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ASSESSING THE IMPACT OF SUPPLY CHAIN INTEGRATION THROUGH AN ERP SYSTEM

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Abstract

Many organizations have implemented Enterprise Resource Planning (ERP) systems, hoping to use the information integration these systems provide to improve process efficiency and effectiveness. In particular, ERP systems may be instrumental in realizing Cooperative Planning, Forecasting, and Replenishment (CPFR). In this paper, we present an experimental approach that will be used to assess the real impact of the implementation of CPFR through an ERP system.

Keywords: Cooperative Planning, Forecasting, and Replenishment (CPFR), ERP simulation, supply chain integration.

Context

Enterprise Resource Planning systems (ERP) are commercial software applications that integrate data and processes throughout the enterprise [1]. These systems aim to replace existing functional systems that typically work in silos, creating inefficiencies due to their lack of integration. The hope of enterprises in using ERP systems is to improve process efficiency and effectiveness, and in the long run to develop competitive advantage.

Implementing ERP systems has proven to be a complex task, full of challenges, human and technical, and requires huge investments from the enterprise. It has been estimated that 60 to 80% of these investments were aimed at the organizational transformation that necessarily comes with such implementation [2][3]. Yet, the impact of these investments on the enterprise's results is often suboptimal, as workers find it difficult to reap the full potential of such systems. Studies have shown that the potential of advanced intra- and inter-enterprise collaborative decision making tools is underutilized [4]. Yet, these systems are one of the main factors contributing to making an enterprise a world-class business. By not using these tools efficiently, an enterprise eventually loses its competitive edge against more agile and flexible competitors.

It has been demonstrated that intra- and inter-organizational collaboration is of high value for managers and practitioners [5]. IT literature greatly values the use of integrative and collaborative technologies, such as ERPs. In the context of supply chain management, collaboration occurs with two or more enterprises within a supply chain share planning, management, execution and performance data [6]. Collaboration within the supply chain leads to better performances of the collaborating enterprises, as compared to enterprises acting independently [7]. Within a supply chain, collaboration may take many forms, for instance: *Collaborative Planning, Forecasting, and Replenishment* (CPFR) and *Vendor-Managed Inventory* (VMI). Electronic collaboration, mediated by information systems or electronic commerce tools, may also help in integrating the activities of enterprises in the supply chain. These IT-based innovations were fuelled by the development of the ERP systems, in particular their goal to improve the flexibility and the integration of the supply chain, to extend the business process of an enterprise to its partners using e-commerce technologies and the Internet.

Web technologies and other technical innovations in telecommunications are also important factors contributing to the emergence of virtual teams [8]. For enterprises, it then becomes crucial to take advantage of their employees' potential, wherever they are located on the planet. However, this does not come without challenges, especially in time-limited projects where knowledge transfer and routinization is limited [9]. In recent years, using and coordinating expertise within geographically distributed virtual teams has been the focus of many research projects (e.g., [10][11] [12]). These teams are typically defined as a group of interrelated individuals, physically separated from each other, who are using information technologies

to cooperate [13]. For these teams, success strongly depends on their capacity to use information technologies to create the appropriate coordination mechanisms.

From a methodological standpoint, past research on team collaboration may be structured in three main categories: conceptual studies, empirical studies, and mathematical models. Conceptual studies mainly aim at identifying the causes of technology adoption for supporting collaboration relationships across the supply chain and identifying the critical success factors for implementing such technology within the supply chain. Empirical studies focus on testing a number of hypothesis using case studies and surveys. Results from these studies are mitigated. Some studies [14][15] conclude that networks composed of large organizations (prime manufacturers, integrators) show a high level of collaboration and integration, while other studies show that only a few enterprises have the capacity to attain the level of integration required to fully reap the benefits of inter-enterprise collaboration [16]. Finally, studies based on mathematical models and on simulation may be used to assess the potential impact of collaboration within the supply chain. This is achieved by modeling the impact of information exchange on operational and financial performances of the supply chain. However, these quantitative models are not typically based on real collaborative processes nor on real data, therefore reducing the impact of their results.

An Experimental Approach Proposal

In this work, we are interested in the impact of using ERP systems to support the integration of a whole supply chain, in particular when collaborating enterprises are using the CPFR approach. Using an experimental approach, we seek to study how the combined use of these technologies can help integrate the operations within the supply chain. The experimental environment will reproduce the technological settings that would be available to a manager.

The proposed experimental approach should allow us to reach two main research goals: (i) identify organizational and technical factors that impact on the IT-mediated collaboration within a supply chain and (ii) measure the impact of the IT-mediated collaboration on decision making and organizational performance.

Of prime importance in this context is the notion of the coordination required to achieve collaboration. Consequently, the proposed approach should facilitate the study of the main coordination mechanisms, which in turn lead to efficiency and effectiveness of the supply chain. Specifically, these mechanisms are composed of the actions and behaviours performed by the supply chain participants to manage and maintain trust within the supply chain, to support decision making, and to coordinate individual and collective activities. These mechanisms may be explicit (observable interpersonal behaviours) or tacit. Explicit mechanisms have been studied in classical literature on organizational coordination and control [17][18]. Tacit coordination consists of the facilitation of activity synchronization using a common mental schema that does not require any specific communication, nor any formal managerial actions from members [19] [20]. Together, these two complementary coordination mechanism types enable the integration of members' expertise and efforts, which in turn contributes to improve the collective decision making process.

Trust is also another important factor to consider. We will pay special attention to factors influencing the trust of members of the supply chain towards the collective decision making process at the organizational level. Although IT literature has investigated the role of trust and collaboration for IT adoption and usage, in the context of supply chain collaboration, we are more interested in on-line environments. Few studies have investigated the role of trust when collaboration is mediated by an ERP system.

Experimental approaches are seldom used by researchers in this area as it requires an IT infrastructure that is typically non-existent. As opposed to the other approaches used in the domain, the use of the experimental approach enables the systematic and controlled analysis of the different dimensions of collaboration, for instance the impact of technology, users, and the business context. The methodology we propose will recreate different experimental conditions that mimic various geographical dispersion and task segmentation within the supply chain.

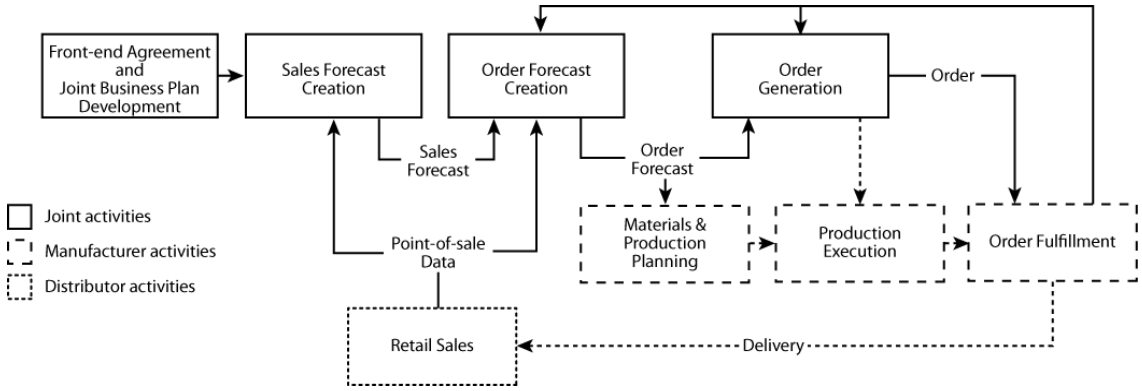

Figure 1. Main Activities of Collaborative Planning, Forecasting, and Replenishment (CPFR)

One of the challenges of using an experimental approach is the ability to recreate realistic organizational environments where the IT artefact's role is central. The ability is made possible with a simulation technology developed at HEC Montréal, namely ERPsim [21]. This technology allows for the simulation of extremely realistic collaboration scenarios through the use of an ERP system. Participants are put in a situation where they must make decisions and manage the operation of their enterprise using a real-life ERP system, such as those used by the large organizations. One primordial characteristic of ERPsim is that all decisions made by participants must be entered into the ERP system and that all the information required to make those decisions must be extracted through standard reports of the ERP system. Think of ERPsim as a flight simulator where the pilots are in a real plane in a virtual sky.

The experimental approach we propose will use the ERPsim platform to simulate a realistic supply chain environment, where a manufacturer is managing the inventory at his distributor's site, hence performing VMI. In this context, we will investigate the impact of information sharing on the quality of planning, forecasting, and replenishment.

In a first series of experiments, we will focus on the planner's task. The planner is responsible for Materials & Production Planning (Fig. 1). Without CPFR, order forecasting can only be performed based on past orders received from the distributor. With CPFR, we can also use sales forecast and point-of-sale data to refine the forecasting process.

We will conduct simulations where decisions must be made on the basis of inventory levels and demand. Different scenarios could be tested:

1. Complete CPFR: An ideal case where the planner has access to his own orders, as well as point-of-sales data and sales forecasts;
2. With sales forecast only: This scenario represents the situation where the planner has access to the sales forecasts from the distributor, but not to actual point-of-sales data;
3. Without external data: This is the worst case scenario where only past orders from the distributor can be used to perform the forecast.

In all cases, the decision maker will be informed beforehand of what data is available to perform materials and production planning. Extensions will be developed in ERPsim to support these different scenarios, and provide the necessary information to the planner.

We propose the following research protocol. At least 90 simulations will be performed using actual planners. These planners will be randomly assigned to one of the three scenarios. Each planner will be performing materials and production planning for the same company in the same economic environment with the same market trends. The other activities of the company, such as production execution and order fulfillment, will be automated by ERPsim.

Data Collection Strategy

In an ERP system, all transactions performed are recorded for audit purposes. As the business simulation supported by ERPsim is built on a competitive business environment, financial status and operational performances may be objectively measured for each company participating in a simulation. In the proposed setting, each planner will run his own company. Consequently, for each simulation, a number of data points can be collected: (i) objective IT usage data (number of transactions and when transactions were performed) (ii) operational performance and financial data for each participants, and (iii) psychometric measures (e.g, questionnaires before, during, and after the

simulation).

Usage data is obtained through the auditing functions of the ERP system. These audit data are enriched with the simulated time information to track which transaction was performed at which instant during the simulation.

Operational performance and financial data is calculated and recorded by ERPsim at every simulated day. We are therefore able to match time-based results with user actions.

Psychometric measures will include questions to ascertain the user's experience as a planner (e.g., number of years as a planner), objective questions determining the user's skills as a planner, and questions assessing the perceptual factors such as its perceived knowledge of the system, its attitude toward the ERP, effort expectancy and perceived trust in the data available during the simulations [22][23].

Concluding comments

In order to objectively assess the impact of using an ERP system to support CPFR, the use of a simulation approach seems the most appropriate. Indeed, a theoretical analysis of these benefits would stop short of convincing practitioners, as it would be based on suppositions and hopes. Using a simulation, we will be able to show how "real" decisions are made when additional data is available in the planning process.

Simulations with a control group will be used to assess the impact of performing planning without shared data from the distributor. Here, one factor for which we cannot control is the quality of the subjects beforehand, as the three groups are independent. We can only mitigate this factor by selecting candidate for each group randomly.

To date, studies on organizational collaboration are mainly based on psychometric measures, (e.g., [14][15]. The research approach proposed in this paper combines these psychometric measures with an experimental approach.

Potential contributions of this research are the study of factors associated to user behaviour that are not taken into consideration by typical intra- and inter-organizational collaboration models. While in principle, many studies have highlighted the importance of user behaviour in organizational collaboration, most of these studies do not investigate the mediator or moderator effects of these behavioural factors on collaboration. The experimental approach presented herein will enable us to study these effects in laboratory settings.

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