procurement advisory service and development of joint procurement and e-procurement strategy (Murray, Rentell, & Geere, 2008). Procurement as a shared service enables development of procurement code of practice, standardization of procedures and specifications, coordination, group contracting, and common documentation (Murray, Rentell, &

Geere, 2008). It is an effective model for deploying multi-user multi-supplier framework agreements with professional procurement services at the core (Murray, Rentell, & Geere, 2008).

The key benefits derived from procurement as a shared service are reduced transaction costs, elimination of duplicate and waste processes, and shorter lead-times (Murray, Rentell, & Geere, 2008). These are the key benefits expected in framework agreements (Arrowsmith, 2009; OGC, 2008a; Goodier *et al.*, 2006; Khalfan, McDermott, and Kyng, 2006). The values derived from framework agreements through procurement as a service systems are reliability, trustworthiness, openness, honesty, cooperation, and commitment (Khalfan, McDermott, and Kyng, 2006). The operational benefits derived are knowledge building, life cycle costing, cost certainty, better quality, faster delivery, reduced returns, less waste, and improved design (Khalfan, McDermott, and Kyng, 2006).

2.3 Mapping user-centered procurement process with framework agreements

In the user-centered procurement process, the steps are designed as per the preferences and usability of a group of users (Lif, Goransson, & Sandback, 2005). In this process, the sellers need to produce customized products meeting user-defined specifications (Lif, Goransson, & Sandback, 2005). The standard products offered in the marketplace may not fulfill the user specifications and their price expectations (Lif, Goransson, & Sandback, 2005). Hence, framework agreements are used as platforms to implement user-centered procurement process for acquiring special customized products with appropriately defined specifications (Khalfan, McDermott, and Kyng, 2006). The key steps of user-centered procurement process are need identification, defining user-specific product specifications, defining usability, evaluating products or product customization needs, defining acceptance criteria and methodology, inviting tenders, and signing contracts (Caldwell & Bakker, 2009; Lif, Goransson, & Sandback, 2005). Through framework agreements, multiple suppliers could be roped in for contributing to the customized products required by the users (Lif, Goransson, & Sandback, 2005).

2.4 Mapping minimum commitment contracts with framework agreements

Some of the initial research studies on minimum commitment supply contracts were conducted by Sadrian and Yoon (1994), Rosenblatt and Lee (1985), Lee and Rosenblatt (1986), and Bassok & Anupindi (1997). They studied the modeling process for price discounts against committed volumes such that the suppliers can achieve profits and buyers can achieve cost reduction. They modeled the concept of priori volume commitments in specialized products industry (like electronics manufacturing) in which, the assembly costs are very high but the transportation and storage costs are negligible. The models presented formulations for selection of optimal contracts with a combination of volume commitments, time horizons, and price discounts. Considering these as variables, an optimal solution exists for gaining best possible discount from the supplier against best possible volume commitment to the supplier. By adopting a sub-optimal solution, the supplier may face the risk of classical newsvendor problem (Bassok & Anupindi, 2008). Custom products designed as per the needs of a group of users are not consumed in the market. Hence, there is a finite risk of newsvendor problem if the volume commitments are not adequate enough to meet the profit targets of suppliers. The newsvendor problem is about a newsvendor who cannot sell the residual newspapers after the day’s sales are over because the news is already old (Xanthopoulos, Vlachos, & Iakovou, 2012). This problem has been compared with non-consumable residual inventory left with suppliers in general (like inventory of expired products or inventory of customized products not purchased by the consumers) (Xanthopoulos, Vlachos, & Iakovou, 2012). In such scenarios, the suppliers need to make sufficient profits to absorb the losses due to unconsumed inventory retained with them (Xanthopoulos, Vlachos, & Iakovou, 2012). In multi-supplier models, a deterministic demand model is needed for determining number of suppliers and their optimal lot sizes depending upon their levels of reliability (Xanthopoulos, Vlachos, & Iakovou, 2012). Suppliers would restrict their inventories to avoid the newsvendor problem (Xanthopoulos, Vlachos, & Iakovou, 2012). In such a case, the cost charged by the supplier increases with the reliability level demanded by the consumers (Xanthopoulos, Vlachos, & Iakovou, 2012).

The framework agreement is not a minimum commitment contracts because the buyers do not make any volume commitments (Arrowsmith, 2009; OGC, 2008a; Procurement Lawyers Association, 2012). In such a scenario, the suppliers’ coalition cannot commit costs to the buyers’ coalition such that each call-off will invoke a competition among the suppliers. This arrangement cannot work for customized products given the high risk of newsvendor problem. Hence, some level of initial commitment is required such that a demand forecasting model can be developed and used for predicting volumes in the subsequent call-offs (Hsu & Chen, 2011). Alternatively, suppliers joining the suppliers’ coalition may sign a mutual revenue sharing contract for distributing the orders as per the in-hand inventories at the time of call-offs (Yao, Leung, & Lai, 2008). Suppliers signing framework agreements for standard products may not need volume commitments because they can anyways sell their inventories in the open market. For them the framework agreement may be only a constraint for prioritizing deliveries to the buyers' coalition whenever a call-off is invoked.

2.5 Mapping collaborative supply chain theory with framework agreements

The most appropriate theory supporting framework agreements is the collaborative supply chain theory. Supply chain collaboration helps in reducing costs, wastes, response time, lead-time, and variability. Some of the prominent supply chain collaboration programs are collaborative planning, forecasting, and replenishment, efficient customer response, continuous replenishment, vendor managed inventory, and quick response (Holweg *et al.*, 2005; Ireland & Bruce, 2000; Frankel, Goldsby, & Whipple, 2002; Lowson, King, & Hunter, 1999). The key elements of supply chain collaboration are process integration, channel alignment, and information sharing that help in reducing adverse effects in supply chains, like the Forrester effect (Lee, Padmanabhan, & Whang, 1997). Channel alignment may be further classified as pricing alignment, inventory alignment, and storage and transportation alignment (Lee, Padmanabhan, & Whang, 1997).

The architecture of supply chain collaboration is built upon five key building blocks: supply chain processes, collaborative performance, incentive alignment, decision synchronization, and information sharing (Simatupang & Sridharan, 2008). The guiding principles for supply chain collaboration are know the customer, integrate business processes, integrate information infrastructure, employ decision support systems, and deploy lean and flat organizational structures (Muckstadt *et al.*, 2001). Modern organizations are heavily dependent upon webs of relationships formed through knowledge sharing networks, alliances, and partnerships (Lowson, King, & Hunter, 1999). Businesses are growing through benefits, resources, and information sharing for gaining collective values (Lowson, King, & Hunter, 1999). The role of integrated processes is to make the collaboration effective and the role of information sharing is to make the integrated processes effective (Muckstadt *et al.*, 2001). Decision support systems help in managing complex scenarios, ensure demand fulfillment through collaborative contributions by all partners, and ensure fruitful benefits sharing among all partners (Muckstadt *et al.*, 2001).

Based on planning and inventory collaboration, a supply chain may be categorized as Type 0, Type 1, Type 2, and Type 3 (Holmstrom *et al.*, 2003; Holweg *et al.*, 2005) as shown in Figure 1.

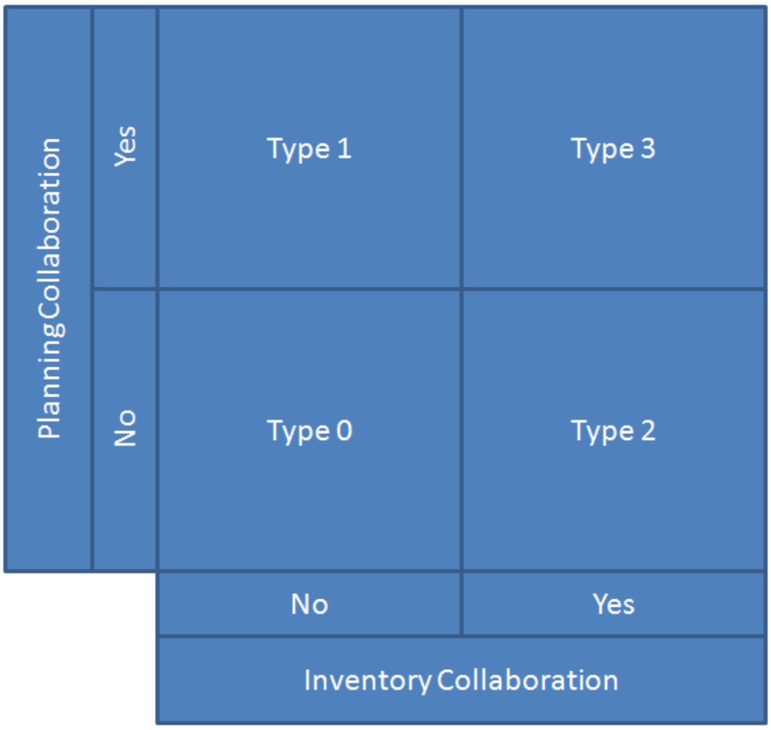


Figure 1: Categorization of supply chains based on inventory and planning collaboration (Holmstrom *et al.*, 2003; Holweg *et al.*, 2005)

A Type 0 supply chain is without any planning or inventory collaboration (Holweg *et al.*, 2005). This is the traditional supply chain without any information sharing or partnerships such that replenishments are based on basic order-up-to policy (Holmstrom *et al.*, 2003). A Type 1 supply chain has planning collaboration only in which, the replenishments are based on replenishment information shared by two partnering entities (Holweg *et al.*, 2005). There is no demand information sharing or demand forecasting in Type 1 supply chains (Holmstrom *et al.*, 2003). A Type 2 supply chain has inventory-level collaboration in which, inventory-level information sharing is combined with demand forecasting (Holweg *et al.*, 2005). In this type of supply chain, the demand forecasting is based on mathematical models using information on consumption and lead-times (Holmstrom *et al.*, 2003). A Type 3 supply chain combines inventory-level information sharing with demand forecasting based on customer inventory management (Holweg *et al.*, 2005).

None of these supply chain categories is suitable for framework agreements because of lack of collaboration of deliveries. A framework agreement is an engagement between a coalition of buyers and another coalition of suppliers such that the buyers' procurement needs can be pooled and fulfilled by the combined capacity of more than one supplier. Hence, in addition to planning and inventory collaboration, the suppliers should also collaborate for managing deliveries to the buyers. Holmstrom *et al.* (2003) have solved this problem by introducing the Type 4 supply chain comprising delivery collaboration as one of the strategic elements. A system for distribution requirements planning is introduced in the Type 4 supply chain for monitoring the lead-time delays in suppliers' inventory replenishment and integrating this information with the consumption rate of the customer such that the order-to-delivery times can be kept within a tolerable range. To avoid bullwhip effect, the demand forecasting should be very accurate in the Type 4 supply chain designed for implementing framework agreements.

3. Problem description:

The idea of framework agreements is not successful in many quarters. It works satisfactorily for standard products that can be sold in the open market if not consumed through the framework agreement (Wood, 2006). However, in case of customers needing customized products there are many gaps to be addressed (Wood, 2006). First, there is uneven distribution of risks between the two coalitions (Wood, 2006). Suppliers have complained that they are required to take all the risks and the clients only want benefits (Wood, 2006). They have further complained that there is uneven sharing of pains and gains whereby clients want more gains and the pains are normally pushed to the suppliers (Wood, 2006). The suppliers demand more leverage in the supply chain for better coordination of profits and inventory that are currently limited by the anti-collusion rules (Albano & Sparro, 2010; Gur, Lu, & Weintraub, 2013). On the other hand, the clients want the leverage to access open markets and do not remain bounded by the framework agreements for each call-off (Albano & Sparro, 2010; Gur, Lu, & Weintraub, 2013).

The governments spend billions of dollars through public procurement (Gur, Lu, & Weintraub, 2013). Framework agreements are designed to exploit the bargaining power of the central government (Gur, Lu, & Weintraub, 2013). Suppliers see a lot of incentives in participating in framework agreements (Gur, Lu, & Weintraub, 2013). However, lack of demand information results in overstating the lock-in prices including charges for uncertainties at the beginning of the contract (Albano & Sparro, 2010; Gur, Lu, & Weintraub, 2013). High bargaining power, coordination, innovation, and network effects are fundamental benefits expected from framework agreements (Albano & Sparro, 2010). The centralized model helps in streamlining information sharing, knowledge development, and specialization (Albano & Sparro, 2010). However, buyers get delinked from the open markets because they need to purchase strictly from the framework (Gur, Lu, & Weintraub, 2013). There are evidences that an auction carried out in the marketplace result in lower prices than an auction carried out within the framework (Gur, Lu, & Weintraub, 2013). Loading of uncertainty costs is perhaps never revoked throughout the contract period (Gur, Lu, & Weintraub, 2013). Albano and Sparro (2008) presented a model of auction within the framework by involving suppliers based on their quoted price, transportation costs, logistics costs, and utility of the goods. The current framework agreements allow catalogue-based procurement only in which, the stated prices may be higher than the market prices and the product specifications may not be the latest available from the market (Procurement Lawyers' Association, 2012). Such problems arise in goods exposed to continuous enhancements in the market (like, computers and communication items) (Procurement Lawyers' Association, 2012). Mini competition may be possible but among very few bidders (Procurement Lawyers' Association, 2012). There is a high risk of collusion in such mini competitions, as well (Procurement Lawyers' Association, 2012).

Current framework agreements appear to utilize a Type 0 supply chain while the need is for Type 4 supply chain. The concept of catalogue-based procurement denies the benefits of cooperative games, inventory games, procurement as a shared service, user-centered framework and the models of collaborative supply chains. The role of the centralized professional procurement service is to define standards, float tender, assess and recruit suppliers as per the standards, build centralized catalogues and price lists, and update the catalogue by getting updates from suppliers through Internet or through EDI batches (Albano & Sparro, 2010). This role needs to be enhanced in operating the contract, analyzing economics, and monitoring supplier performance

(Procurement Lawyers' Association, 2012). For these tasks, the information collection and presentation system should be real time from all the agents participating in the framework (Gur, Lu, & Weintraub, 2013). There is a need for integrated information systems with a standard framework of information exchange and multi-agent processes (Albano & Sparro, 2010; Arrowsmith, 2009; Gur, Lu, & Weintraub, 2013).

4. Modeling the solution:

The e-procurement public procurement systems comprise partial implementation of the solution. E-procurement is a system in which, tendering, bidding, auctions, contracts, ordering, shipping tracking, delivery tracking, and payments are done through the Internet (Moon, 2005). E-procurement has helped in adopting centralized procurement specially through framework agreements (Moon, 2005). E-procurement has been made successful in public procurement through information systems integration, process reengineering, security, change management, performance measurement, and implementation of e-procurement standards and strategy (Vaidya, Sanjeev, & Callender, 2006). In the EU, the e-procurement system for public procurement comprises an announcement system (for inviting bidders), distribution system for procurement-related documents, electronic system for bid submission (using public key encryption and digital signatures), and electronic processing of contracts and its monitoring (Carayannis & Popescu, 2005). The cost of processing purchase requisitions reduces significantly in e-procurement systems (Carayannis & Popescu, 2005). In framework agreements, e-procurement systems help in provisioning centralized procurement support, aggregating demands and supplies, reducing order-processing costs, reducing search costs, improving knowledge sharing, improving communications, and improving visibility (Croom & Brandon-Jones, 2007). However, the problems highlighted in the previous section cannot be solved only by digitizing the purchase process and contracts management. Information sharing needs to be real-time such that the purchaser can gain access to real-time market prices, stock availability, delivery schedule, and delivery charges. On the other hand, the suppliers need to gain real-time access to stock consumption information of the buyers such that they can plan for their stock replenishments. Such a system can be built using the cloud computing e-marketplace concept. The cloud e-marketplace system is a concept in which the stock registers, product catalogues, and price lists can be made accessible real-time for the purchasers and the suppliers (Grilo & Jardim-Goncalves, 2013). The purchaser can run simple XML-based queries on the databases holding stock levels, product e-catalogues, and e-price-lists and prepare purchase order (call-out) for the lowest bidder (Grilo & Jardim-Goncalves, 2013). The price lists and the stock levels may be the same as those published for the open markets (except for customized products). The only difference may be that there will be a pre-agreed discount on each product within the framework agreement. This model will ensure that the suppliers will have leverage in the supply chain as their offerings will be linked with the market prices and the buyers will be assured that they will never have to pay more than the market price within the framework.

In the cloud computing system, there could be multiple virtual machines each hosting at least one database or order-processing/invoicing module (Kiroski, Gusev, & Ristov, 2013). The data used for order processing and invoicing can be generated online by running real-time queries on the product e-catalogue, stock registers, and delivery information databases (Kiroski, Gusev, & Ristov, 2013). On the other hand, the suppliers may gain access to the stock registers of the customers such that they can make their own replenishment decisions (Kiroski, Gusev, & Ristov, 2013).

The papers by Grilo & Jardim-Goncalves (2013) and Kiroski, Gusev, & Ristov (2013) are initial efforts for proposing the cloud-based e-marketplace solution for governing framework or framework-type agreements. These papers are technology-positioning papers presenting the concepts theoretically. This research extends the concepts to produce an OPNET model of cloud e-marketplace and presents a discussion on how the theories of collaborative inventory games, procurement as a service, user-centered procurement, and collaborative supply chains can be implemented.

The model is based on an assumption that there are four suppliers and four buyers engaged in a framework agreement. The eight players are hooked to the cloud-based e-marketplace. The buyers are bound to purchase from the four suppliers only at a pre-determined discount on the published lowest market price of the product. There are no price lock-ins agreed between the suppliers and the buyers. If there are discount schemes offered in the market, they will be passed on to the buyers in addition to the pre-agreed discounts. The systems essential for operating the framework agreement are open to the members for running XML-based queries and gaining access to real time information. The buyers may use e-ordering for generating purchase orders based on real-time information fetched from the suppliers stock, prices, and delivery information. The e-delivery tracking module will help in expediting deliveries after order acceptance. The e-invoicing module will generate automated invoices after the products are delivered. The model is presented in Figure 2 comprising all the components needed to operate a framework agreement in the cloud-based e-marketplace. The entire model shall operate on an integrated process explained in Table 1. The process steps in Table 1 are defined assuming that the quantity of products to be ordered is required by all the four buyers that will be fulfilled from the inventories of two suppliers.

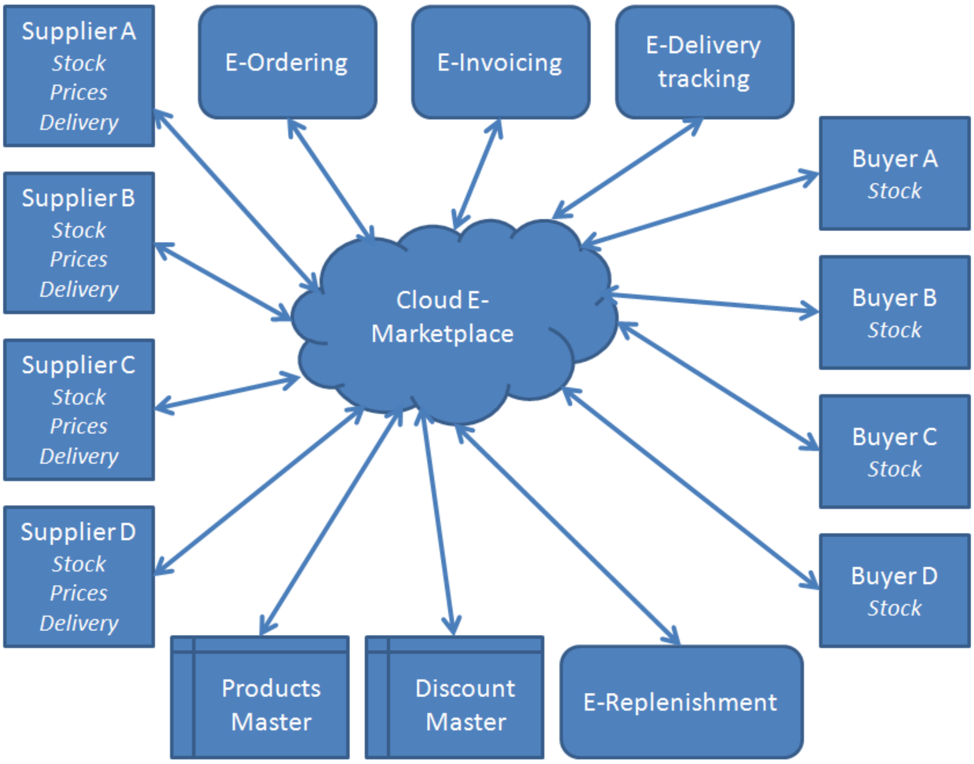


Figure 2: A layout of the Cloud E-Marketplace model for framework agreements

Table 1: The process for operating the framework agreement

Task name	Task Description	Outcomes
FetchProd	E-ordering fetches product IDs and description from Products master	The ordering form is populated by the product IDs and description to be ordered
FetchPrice	E-ordering fetches published market prices from the price tables of the four suppliers	The ordering form is populated by price quotes of the chosen products from the four suppliers.
FetchStock	E-ordering fetches published stock status from the stock tables of the four suppliers	The ordering form is populated by stock details of the chosen products at the inventories of the four suppliers.
FetchDelivery	E-ordering fetches the delivery schedules from the delivery tables of the four suppliers	The ordering form is populated by delivery schedules of the chosen products published by the four suppliers.
FetchDiscounts	E-ordering fetches the agreed discounts on the market price of the chosen products agreed within the framework agreement.	The ordering form gets populated by the discounted prices of the chosen products.
PlacePO1	E-ordering places the purchase order of the products on the lowest bidder with fastest delivery commitment for the entire stock (assuming that it is Supplier A).	A purchase order is placed to the supplier A for the entire stocks of the products.
PlacePO2	E-ordering places the purchase order of the products on the next highest bidder with the fastest delivery commitment after supplier A for the remaining quantity (assuming that it is Supplier	A purchase order is placed to the supplier B for the remaining quantity needed.

Task name	**Task Description**	**Outcomes**
	B).	
InitiateDelivery1	E-delivery instructs Supplier A to ship the products ordered.	Supplier A gets a delivery instruction against PO1
InitiateDelivery2	E-delivery instructs Supplier B to ship the products ordered.	Supplier B gets a delivery instruction against PO1
InitiateInvoice1	E-invoicing generates invoice to the customers for Supplier A.	On initiation of delivery, the invoice for amount due to Supplier A is raised automatically.
InitiateInvoice2	E-invoicing generates invoice to the customers for Supplier B.	On initiation of delivery, the invoice for amount due to Supplier B is raised automatically.
FetchOrderHistory	E-replenishment fetches historical ordering data from the E-ordering database.	A history of orders placed (for the ordered products and quantities) are fetched and loaded in the E-replenishment forecasting model.
EstimateQuantity	E-replenishment estimates replenishment quantity from the ordering history using a suitable forecasting method (like, moving averages).	An estimate for replenishment after delivery of the products ordered is prepared for both the suppliers.
InitiateReplenish1	E-replenishment estimates future demand and instructs Supplier A for replenishment of the products delivered.	Supplier A gets replenishment ordering details for the products dispatched.
InitiateReplenish1	E-replenishment estimates future demand and instructs Supplier B for replenishment of the products delivered.	Supplier B gets replenishment ordering details for the products dispatched.

The design of OPNET model for framework agreements is presented in Figure 3. The model was created using vendor models (in OPNET objects library) comprising four Cisco 8000 series switches, eight Dell Power edge servers and six Dell workstations. The four switches are interconnected using 1000 Mbps Ethernet links and further connected to the servers and workstations. In real clouds, there may be thousands of such servers, workstations, and switches. For the purpose of this research, the numbers are restricted to facilitate high performance simulation in a laptop.

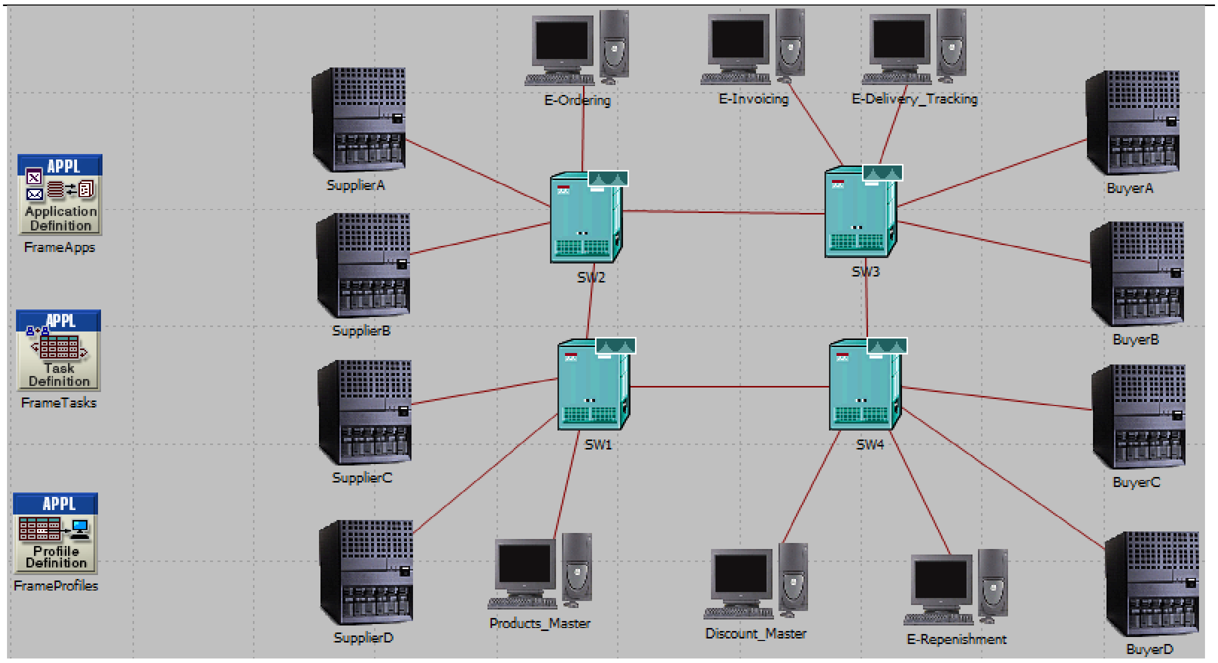


Figure 3: The framework agreement model design prepared in OPNET

The servers of suppliers are marked as SupplierA, SupplierB, SupplierC, and SupplierD, and the servers of buyers are marked as BuyerA, BuyerB, BuyerC, and BuyerD. The six workstations are running common applications used by a centralized procurement team and a centralized supplier administration team for operating the framework agreement. The E-Ordering station runs an application for fetching required data from buyers and suppliers and release purchase orders. The E-Delivery station issues delivery orders and tracks the delivery process. The E-Invoicing station issues invoices once the delivery is initiated. The Products_Master station holds a list of product codes and description of all the products agreed within the framework agreement. The list is updated continuously with the help of the suppliers. The Discount-Master station holds a list of agreed discounts against each product category. The E-Replenishment station fetches ordering data from the E-Ordering system, estimates a forecast, and issues replenishment instructions to the suppliers.

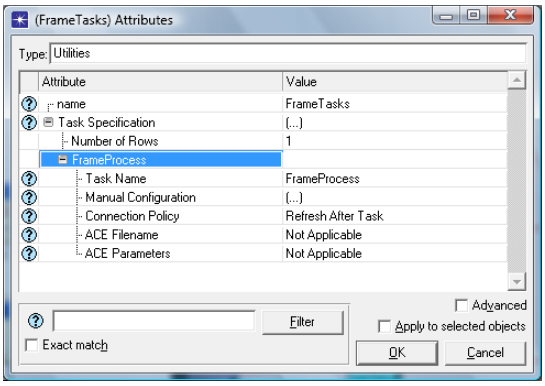
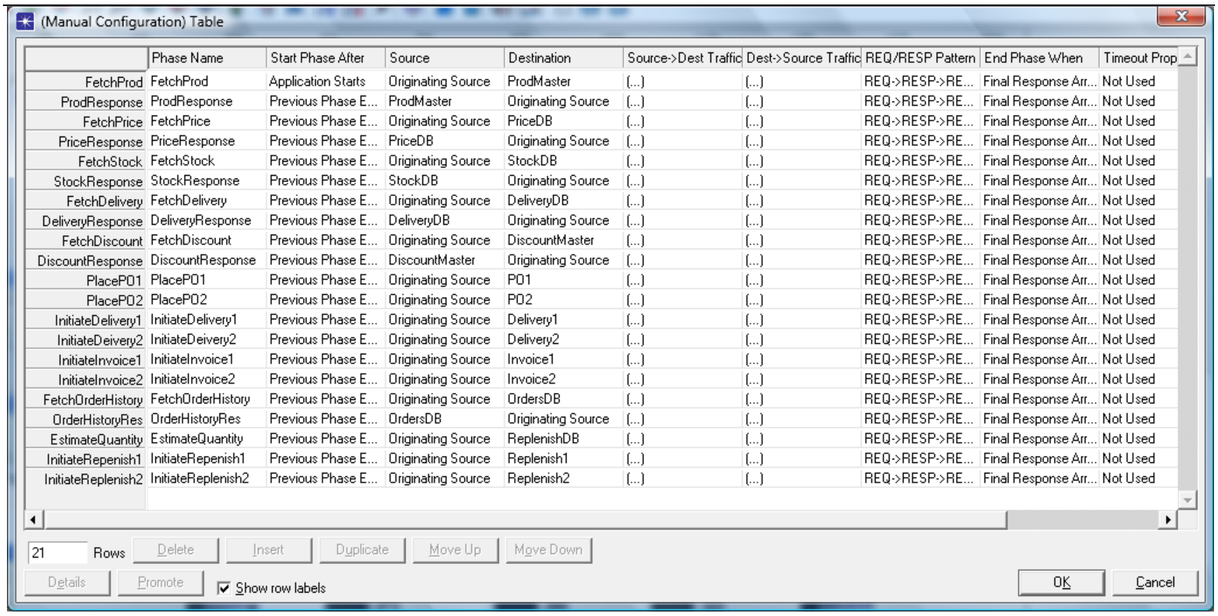


Figure 4: Configuring FrameTasks

The process steps are configured in the OPNET's task configuration module and named as FrameTasks (Figures 4 and 5). Figure 4 presents the initial window to define FrameTasks and Figure 5 presents the detailed configuration window in which, all the task steps are defined. The tasks are sequential in a Request-Response mode except the ones issuing instructions. The Fetch instructions are responded by the database requested (like, ProdResponse, PriceResponse, and DeliveryResponse; these are not shown in Table 1), and the Place, Initiate, and Estimate instructions are simply meant for initiating a task.



	Phase Name	Start Phase After	Source	Destination	Source->Dest Traffic	Dest->Source Traffic	REQ/RESP Pattern	End Phase When	Timeout Prop
FetchProd	FetchProd	Application Starts	Originating Source	ProdMaster	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
ProdResponse	ProdResponse	Previous Phase E...	ProdMaster	Originating Source	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
FetchPrice	FetchPrice	Previous Phase E...	Originating Source	PriceDB	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
PriceResponse	PriceResponse	Previous Phase E...	PriceDB	Originating Source	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
FetchStock	FetchStock	Previous Phase E...	Originating Source	StockDB	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
StockResponse	StockResponse	Previous Phase E...	StockDB	Originating Source	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
FetchDelivery	FetchDelivery	Previous Phase E...	Originating Source	DeliveryDB	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
DeliveryResponse	DeliveryResponse	Previous Phase E...	DeliveryDB	Originating Source	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
FetchDiscount	FetchDiscount	Previous Phase E...	Originating Source	DiscountMaster	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
DiscountResponse	DiscountResponse	Previous Phase E...	DiscountMaster	Originating Source	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
PlacePO1	PlacePO1	Previous Phase E...	Originating Source	PO1	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
PlacePO2	PlacePO2	Previous Phase E...	Originating Source	PO2	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
InitiateDelivery1	InitiateDelivery1	Previous Phase E...	Originating Source	Delivery1	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
InitiateDeivery2	InitiateDeivery2	Previous Phase E...	Originating Source	Delivery2	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
InitiateInvoice1	InitiateInvoice1	Previous Phase E...	Originating Source	Invoice1	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
InitiateInvoice2	InitiateInvoice2	Previous Phase E...	Originating Source	Invoice2	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
FetchOrderHistory	FetchOrderHistory	Previous Phase E...	Originating Source	OrdersDB	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
OrderHistoryRes	OrderHistoryRes	Previous Phase E...	OrdersDB	Originating Source	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
EstimateQuantity	EstimateQuantity	Previous Phase E...	Originating Source	ReplenishDB	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
InitiateRepenish1	InitiateRepenish1	Previous Phase E...	Originating Source	Replenish1	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used
InitiateReplenish2	InitiateReplenish2	Previous Phase E...	Originating Source	Replenish2	(...)	(...)	REQ->RESP->RE...	Final Response Arr...	Not Used

Figure 5: Process steps in Frame Tasks as described in Table 1

The next modeling step is to create the applications. The list of tasks defined under FrameTasks is packed in an application named Frame Process (Figure 6). The databases configured for operating the framework are Prod Master, Pricedb, Stock DB, Delivery DB, Discount Master, OrdersDB, and Replenish DB (Figure 6). They are configured as low-load databases because this cloud has only eight servers and six workstations. In real world framework agreements, there may be hundreds of such servers with significantly high loads as the frameworks are used for purchasing goods and services worth billions of dollars (Gur, Lu, & Weintraub, 2013).

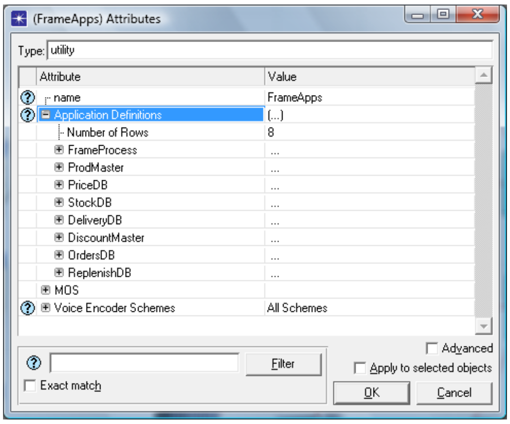


Figure 6: Configuring the FrameProcess agreement and the databases (displayed partially)

ProdMaster is the database hosted on Products_Master workstation. It holds the list of product IDs and their descriptions included within the scope of the framework agreement. PriceDB, StockDB, and DeliveryDB are the databases hosted on suppliers' servers for publishing the market prices, stock-in-hand, and delivery lead-times. DiscountMaster is the database hosted on the Discount-Master workstation for publishing the discounts on market price agreed for each product category included in the framework agreement. OrdersDB is the database hosted by the E-Ordering workstation for publishing the historical records of all the orders released by the buyers' participating in the framework agreement. ReplenishDB is the database hosted by E-Replenishment workstation for forecasting replenishment quantities based on data collected from the OrdersDB.

The FrameProcess application and all the databases are executed within the simulation environment using the FrameProfiles object (Figure 7). This object is used for making the simulation settings for the packaged tasks and the database objects. The execution times of the task events and the databases used by the task events are synchronized through manual configurations in the FrameProfiles object.

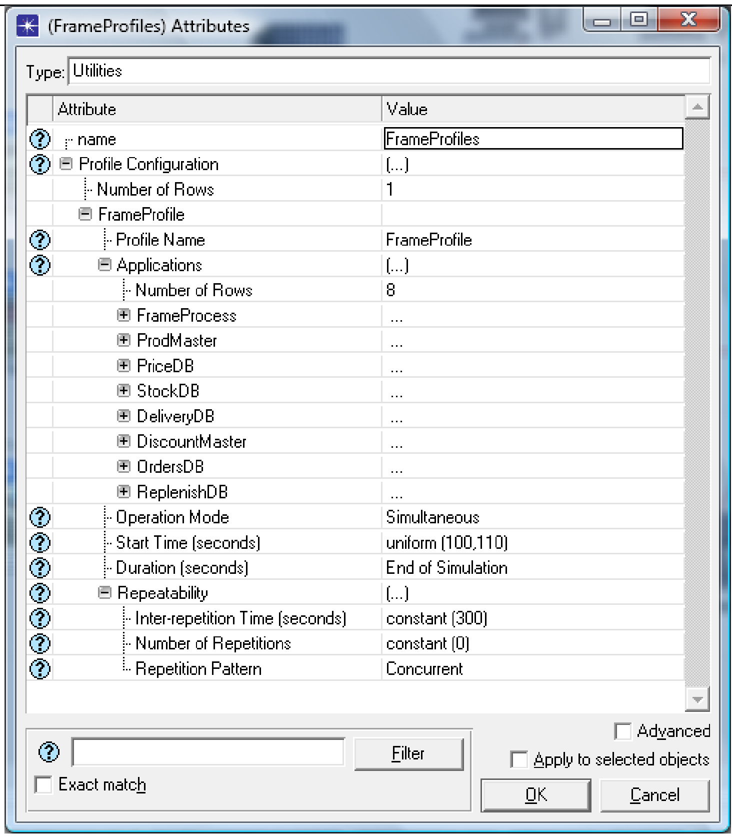


Figure 7: Configurations in the FrameProfiles object (displayed partially)

The final step in the modeling is to assign the respective roles to the servers and workstations configured on the cloud. For assigning the roles to the devices in the tasks of FrameProcess, two configurations are important. First, the destination preferences of the devices need to match the process steps, and second, databases hosted by the devices need to be assigned. The destination preferences configured for E-ordering workstation are shown in Figure 8. Not all the settings can be displayed on a single screen and hence a sample of the configurations is presented in Figure 8. The screenshot shows the destination servers/workstations configured for the process objects ProdMaster, DiscountMaster, and PriceDB. From the process flow presented in Figure 5, it is evident that E-Ordering has a role to interact with these process objects. To make the interactions complete, the destination preferences to all the process objects should be configured. In a similar fashion, the destination preferences of all other devices on the network model are configured (except the switches, as they are not involved directly in FrameProcess).

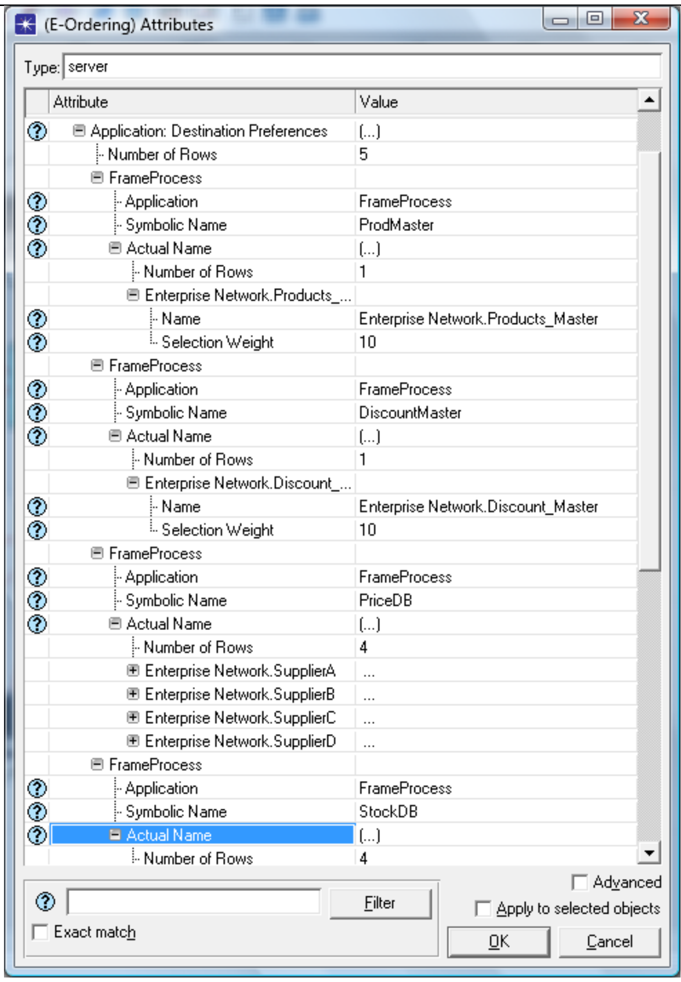


Figure 8: Destination preferences configured for the E-ordering workstation

The databases hosted by Supplier-A server have been configured as shown in Figure 9. The configurations are done using the attribute "Application Supported Services" after including the device in the profile named "FrameProfile".

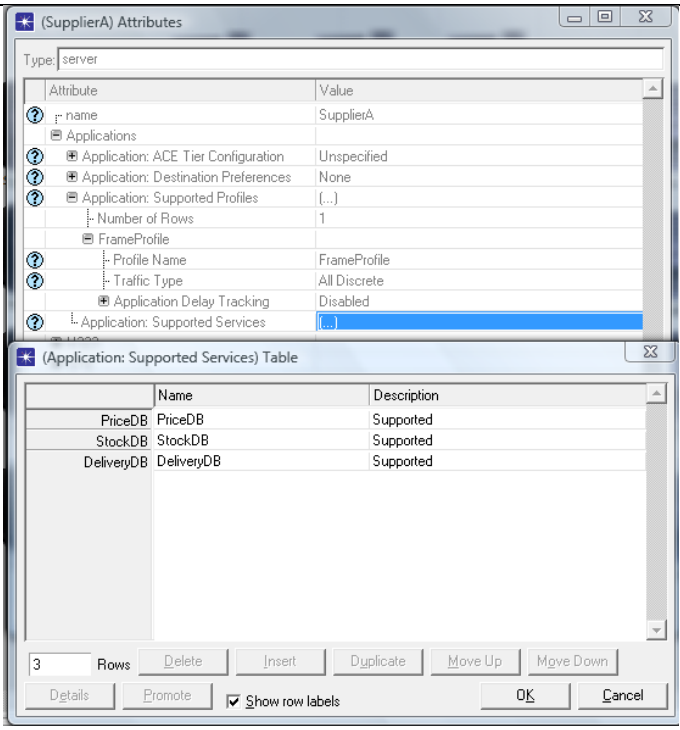


Figure 9: The databases hosted by Supplier-A server

After completing the settings, the OPNET model was simulated for two hours. The results of simulation are discussed in the next section.

5. Simulation results and discussions:

The performance statistics are reported in Figures 10 to 13. Figure 10 reports the average packet network delay (average time taken for delivering a network packet from sources to destinations). It has peaked to 9 milliseconds and has remained overall less than this value. Figure 11 reports the average query response times of the databases on the network that has remained less than 17 milliseconds. The TCP and TCP segment delays are less than 8 milliseconds (Figure 12). The servers have returned acceptable performance statistics, as well (less than 0.15 requests per second, less than 20 tasks per second, and the average task processing times of less than 0.02 milliseconds; Figure 13).

Response times in milliseconds are expected from cloud-hosted application systems (Jha & Dalal, 2011). Larger clouds can even yield response times in microseconds (Duan, 2011). This reveals that when the proposed model is scaled up to hundreds of servers and network switches, the purchasing transactions worth billions of dollars can be executed within a few minutes. The system is suitable to handle transactions worth billions of dollars as evident in modern framework agreements executed in governments and public sector organizations.

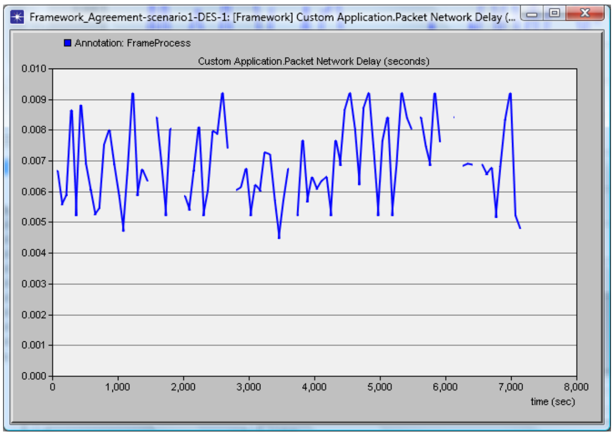


Figure 10: The average network packet delay faced by the tasks under FrameProcess

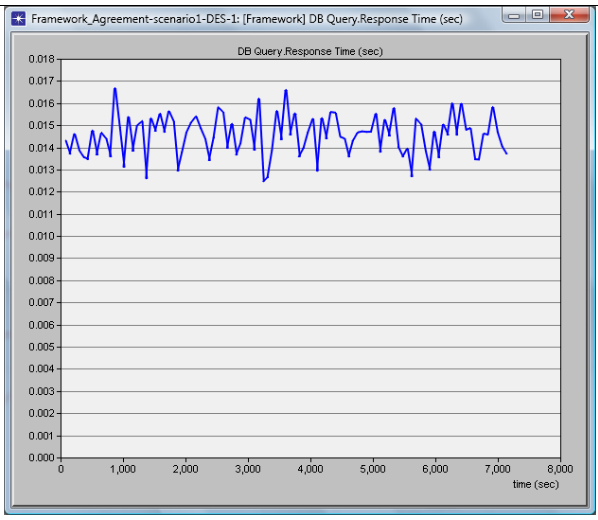


Figure 11: The average database query response time for executing tasks under FrameProcess

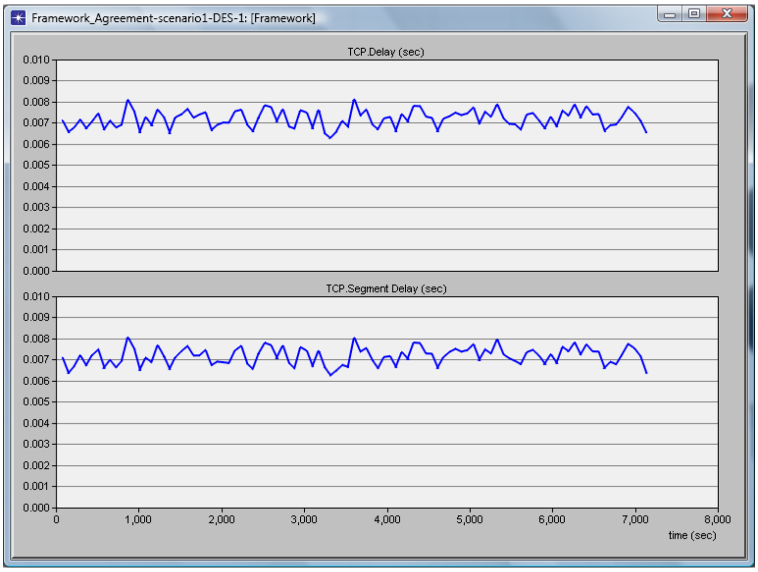


Figure 12: The average TCP delays for executing all the tasks under FrameProcess

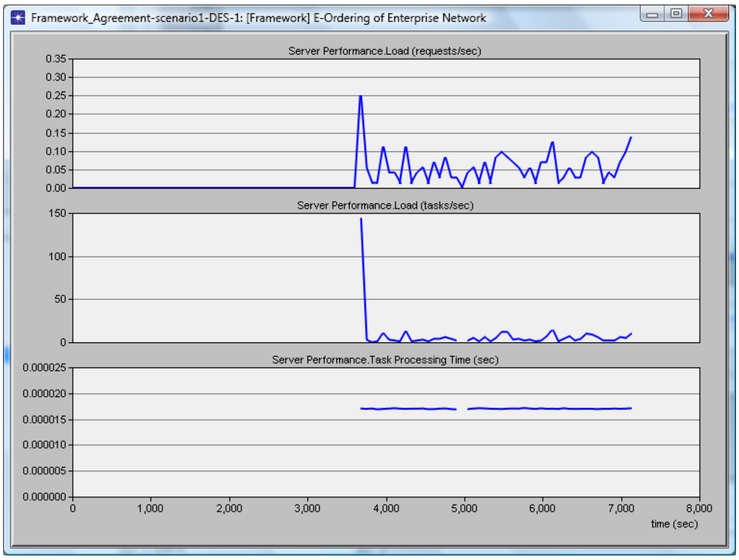


Figure 13: The average Server Performance for executing all the tasks under FrameProcess

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The proposed task automation in FrameProcess application makes the purchase process quite easy and automatic. The buyers just need to raise purchase requisitions to the E-Ordering application and the rest of steps will be executed automatically through the FrameProcess application. The automated requests and responses of the E-ordering server are presented in Figure 14. The fetch instructions are shown as requesting sessions and the responses by the databases are shown as responding sessions. If this level of automation is not feasible in practical environments, the designer may introduce some manual decision-making steps in between causing human-induced delays. For example, there may be a step added to validate the products availability and prices quoted before allowing the system to place the purchase orders. Further, the procurement managers may like to validate the delivery lead times estimated by the system before making commitments to the stakeholders.

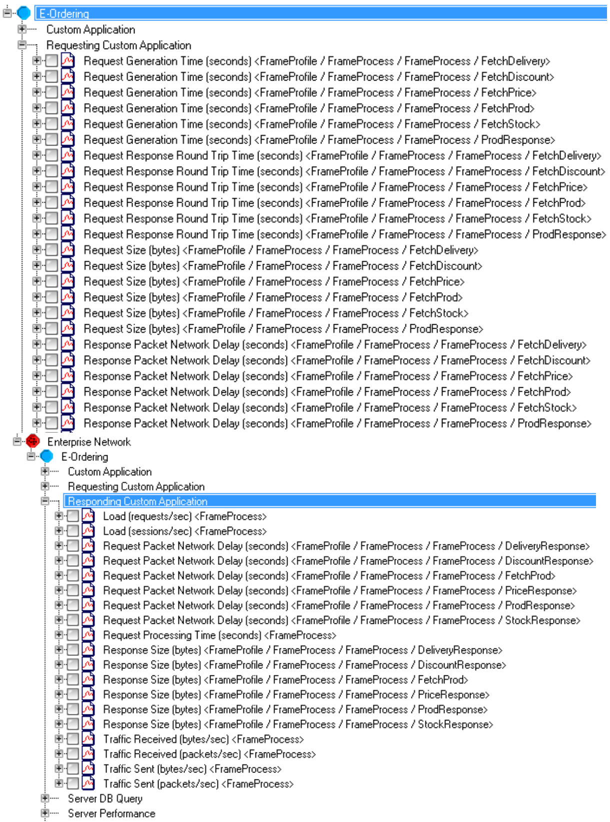

Figure 14: The request and response sessions from/to E-Ordering for executing all its tasks under FrameProcess (displayed partially)

The system acts in compliance with the EU directives 2004/17/EC and 2004/18/EC because it does not allow collusion among the suppliers and operates a mini-competition among all suppliers participating in the framework agreement. The problems faced by suppliers and buyers in multi-supplier and multi-buyer framework agreements are solved. This is because the buyers can be assured of getting less than market prices and the suppliers can expect fair participation in the framework with reduced burden of risks. On the other hand, the collaborative inventory games theory, user-centered procurement theory, and collaborative supply chain theory are also in action (with controls on collusions and unethical collaborations enforced by the system itself). There is no collusion among the suppliers. However, continuous inputs for replenishment give them the opportunity to maintain inventories as per buyers' purchasing history without losing the opportunities offered by the market. The suppliers know the stocks, published prices, and delivery schedules of each other. Hence, while they cannot enter into collusion (as may result because of the collaborative games theory), they do have the opportunity to reduce prices for clearing stocks and plan specific stocks as per the rising demands of the buyers. They can build competencies to gain priority of the buyers based on the published price and stocks information and ordering history. There is no formal collusion but suppliers can use the published information to share orders by publishing lower prices of the products they want to promote to the buyers. Every supplier can get a fair chance in the framework. The system is buyer-centric because all the request-response cycles are controlled by the tools managed by the centralized framework operator. The suppliers gain from this system by reducing their risks and gain access to the opportunities offered by the buyers with a fair chance of competing.

6. Conclusions:

Cloud computing is an effective high performance system for implementing and operating collaborative systems for framework agreements. There is no limit to scalability and performance achievements and information sharing is almost real time. The entire ordering, delivering, invoicing, and replenishment process can be automated with little or no manual interventions. Large purchase orders can be issued within a few seconds and deliveries expedited automatically. The suppliers can replenish the inventories using automatic instructions raised by the E-Replenishment module. In this way, framework agreements can be put in action as Type 4 supply chains driven by an automated cloud-based ordering and replenishment system.

The rules of EU directives 2004/17/EC and 2004/18/EC can be fulfilled through the proposed model. There cannot be any collusion thus enforcing a fair mini-competition among the suppliers. On the other hand, the buyers can be assured of getting less than market prices because the agreement is based on pre-agreed discounts on market prices and not based on pre-agreed lock-in prices. The suppliers can expect fair participation in the framework with reduced risks given the level of information transparency. The proposed model does not have published stock burn reports of the buyers. This may be added for more accurate replenishment decisions with the help of orders history and stock burn reports. However, its feasibility needs to be assessed as per the EU directives (currently, this supplier privilege is not mentioned anywhere in the stated EU directives).

The theories of collaborative inventory game theory, user-centered procurement, and collaborative supply chains are executed partially through the proposed model. The suppliers are not maintaining common inventories in this model. However, they can plan their inventories by using the published prices and stock details of fellow suppliers. They can plan for promotions to clear their stocks or gain better profits by assuring faster delivery lead-times.

References:

[1]. Albano, G. & Sparro, M. (2008), “A simple model of framework agreements: competition and efficiency”, *Journal of Public Procurement*, 8, 356-378.

[2]. Albano, G. & Sparro, M. (2010), "Flexible strategies for centralized public procurement", *Review of Economics and Institutions*, 1, 1-32.

[3]. Arrowsmith, S. (2009), "EC Regime on public procurement, Book Chapter: *International handbook of public procurement*", K. V. Thai (Ed.), London: CRC Press

[4]. Bassok, Y. & Anupindi, R. (1997), "Analysis of supply contracts with total minimum commitment", *IIE Transactions*, 29, 373-381.

[5]. Bassok, Y. & Anupindi, R. (2008), "Analysis of Supply Contracts with Commitments and Flexibility", *Naval Research Logistics*, 55, 459–477.

[6]. Beuter, R. (2005), "European Public Procurement Reform: Main Innovations in the Public Sector Directive – A Preliminary Assessment", EIPASCOPE 2005/3, 1-7.

[7]. Cachon, G. & Netessine, S. (2004), "Game theory in supply chain analysis", In: *Supply chain analysis in the eBusiness era*, Simchi-Levi, D., Wu, S. D., & Shen, M. (eds), Kluwer Publishing.

[8]. Caldwell, N. & Bakker, E. (2009), "Procurement Process in the Public Sector: An International Perspective", Book Chapter: *International handbook of public procurement*, K. V. Thai (Ed.), London: CRC Press

[9]. Carayannis, E. G. & Popescu, D. (2005), "Profiling a methodology for economic growth and convergence: learning from the EU e-procurement experience for central and eastern European countries", *Technovation*, 25, 1–14.

[10]. Cartlidge, D. (2006), “Public-Private partnerships in construction”, NY: Taylor& Francis.

[11]. Chen, X. (2009), "Inventory Centralization Games with Price-Dependent Demand and Quantity Discount", *Operations Research*, 57 (6), 1394-1406.

[12]. Croom, S. & Brandon-Jones, A. (2007), "Impact of e-procurement: Experiences from implementation in the UK public sector". *Journal of Purchasing and Supply Management*, 13 (4), 294-303.

[13]. Duan, Q. (2011), "Modeling and Performance Analysis on Network Virtualization for Composite Network–Cloud Service Provisioning", IEEE, 548-555.

[14]. Frankel, R., Goldsby, T. J. & Whipple, J. M. (2002), “Grocery industry collaboration in the wake of ECR”, *International Journal of Logistics Management*, 13 (1), 57-72.

[15]. Goodier, C., Soetanto,R.,Fleming, Austin, & McDermott (2006), "The future of construction procurement in the UK: a shift to service provision", 182-193, *In Symposium on Sustainability and value through construction procurement*, 29 November - 2 December 2006, The Digital World Centre, Salford, UK.

[16]. Granot, D. G. and Huberman, G. (1982). "The relation between convex games and minimal cost spanning tree games: a case for permutationally convex games," *SIAM Journal of Algebraic and Discrete Methods*, 3, 288-292.

[17]. Grilo, A. & Jardim-Gonclaves, R. (2013), "Cloud-Marketplaces: Distributed e-procurement for the AEC sector", *Advanced Engineering Informatics*, 27, 160–172.

[18]. Guardiola, L. A., Meca, A. and Puerto, J. (2006). "Coordination in periodic review inventory situations", CIO Universidad Miguel Hernández, Elche, 1-77.

[19]. Gur, Y., Lu, L., & Weintraub, G. Y. (2013), "Framework Agreements in Procurement: An Auction Model and Design Recommendations", Columbia Business School, 1-45.

[20]. Holmstrom, J., Smaros, J., Disney, S. M., & Towill, D. R. (2003), "Collaborative supply chain configuraions: The implications forsupplier performance in production and inventory control", *In 8th International Symposium on Logistics*, July 6th-8th, 2003, Seville, Spain, 1-8.

[21]. Holweg, M., Disney, S., Holmstrom, J., & Smaros (2005), "Supply Chain Collaboration: Making Sense of the Strategy Continuum", *European Management Journal*, 23 (2), 170-181.

[22]. Hsu, H. & Chen, Z. (2011), "Two-Stage Ordering Policy under Buyer's Minimum-Commitment Quantity Contract", *American Journal of Operations Research* (2011), DOI: 10.4236/ajor.2011.13012, 84-99.

[23]. Ireland, R. and Bruce, R. (2000), "CPFR only the beginning of collaboration", *Supply Chain Management Review*, 4 (4), 80-88.

[24]. Jha, R. K. & Dalal, U. D. (2011), "On Demand Cloud Computing Performance Analysis With Low Cost For QoS Application", IEEE, 1-4.

[25]. Khalfan, M. M. A., McDermott, P., & Kyng, E. (2006), "Procurement Impacts on Construction Supply Chains: UK Experiences", 322-331, *In Symposium on Sustainability and value through construction procurement*, 29 November - 2 December 2006, The Digital World Centre, Salford, UK.

[26]. Kiroski, K., Gusev, M., & Ristov, S. (2013), "IaaS Cloud Model for e-Ordering and e-Invoicing", *In 2013 Federated Conference on Computer Science and Information Systems (FedCSIS)*, 8 - 11 September, 2013, Kraków, Poland, PTI, 105–110.

[27]. Lee, H. L. & Rosenblatt, M. (1986), "A generalized quantity discount pricing model to increase suppliers' profits". *Management Science*, 32, 1177-1185.

[28]. Lee, H. L., Padmanabhan, V. and Whang, S. (1997), "The bullwhip effect in supply chains", *MIT Sloan Management Review*, 38 (3), 93-102.

[29]. Lif, M., Goransson, B., & Sandback, T. (2005), "Buying Usable – the User-Centred Procurement Process", *In User-driven ICT design and quality assurance (UITQ) 2005*, 43-46, May 24-25 2005, Stockholm.

[30]. Lowson, B., King, R., & Hunter, A. (1999), "Quick Response: Managing the supply chain to meet consumer demand", NY: Wiley.

[31]. Meca, A. & Timmer, J. (2007), "Supply Chain Collaboration", Centro de Investigación Operativa, Universidad Miguel Hernández de Elche, Avda. de la Universidad, Elche, 1-16.

[32]. Meca, A. (2007), "A core-allocation family for generalized holding cost games", *Mathematical Methods of Operation Research*, 65 (3), 499-517.

[33]. Meca, A., García-Jurado, I. and Borm, P. E. M. (2003), "Cooperation and competition in Inventory Games", Mathematics Methods of Operation Research, 57, 481-493.

[34]. Meca, A., Timmer, J., García-Jurado, I. and Borm, P. E. M. (2004), "Inventory Games," *European Journal of Operational Research*, 156, 127-139.

[35]. Moon, M. J. (2005), "E-Procurement management in state governments: diffusion of e-procurement practices and its determinants", *Journal of Public Procurement*, 5 (1), 54-72.

[36]. Muckstadt, J. A., Murray, D. H., Rappold, J. A., & Collins, D. E. (2001), "Guidelines for Collaborative Supply Chain System: Design and Operation", *Information Systems Frontiers*, 3 (4), 427–453.

[37]. Murray, J. G. & Rentell, P. G. (2008), "Procurement as a shared service in English local government", *International Journal of Public Sector Management*, 21 (5), 540-555.

[38]. Nagarajan, M., Sosis, G. (2008), "Game-theoretic analysis of cooperation among supply chain agents: Review and extensions," *European Journal of Operational Research*, 187 (3), 719-745.

[39]. Rosenblatt, M. & Lee, H. L. (1985), "Improving profitability with quantity discount with fixed demand", *IIE Transactions*, 17, 388-395.

[40]. Sadrian, A. & Yoon, Y. S. (1994), "A procurement decision support system in a business volume discount environment", *Operations Research*, 42 (1), 14-22.

[41]. Thai, K. V. (2009), "International Public Procurement: Concepts and Practices", Book Chapter: *International handbook of public procurement*, K. V. Thai (Ed.), London: CRC Press

[42]. OGC (2008a), "Framework Agreements: OGC Guidance on Framework Agreements in the Procurement Regulations", Office of Government Commerce, UK, 1-13.

[43]. OGC (2008b), "An introduction to public procurement", Office of Government Commerce, UK, 1-24.

[44]. Procurement Lawyers Association (2012), "The use of framework agreements in public procurement", online discussion paper, 1-57. http://www.procurementlawyers.org/pdf/PLA%20paper%20on%20Frameworks%20PDF%20Mar%2012.pdf [Accessed: 25 May 2014].

[45]. Simatupang, T. M. & Sridharan, R. (2008), "Design for supply chain collaboration", *Business Process Management Journal*, 14 (3), 401-418.

[46]. Vaidya, K., Sanjeev, S. M., & Callender, G. (2006), "Critical factors that influence e-procurement implementation success in the public sector", *Journal of Public Procurement*, 6 (1), 70-99.

[47]. Wood, G. (2006), "Addressing the economic realities of Partnering arrangements within the UK construction industry", *In Symposium on sustainability and value through construction procurement*, 29 November – 2 December 2006, The Digital World Centre, Salford, UK, 614-625.

[48]. Xanthopoulos, A., Vlachos, D., & Iakovou, E. (2012), "Optimal news vendor policies for dual-sourcing supply chains: A disruption risk management framework", *Computers and Operations Research*, 39, 350-357.

[49]. Yao, Z., Leung, S. C. H., & Lai, K. K. (2008), "The effectiveness of revenue-sharing contract to coordinate the price-setting newsvendor products' supply chain", *Supply Chain Management: An International Journal*, 13 (4), 263–271.