

# Proposing a Paradigm for e-Collaboration

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## Abstract

E-Collaboration has been attracting more and more attention and interest of academic researchers and industry practitioners. However, the paradigm of e-Collaboration has yet to be established. Various researches often incline to label subjective research studies relate to inter-organization interaction or integration with the hot title. To clarify terminology used and to remove ambiguity on e-Collaboration, the paper aims to provide a cohesive framework of e-Collaboration from the perspective of inter-organizational integration. The framework highlights the core feature of e-Collaboration—joint intellectual efforts, which has been neglected by existing studies. Moreover, a mathematical modeling approach is further used to illustrate the differences among each levels of integration in a two-party context. The descriptive and modeling approaches both attempt to establish a paradigm for e-Collaboration. And the future research directions will be indicated based on the paradigm.

## Keywords:

e-Collaboration, Integration, Paradigm

## 1. Introduction

Several related concepts appeared under the umbrella of collaboration, such as e-Collaboration and collaborative commerce, attracting more and more attention from academic researchers and practitioners [9] [11] [15] [25] [26]. However, there is no consensus of what e-Collaboration is. Different interpretations lead to difficulty in the differentiation of related concepts such as cooperation, contribution, coordination, cooperation and collaboration. A paradigm of e-Collaboration must be established.

As we all know, the incommensurability of paradigms is crucial to the development of scientific theories. “Scientists who pursue different paradigms are, in a sense, living in different worlds.” They cannot communicate nor share insights on “the problems to be solved, the theories to be employed, or the terminology to be used” [1] [20]. Hence, to benefit the pullulation of e-Collaboration in electronic environment, an agreeable and acceptable paradigm of e-Collaboration is needed to facilitate idea communication, theory development and knowledge accumulation within the research community.

The paper firstly surveys the current views on

e-Collaboration. Consequently we attempt to bring the diverse views into a unified framework of e-Collaboration, based on levels of inter-organizational integration. And a mathematical modeling approach is further used to illustrate the details of framework in a two-party context. Both descriptive and mathematical illustrations of e-Collaboration framework provide concrete theoretical foundation for paradigm of e-Collaboration. Furthermore, the framework can be used to organize current research findings and share insights on future directions.

## 2. Literature Review

### 2.1 Importance of e-Collaboration

Collaboration plays a major role in many differing business processes. Various research on collaboration spanned across topics that include manufacture production [3] [7] [21], supply chain management, logistics management [6], process reengineering [8] [24]. Highly competitive markets impose new requirements on inter-organizational relationship among ventures [4] [17]. Especially those processes that now operated in an electronic environment, online inter-organization activities often involve various degrees of e-collaboration. Such collaboration involved sharing of information, resource, risk and responsibility should be achieved in a more effective and efficient manner using electronic means. The success of inter-organizational systems [13], a kind of implementation of e-Collaboration, for example, is essential for co-operative ventures in electronic environment.

### 2.2 Diverse views of e-Collaboration

Although quite a number of researchers have offered their insights on e-Collaboration, few have directly indicated a specific definition. A common understanding has not been reached. Pinsonneault and Kraemer [25] and Dasgupta et al. [10] referred to “collaboration among individuals” as they are being “engaged in a common task using electronic technologies.” Blevins [23] highlighted the newness of e-Collaboration as “electronic automation of collaboration interactions”. And Lee and Whang [22] specifically took e-collaboration as an application of e-business existing in such functions as information sharing, collaborative decision-making and product change management. However, the diverse views mainly

consider e-Collaboration as simply a sum of collaboration and electronic technologies and do not indicate or expose the core feature of collaboration. More importantly, “common task” is not the sufficient condition of e-Collaboration. And we cannot classify some process or applications in the scope of e-Collaboration simply based on its using in information sharing, collaborative decision-making or electronic automation of collaboration interactions. The above interpretations contribute to understand some features of e-Collaboration, but they do not touch on the essential feature of e-Collaboration, joint intellectual efforts. And the problem of using the same term to indicate different levels of interaction, limits the ability to compare, and build or improve, on existing concepts.

Existing studies pay little attention on the different levels of integration, and the outcomes based on various kinds of technologies with respective to integration could not be collectively claimed as impacts of e-Collaboration. Lefebvre et al. [23] assessed the impacts of the eight so-called web-based collaboration tools on innovativeness and performance of firms in a telecommunications equipment supply chain. However, these tools facilitate the enforcement of the different levels of integration, not sole for collaboration.

In addition, research on taxonomies and classifications of e-Collaboration systems embodied most information systems, and classified the systems in such dimensions as technical consideration, group issues, application, time/space, etc., but do not in the perspective of integration [2] [19] [12]. Such classifications further deepen the diversity of views on e-Collaboration.

### 3. A Framework of e-Collaboration

To begin our attempt to conceptualize the idea of e-Collaboration, we base our development on the insights of Taylor-Powell [26]. They contributed an important edification on interpreting the concept of collaboration in an intact framework—integration. They ranked communication, contribution, coordination, cooperation and collaboration by the different extents of integration and preliminarily described their differences. To allow a clear differentiation of different efforts in collaboration, the specialties of each level must be established. A framework of e-Collaboration will be proposed to clarify terminology used and to remove ambiguity on e-Collaboration. An essential uniqueness in our approach is the specification in the framework for e-Collaboration — joint intellectual efforts, a feature that is not considered by existing research in imprudence.

#### 3.1 Levels of Integration

In our framework, communication is the lowest level, supporting dialog and common understanding in general. Contribution benefits participant parties by mutual support based on communication. And coordination integrates parties in deeper extent by matching needs and adjusting activities. To achieve common goals, higher

integration — cooperation is required by parties. When the demanding requirements deduce the joint intellectual, comes collaboration and e-Collaboration in electronic environments.

Thus, e-Collaboration can be referred to the process of working together with joint intellectual efforts in electronic environments. Information technologies are used to facilitate the parties to work together and to contribute joint intellectual efforts. And the benefits of e-Collaboration are, for example, to facilitate the offering existing or newly created common products or services with reallocation of controlled resources, even with new production skills or marketing methods.

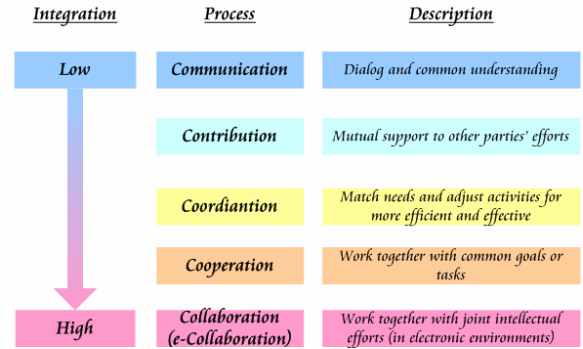


Figure 1: Description of Levels of Integration

However, researchers may hold different interpretations on common understanding, mutual support, working together or joint intellectual efforts. Thus, we develop a cohesive interpretation by using mathematical modeling approach, to delineate the different levels of integration and to quantify the activities within each.

#### 3.2 Mathematical Modeling

##### Assumption

Let us assume two parties integrate to maximize the respective sum of individual outputs originally. Each of them produces the products or services by some specific production skills with the controlled resources as inputs. Let:  $B_i$  denotes the vector of resources of party  $i$ ;  $X_i$  denotes the vector of outputs of party  $i$ ; and  $A_i$  denotes the matrix of coefficient of production of party  $i$  ( $i=1$  or  $2$ , in this case).

Then the decision making of production of each party can be modeled in L-P equations.

$$\begin{aligned}
 & \text{Max } Z_1 = f_1(X_1) & \text{Max } Z_2 = f_2(X_2) \\
 & \text{s.t. } A_1 X_1 \leq B_1 & \text{s.t. } A_2 X_2 \leq B_2 \\
 & \text{or } A_1 X_1 + C_1 = B_1 & \text{or } A_2 X_2 + C_2 = B_2 \\
 & C_1 \geq 0 & C_2 \geq 0 \\
 & B_1 \geq 0 & \text{and } B_2 \geq 0
 \end{aligned}$$

Where  $C$  is the slack variables of the L-P equations.

##### Modeling Communication

Communication in electronic environments can establish common understanding on some terms or facts. Thus, it can be abstracted as exchanging and

understanding declaration of variables in our model.

### Modeling Contribution

With the contribution mechanism, parties involved in integration can share their information by exchanging some values of common variables. These exchanged values can support parties to make decision more efficient and effective. A better optimal solution of L-P equations can be reached, compared to the stand-alone situation. Such level of integration—contribution, has been shown to have positive impacts and benefits for parties, e.g. on information sharing in supply chain.

### Modeling Coordination

Coordination mainly focuses on finding out feasible solutions on adjustment of activities, removal of duplication, or allocation of resources to improve the performance of resource usage. In L-P modeling, the possible degree of adjustment of resources is represented by the scale of slack variables.

### Modeling Cooperation

Cooperation refers to working together with joint goals. Thus it is logical to deduce that the objective functions of two parties must have at least one common component to denote the existence of joint goals. And both should reallocate their controlled resources beyond the limitation of slack variables to meet the requirements of joint goals.

### Modeling Collaboration

Collaboration differs to other levels of integration in incorporating joint intellectual efforts. In producing products or offering services with controlled resources and skills on hand, the joint intellectual efforts can be shown specifically in creating new joint products or new services ( $X_4$ ), generating or enrolling new production skills ( $A'$ ), coming up new marketing methods to joint products or services ( $f'$ ), and optimizing the production process of joint outputs.

Consequently the variables need to be redefined to show the possible change of collaboration.  $X_1$  will be divided into  $X_{11}$  for local products,  $X_{13}$  for existing common products and  $X_{14}$  for new created common products. So will  $X_2$  as  $X_{21}$ ,  $X_{23}$  and  $X_{24}$ . Then the common output  $X_3$  is the sum of  $X_{13}$  and  $X_{23}$ , and  $X_4$  the sum of  $X_{14}$  and  $X_{24}$ . Concurrently  $f_1$  may break into  $f_{11}$  and  $f_{13}$ ,  $f_2$  into  $f_{21}$  and  $f_{23}$ ,  $B_1$  into  $B_{11}$  for local products and  $D_{12}$  for common products, and  $B_2$  into  $B_{21}$  for local products and  $D_{22}$  for common products. Therefore, the optimization of common products is

$$\begin{aligned} \text{Max } & f_3'(X_3) + f_4'(X_4) \\ \text{s.t. } & A_3'(X_3) + A_4'(X_4) \leq D_{12} + D_{22} \\ & 0 \leq D_{12} \leq B_1 \\ & 0 \leq D_{22} \leq B_2 \end{aligned}$$

For party 1, it will make its optimal solution for the amount of each output.

$$\begin{aligned} \text{Max } & Z_{11} + Z_{13} + Z_{14} = f_{11}(X_{11}) + f_{13}(X_{13}) + f_{14}(X_{14}) \\ \text{s.t. } & f_{11}(X_{11}) + f_{13}(X_{13}) + f_{14}(X_{14}) \geq Z_1 \\ & A_{11}(X_{11}) \leq B_{11} \\ & B_{11} + D_{12} \leq B_1 \\ & \frac{\partial Z_{11}}{\partial B_{11}} \leq \frac{\partial (Z_{13} + Z_{14})}{\partial D_{12}} \\ & X \geq 0, \quad B \geq 0, \quad D \geq 0 \end{aligned}$$

For party 2,

$$\begin{aligned} \text{Max } & Z_{21} + Z_{23} + Z_{24} = f_{21}(X_{21}) + f_{23}(X_{23}) + f_{24}(X_{24}) \\ \text{s.t. } & f_{21}(X_{21}) + f_{23}(X_{23}) + f_{24}(X_{24}) \geq Z_2 \\ & A_{21}(X_{21}) \leq B_{21} \\ & B_{21} + D_{22} \leq B_2 \\ & \frac{\partial Z_{21}}{\partial B_{21}} \leq \frac{\partial (Z_{23} + Z_{24})}{\partial D_{22}} \\ & X \geq 0, \quad B \geq 0, \quad D \geq 0 \end{aligned}$$

## 4. Remarks

The proposed paradigm clearly describes the differences of concepts at various levels of integration. And the modeling framework further details the different requirements of information sharing, resource sharing, process management, and marketing of products or services in different levels. Moreover, the paradigm can illustrate some promising potential research issues in e-Collaboration: (1) benefits or impacts of each level of integration, including e-Collaboration; (2) interdependency and interaction between e-Collaboration and intra-organizational structure or inter-organizational relationships; (3) establishment, manipulation and assessment of information infrastructures or systems of e-Collaboration. In addition, from the viewpoint of development, issues such as the negotiation of forming partners, adjustment or change of intra-organizational structure and inter-organizational relationships, implementation guideline of information systems, and acceptance and adoption of e-Collaboration are alike in importance in e-Collaboration research.

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