AN EXPERT SYSTEM APPROACH FOR IMPROVING SERVICE-LEVELS BETWEEN BUYER AND SUPPLIER

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ABSTRACT
Service-level requirements emerge among the alternative strategies for supply chain firms that have already harvested the benefits of adopting ever low system wide costs. Though, the subjective and ever changing nature of services related understandings creates a challenge. In an attempt to fill this gap, our recent work presents an expert system approach, ESSER (**E**xpert **S**ystem Application for Suppliers to Improve **Ser**vice-Levels) as a decision support mechanism for helping supplier firms to tailor their service offerings in order to meet updated service level requirements of their individual buyers.

Keywords: Expert Systems, Service-levels, SCM

INTRODUCTION
Kathawala and Abdou (2003) stated that SCM "has been poorly defined and there is a high degree of variability in people's minds about what is meant". Simchi-Levi (2003) attempted to overcome this state of affairs by proposing a definition that is broad, not confined to any specific discipline area and adequately reflecting the breadth of issues that are usually covered under this term. As the Simchi-Levi's (2003) definition suggests, the areas of focus in supply chain management are; (1) minimizing system wide costs, and (2) satisfying service-level requirements; via set of approaches used to efficiently integrate suppliers, manufacturers, warehouses, and stores. Production and distribution of merchandise at the right quantities, to the right locations, and at the right time had been thoroughly researched and system wide costs has been reduced to the ever possible levels by advanced tools, leaving the service-level requirements as a fertile area for firms and researchers (Bitran et al., 2003; Johnston, 2004). As "service quality is an elusive and abstract construct that is difficult to define and measure" (Cronin et al., 1992), so is defining service expectations (Bitran et al., 2003) of buyers which serves as the basis for their service-level requirements. Advanced tools are yet to be designed for further enhancing the topic. The stiff competition kept on diminishes supply chain management's satisfaction from the adoptation of ever low system wide costs, complex service-level requirements become a concern for designing improved competitive SCM strategies. In its simplest form, SCM is considered as a trade-off between cost and services (Robinson *et al.*, 1993; Barsky *et al.*, 2001). Hitherto mathematical approaches that claim superiority upon inclusion of service factors define complex service-levels only as the percentage of time without stock outs (Lee *et al.*, 1993; Newhart *et al.*, 1993; Pyke *et al.*, 1994; Graves *et al.*, 1998; Talluri *et al.*, 2002; Minner, 2003), while breakdown for costs of all sorts are available. Our research follows Metaxiotis's (2005) suggestions for utilizing Expert Systems in services focused research, and contributes to existing SCM literature by examining

formation of service level requirements of buyers and suppliers. Interviews (with Automotive Industry's major players' SCM relationship specialists) conducted during this research also confirms that contemporary industry practice had started to shift its attention to services and their capacity in creating buyer value. Today's supply chain management calls for operational strategies for existing supply chains and focuses on differentiation via service-orientation for enhancing competitive edge. It has been identified that services play an important role in determining competitiveness due to ever-minimum system wide costs granted by the aid of highly advanced mathematical models. All costs being equal, services that accompany an encounter has been claimed to be of key importance in shaping the perceived buyer value, which in turn expected to improve supplier's competitiveness (Woodruff *et al.*, 1998; Lapierre, 2000; Barsky *et al.*, 2001; Ulaga, 2003). Considering these issues, this paper first conceptualizes the role of services in SCM as creators of perceived buyer value and then presents an experts system approach, namely *ESSER (**E**xpert **S**ystem Application for Suppliers to Improve **Ser**vice-Levels)*, as a decision support system for helping supplier firms to tailor their service offerings in order to meet updated service level requirements of their individual buyers.

CHARACTERISTICS OF SUPPLY CHAIN ENCOUNTERS INVOLVING SERVICES

Services are like the glue that holds together the supplies of a firm. Like the reinforcement applied to the concrete, services introduce composite structure to a supply chain. Services contribution to operations can be contended as similar to that of small scale impurities, which are present in the atomic structure of any material. Such adds strength, ductility while reducing brittleness, when applied at correct proportions (Callister, 2003). Services are deeds, performances, and procedures. The often cited main characteristics of services include intangibility, heterogeneity, simultaneous production and consumption, and perishability (Zeithaml et al., 2002). In the contemporary business world, pure services or pure products are rarely seen, but a combination is a common practice. Indeed, it is this combinatorial structure that differentiates a firm from the competition.

A common characteristic of services that is often visited is the "subjectivity" inherited and the co-linked possibilities of generating added value. In the dyadic relation among a supplier and a buyer, the buyer holds a set of expectations regarding what the supplier should perform. When the supplier performance meets or exceeds the expectations of the buyer, only then perceived buyer value generation would become possible. Contrary to being easily said, supplier faces a great challenge as usually there is limited information readily available about the expectations of its buyer prior to the encounter. However, it is often these unsolicited expectations that determine the service-level requirements for the buyer. Such expectations are usually influenced from prior experiences, and shared knowledge. In a supply chain, one would expect the long-term relations and contracts to build trust and mutual understandings about service-level requirements. When service-level requirements exceed the boundaries of "stock out rates" and include real services that accompany delivered products, the subjectivity also becomes a factor. Moreover, what would be considered as a normal service-level performance shall also be subject to change with an upwards trend in today's highly competitive global business environment. The services focus competition raises the bar each and every day by making some luxuries of past standards of today. To better comprehend the upwards trend of expectations in terms of service-level requirements, an example is included below:

Service-level requirements are shaped by expectations, and expectations are often build by experience, and/or knowledge. In addition, expectations of a buyer from its supplier are also cultivated by the dynamics of the business environment but not only by the steady relations of the supplier-buyer couple. A firm, whether it is a supplier or buyer, undertakes various operations with numerous firms in its periphery. The stakeholders in a firm's periphery provide continuous information to the firm, and thus shape the understanding about a particular service. Some firms appear to have more advanced services knowledge and experience, and depending on their role in a supply chain, they either perform or expect higher service-level requirements. On the other hand, some firms understanding of services appear to be at infancy. This secondary group often carries lower service-level requirements in their agenda both as a buyer and a supplier. Whether a firm has an advanced or infant standing in terms of service-level requirements is mainly determined by its operational medium, which is amalgamated by the services related knowledge and experience the stakeholders in its periphery have. Following their earlier establishments on the issue (Aykaç *et al.*, 2007), researchers contend that the firms' operational medium is often the main influencer in determining whether an encounter would in fact create a superior perceived buyer value.

Perceived Buyer Value

Purchaser value is the measure of a company's contribution to its buyer, based on the entire range of products, services, and intangibles that constitute the company's offerings (Simchi-Levi, 2003). In recent years, this measure has superseded measures such as quality and customer satisfaction as firms often wish to exceed (or at least fulfill) buyers' expectations to provide value.

Buyers' (1) *product,* (2) *services*, and (3) *providers of product and services* preferences are heavily shaped by how well they create value for them. Comprehending what is a buyer's value can be extremely difficult, and often multidimensional. One relatively comprehensive definition of perceived buyer value is "perceived performance for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations" (Woodruff et al., 1998). The idea of a trade-off is included in the value concepts of buyer, i.e., same price but higher quality, or fewer sacrifices with more benefits. Similarly, buyers participating in a supply chain are usually concerned with a trade-off, but between functional, service, and relationship benefits, and monetary and non-monetary sacrifices as these relate to certain goals (Lapierre, 2000; Ulaga, 2003). In this research's context, value refers to the specific quality of a service as perceived by users in relation to their needs, such as the speed or quality of performance on a new task or the aesthetics or performance features of a new product.

Neither the buyer's nor the supplier's operational medium by itself is deemed to be capable of yielding to perceived buyer value, but a comparative standing of the buyer's operational medium against the supplier's. A comparison between what the buyer feels should be offered and what the supplier attempts to provide (Pitt et al., 1995), can be measured on ten dimensions; (1) tangibles, (2) reliability, (3) responsiveness, (4) competence, (5) courtesy, (6) credibility, (7) security, (8) access, (9) communication, (10) understanding the customer (Berry et al., 1990) as this research defines operational medium by the amalgamated the services related knowledge and experience a firm's stakeholders in its periphery have. In addition, often visited three ways for supply chain management to generate perceived buyer value include (1) effectiveness, (2) efficiency and (3) differentiation. Here, supply chain effectiveness refers to the level of performance or service provided; efficiency deals with the return on resources committed to supply chain activities or the level of cost control achieved; and differentiation refers to the uniqueness of the process being utilized (Barsky et al., 2001).

EXPERT SYSTEM APPLICATION FOR SUPPLIERS TO IMPROVE SERVICE-LEVELS

The phenomena examined involve non-numerical symbolic interpretations. Among artificial intelligence tools, expert systems is detected to be the best serving methodology for capturing human expertise of suppliers in designing unique service offering levels for various buyers. Rather than pursuing a single uniform approach for all buyers, a customized approach for each buyer's service-level expectations depending on the comparison of operational mediums, would both enable optimization of supplier's service-level costs, and ensure perceived buyer value generation to be of superior. In addition, Metaxiotis (2005) stresses the importance of services focused research and suggests use of Expert Systems for improved approaches to be developed.

Investigation site chosen is a major stakeholder of Turkish Automotive Industry and her 39 nationwide buyers participating in the research. Prior to proceeding forward to system specification, site's human experts have been consulted to validate the proposed conceptualizations in terms of their business model. Developed ES promises industry implementation, perhaps at the investigation site, as a decision support tool, which is competent to tailor services for individual buyers with intentions of generating superior perceived buyer value. Here, suggestions, advices, expert knowledge of handling orders etc. have been acquired from human experts of the investigation site. In addition, information to determine current level of service quality perceptions on 39 buyers was also collected to validate the usefulness of the system to be designed. For designing knowledge base on operational mediums of the buyers, Berry et al.'s (1990) ten dimensions for measuring quality of services were drawn upon together with evaluation of these items by human experts at the supplier firm. Validity and sufficiency of these dimensions has been confirmed also by six human experts, e.g., the whole team of logistics and spare parts department of the investigation site, on a consensus. Moreover, preliminary analyses conducted also confirm that such a system would provide insightful decision support data. In addition, specific suggestions, advices, approaches and enquires of tactics on aiming for either one of the three often cited dimensions (Barsky et al., 2001) of generating perceived buyer value in SCM (effectiveness, efficiency, and differentiation) by enhancing service dimensions quality have also been acquired from human experts. Identification of service quality dimensions effect on perceived buyer value has been done on an individual basis for the system development. Combinatorial correspondents have been left out of scope for simplification purposes. Upon consultation with human experts, following categories are set forward: through improvements on (1) reliability and understanding the customer (2) responsiveness, competence, courtesy, access and communication; and (3) tangibles, credibility and security perceived buyer value generation via efficiency, effectiveness and differentiation, respectively, shall be deemed possible.

EXSYS Corvid has been adapted in this research as the state of the art expert system shell (Darlington, 2000). Knowledge acquisition in this research employed direct (i.e., interviews, observations), indirect (i.e., direct judgments) techniques as well as group knowledge acquisition for a duration of six months with six human experts, where Delphi Method had been adapted as the major group knowledge acquisition technique. *Table 1* lists possible buyers presenting opportunities of improvement on various service quality dimensions, and human expert's approaches for such, respectively.

Table 1: Service Quality Dimension correspondents on Perceived Buyer Value Dimension

Service Quality Dimension	Corresponding Perceived Buyer Value Dimension	Buyer IDs that present Opportunities of Improvement*
SQ4. Competence SQ10. Understanding the Customer	S1.Efficiency	- 24, 32, 33, 23, 5, 25. - 24, 32, 33, 23, 25.
SQ2. Reliability SQ3. Responsiveness SQ5. Courtesy SQ8. Access SQ9. Communication	S2.Effectiveness	- 24, 32, 33, 23, 5, 25, 3, 15, 16. - 24, 32, 33, 5, 25, 15, 16, 17, 19, 23, 27. - 24, 32, 33. - 24, 32, 33. - 24, 32, 33, 5, 7, 17, 19, 25, 27.
SQ1. Tangibles SQ6. Credibility SQ7. Security	S3.Differentiation	- 24, 33, 23, 25, 32, 3, 15, 16, 17, 38. - 24, 33, 23, 32, 5, 7, 15, 16, 17. - 24, 32, 33, 5, 23, 25, 15, 16, 19, 35.
* ≥ 1.0 cut-off level is applied for determining possible perceived buyer value generation via comparison of buyer-supplier operational mediums		

For example, for creating perceived buyer value via differentiation, tangibles, credibility and/or security dimensions of service-levels could be improved. Questions Q1, Q22 and Q29 are used as startup questions for SQ1, SQ6 and SQ7, respectively. Same questions are probed for buyer and supplier, and further questions are followed in cases where important and unimportant answers are obtained from buyer or supplier, respectively. In cases of failure in launching a follow-up question for a particular service quality (SQ) dimension, ES assigned a confidence value of -100 for that SQ, and continued probing with another SQ dimension where applicable. In follow up questions of SQ1, SQ6 and SQ7, multiples of "25" and "-25" for "+" and "-" answers of buyers are used respectively, while multiples of "-25" and "25" are assigned for "+" and "-" answers of supplier as confidence interval values. Suggestions generated depending on confidence interval values, and their corresponding dimension for perceived buyer value.

For the purposes of comparing buyer's and supplier's operational mediums, if-then rules have been designed in Exsys Corvid, and confidence intervals are set for each variable. For example, ESSER utilizes below rules to determine Buyer's standing in terms of Service Quality Dimension 1, Tangibility. Similar probing are used for the supplier as well, but "important" and "unimportant" qualities exchange places, to extracts relevant suggestions depending on the range of the interval.

Ask "Do you deem facilities' attractiveness as …?"

- *If "unimportant" then add service quality dimension 1's confidence interval to "-100" and end the process for this service quality dimension. Proceed to service quality dimension 2's questions.*
- *If "important", then add service quality dimension 1's confidence interval to "25" and continue by asking*
  "Do you perceive modern look of technology as …?"
  - *If "unimportant" then add service quality dimension 1's confidence interval to "-75" end the process for this service quality dimension. Proceed to service quality dimension 2's questions.*
  - *If "important", then add service quality dimension 1's confidence interval to "50" and continue by asking*
    "Do you deem materials' ease of understanding … in your communications?"
    - *If "unimportant" then add service quality dimension 1's confidence interval to "-50" end the process for this service quality dimension. Proceed to service quality dimension 2's questions.*
    - *If "important", then add service quality dimension 1's confidence interval to "75" and continue by asking*
      "Do you deem formal dressing code as …?"
      - *If "important", then add service quality dimension 1's confidence interval to "100" and end the process for this service quality dimension. Proceed to service quality dimension 2's questions.*
      - *If "unimportant" then add service quality dimension 1's confidence interval to "-25" and" end the process for this service quality dimension. Proceed to service quality dimension 2's questions.*

If-then rules and principles are operational on SQ1, SQ6 and SQ7 (*Figure 1*) for conducting comparison of buyer's and supplier's operational medium, and delivering corresponding strategy suggestions, where applicable. Those questions that are highly prioritized are also empowered by confidence intervals so that decision to ask following questions is determined by ES according to the answers received for the previously asked questions. Hence, it was possible to capture most relevant information from user with minimum amount of time spent in utilizing ES.

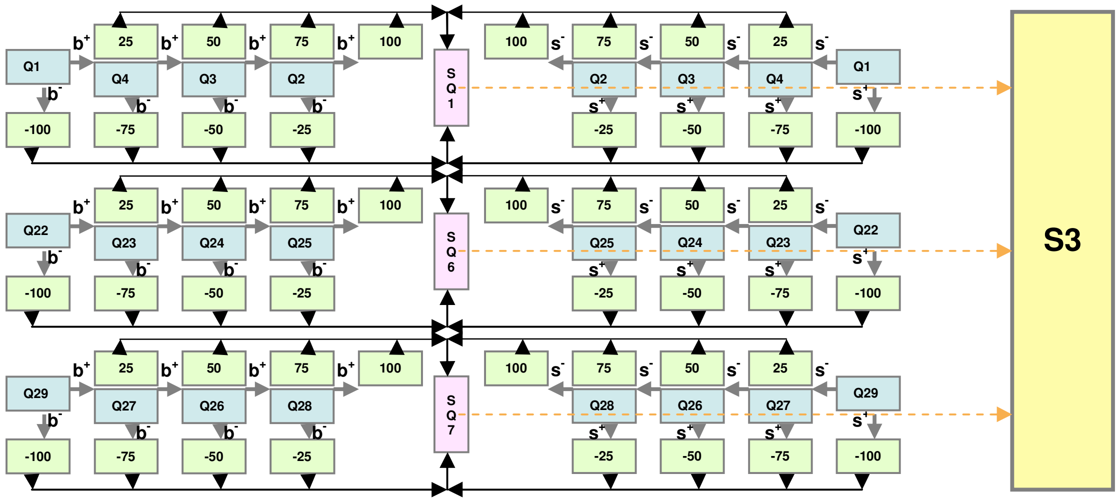

Figure 1: ESSER's Inference Engine working principles for S3 - "differentiation"

As of current state, verification is established through White-Box testing (Awad, 1996). System is built right; all specifications, structure and sequence of inferences are correct. Knowledge base is complete and manipulation of knowledge by inference engine is proper. Design covers all the requirements set forward in the conceptual model; inference engine compares service quality in ten dimensions among supplier and buyers, and puts forward tactical suggestions for cases where "*supplier's operational medium < buyer's operational medium*" is detected. From this perspective, design goals are reflected in the developed expert system (Giarratano et al., 1998). No need of refinement has been detected upon verification (Ignizio, 1991).

CONCLUSION

This paper presents an expert system approach for helping supplier firms to tailor their service offerings in order to meet updated service level requirements of their individual buyers. The built expert system is referred as ESSER, **E**xpert **S**ystem Application for Suppliers to Improve **Ser**vice-Levels. Knowledge acquisition in this research employed direct (i.e., interviews, observations), indirect (i.e., direct judgments) techniques as well as group knowledge acquisition for a duration of six months with six human experts, where Delphi Method had been adapted as the major group knowledge acquisition technique. For the purposes of ESSER to suggest tailor designed approaches on the services that should accompany products supplied to each individual buyer so that perceived buyer value generation would be possible, 42 dynamic questions to capture 10 dimensions of service quality have been designed via if-then rules in Exsys Corvid, and 10 variables with confidence intervals are set. Verification is established through White-Box testing (Awad, 1996). Design covers all the requirements set forward in the conceptual model; inference engine compares service quality in ten dimensions among supplier and buyers, and puts forward tactical suggestions for cases where "*supplier's operational medium's density is less than that of buyer's operational medium's*" in terms of service expectations is detected.

Our research follows Metaxiotis's (2005) suggestions for utilizing Expert Systems in services focused research, and contributes to existing SCM literature by presenting a decision support system. Hitherto, service factors in SCM has been defined often as the percentage of time without stock outs (Lee *et al.*, 1993; Newhart *et al.*, 1993; Pyke *et al.*, 1994; Graves *et al.*, 1998; Talluri *et al.*, 2002;

Minner, 2003). We contend that, service-level requirements are indeed complex and present opportunities of creating perceived buyer value.

Our findings have been limited to the industry of our investigation site, the automotive industry. To better present a SCM decision support system, the scope of this research can be extended to cover other industries.

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