

# A RULE-BASED DSS FOR THE QUALITATIVE PREDICTION OF THE EVOLUTION OF E-SALES

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Keywords: e-Commerce, customer behaviour, decision support system.

Abstract: Many parameters have a significant influence on e-commerce evolution. This complicates the assessment of the requirements for and the consequences of e-sales adoption. In order to support the decisions of companies thinking about a possible e-sales channels introduction a Decision Support System (DSS) is proposed. The relevant e-commerce success factors, which constitute the DSS input, have been identified and their influence described relying upon a literature review. The DSS output aims at describing typical e-commerce evolution patterns taking into account the speed of adoption and the steady state potential diffusion (saturation level). These variables point out the considerable discrepancies between the e-commerce evolution characterizing different industrial sectors. The DSS, which is based on a system of rules, allows to qualitatively predict the expected e-sales evolution for companies introducing a specific e-sales channels strategy in a given environment and to explain it in terms of different e-commerce success factor configurations.

## 1 INTRODUCTION

Due to the continuous and consistent growth of B2B and B2C e-commerce transaction share, an ever increasing number of companies is confronted to the decision of introducing e-sales, thus adopting electronic-enabled sales channels (e-sales channels) to replace and/or to support their traditional sales channels. The adoption of a multi channel sales strategy seems promising both in terms of sales and revenue increase. However, e-commerce is not yet mature and thus is far from having reached its steady state potential, as demonstrated by the high variability of the predictions of its future evolution (Gurunlian, 2001). Furthermore, the choice of an adequate e-sales strategy is complicated by the high degree of uncertainty concerning customer reactions to e-commerce, shown for instance by the uneven utilization of online purchasing across different industrial sectors (Selhofer, 2004; Stansfield, 2003). Moreover, the choice of a wrong e-strategy can have a critical impact on the company wealth. For these reasons e-commerce introduction is considered as highly risky. This hinders many companies to fully profit from the benefits of the e-revolution and demonstrates the need for tools capable of reducing

the complexity of management decisions related to the choice of an e-strategy.

The analysis is mainly focused on B2B e-commerce as it accounts already for about 80% of the total e-commerce transacted monetary value and it is also expected to continue to grow faster than B2C in the next future (Scupola, 2002).

Several explanations have been proposed in order to describe the important differences characterising e-commerce adoption, both at the single company and at the industrial sector level. Proposals have also been made for the identification of the characteristics that ensure a rapid and massive e-purchasing adoption. Many of these analyses focus only on a subset of the factors that potentially influence e-purchasing adoption: e-commerce suitability of the transacted products (Hunter, 2004; Liu, 2004; Levin, 2003; Liu, 2003; Vijayarathy, 2002; Lowengart, 2001; Phau, 2000; Peterson, 1997), customer readiness to adopt e-commerce (Choi, 2004; Selhofer, 2004; Zhou, 2004; Fillis, 2003; Scupola, 2002; Liang, 1998) and brand image as a means to partially leverage customer risk perception (Bendixen, 2004; Lim, 2003; Clemons, 2002; Mudambi, 2002).

Determining customers' e-purchasing behaviour is essential for companies thinking about a new e-sales channel introduction. In fact, it allows to estimate the e-sales amount that can be potentially reached by targeting these customers. The objective of this work is the design and development of a Decision Support System (DSS) linking the value taken by the e-commerce success factors to the e-commerce demand evolution. Compared to previous works, the presented paper is original in that it:

- goes beyond the current approaches and evaluates the success of a given e-strategy, taking into account all the related aspects;
- replaces the traditional division among e-commerce adopters and non adopters with a more detailed prediction of the e-commerce demand evolution;
- provides a DSS to the enterprise management board for a better integration of e-commerce.

In section 2, starting from the analysis of the results of previous works, a comprehensive list of factors influencing e-purchasing adoption is identified and a detailed explanation of their influence magnitude and direction is provided.

In section 3, the relationships between the identified e-commerce success factors and the e-purchasing adoption are investigated in order to develop a rule-based DSS for e-sales evolution prediction. It formalises the relationship between the description of a specific case and the e-purchasing adoption behaviour, which is described relying upon the Diffusion Of Innovation (DOI) theory. It provides qualitative indications about the saturation level (share of e-purchasing at the end of the innovation diffusion process) and the speed of adoption (number of periods necessary to reach the saturation level). The e-sales evolution is described taking into account the combined influences of product features, customer characteristics, brand perception and e-commerce induced purchasing process modifications. The DSS is developed using a system of rules implying linguistic (qualitative) variables in order to facilitate its parameterisation. As shown in section 4 this facilitates the DSS utilisation, in particular for users belonging to companies not already familiar with e-commerce that do not have at their disposal enough reliable quantitative data.

## 2 FACTORS INFLUENCING E-COMMERCE ADOPTION

Customer perception is fundamental for explaining e-commerce adoption process (Choi, 2004; Zhou, 2004; Levin, 2003; Lim, 2003; Liu, 2003; Vijayasathy, 2002; Liang, 1998). A literature review, considering both B2B and B2C works in order to ensure a wider article selection, has been undertaken in order to identify all the e-commerce success factors. This assumes that the B2C and B2B adoption processes are sufficiently similar to allow for an extrapolation of the results from one field to the other.

### 2.1 Product Features

The moderating effect of product/service characteristics on the willingness to adopt e-commerce has often been studied in the literature (Liu, 2004; Levin, 2003; Liu, 2003; Vijayasathy, 2002; Lowengart, 2001; Phau, 2000; Peterson, 1997). The following product characteristics are among the most cited in the analysed literature: degree of intangibility, importance, degree of membership to the search good class, degree of standardization.

#### 2.1.1 Degree of Intangibility

Intangibility, the major characteristic that distinguishes goods from services, affects the customer's ability to judge the quality of the good/service. Intangibility is mainly related to the lack of physical evidence; thus by the extent to which a good cannot be touched or seen, it is inaccessible to the senses and lacks a physical presence. The degree of intangibility has a positive effect on e-purchasing adoption due to transaction costs reduction made possible by instantaneous electronic delivery of digital product (Liu, 2003). Moreover, instantaneous electronic delivery decreases the uncertainty about the goods quality (Liu, 2003). Due to the positive effect on both transaction costs and the quality uncertainty, the degree of intangibility is considered being a very important e-commerce success factor. Evidence of the significant impact of the degree of intangibility on e-commerce adoption can be found both in the B2B (Liu, 2004) and B2C literature (Liu, 2003; Vijayasathy, 2002; Phau, 2000; Peterson, 1997).

### 2.1.2 Importance

Product importance can be defined as the “degree of essentiality” of the supplier delivery to the organization, as perceived by the buyer (Hunter, 2004). Product importance has a negative effect on e-purchasing adoption because it increases perceived risk, which in turn is recognized as an important hindering factor of online shopping (Liu, 2004; Lim, 2003). Two elements characterize the perceived risk: the likelihood of negative outcomes and the magnitude of the undesirable consequences, mainly due to financial and performance risk (Lim, 2003). The magnitudes of both are directly influenced by product importance because the costs and losses resulting from quality problems, delay problems and other uncertainties directly depend on the product importance. In a B2B marketplace both the financial and the performance risks are significant. This requires a comprehensive evaluation of product importance. In B2C, it appears that the product price plays a major role (Lim, 2003; Vijayasathy, 2002; Lowengart, 2001; Phau, 2000; Peterson, 1997). The B2B literature points out the dichotomies between low importance products, such as commodities and Maintenance, Repair and Operations (MRO), and important products, such as direct customised materials. These findings are confirmed by the wider diffusion of e-purchasing for MRO products than for direct materials (Hunter, 2004).

### 2.1.3 Degree of Membership to the Search Good Class

A search good is a product or service with features and characteristics that are easily observable before the purchase. Thus it can be completely described and assessed without the necessity of physical inspection. On the contrary, an experience good is a product or service for which characteristics such as quality or performances/functionalities are difficult to observe in advance and can only be ascertained upon consumption or, at least, physical inspection. Search goods can be more easily transacted online than experience ones because all data about their relevant characteristics can be gathered consulting a website, before transaction fulfilment. In this way, the customer perceived risk is drastically reduced in case of search goods e-purchasing (Clemons, 2002). The degree of membership to the search good class is thus a factor having a pronounced positive impact on e-purchasing adoption. This hypothesis coincides with the results of previous works (Choi, 2004;

Levin, 2003; Clemons, 2002; Phau, 2000; Peterson, 1997).

### 2.1.4 Degree of Standardization

A high degree of standardization reduces the need for product physical inspection (Clemons, 2002; Liang, 1998) and the amount of information necessary for taking a purchasing decision (Hunter, 2004). This results in a reduction of the customer perceived risk that facilitates e-purchasing adoption for highly standardised products. The degree of standardization is considered having a positive effect on e-purchasing adoption, even if the magnitude of its effect is less pronounced than those of the other product features.

## 2.2 Customer Characteristics

The relationships between customer characteristics and e-commerce adoption have been pointed out in various works, both in the case of B2B (Liu, 2004; Selhofer, 2004; Stansfield, 2003; Scupola, 2002) and B2C (Vijayasathy, 2002; Phau, 2000). The following four characteristics have been identified in order to explain the behaviour of customers involved in B2B e-commerce: ICT resources, e-commerce experience, e-sales channel evaluation, purchasing frequency.

### 2.2.1 ICT Resources

The lack of ICT resources can constitute an entry barrier for companies interested in e-commerce, especially for SMEs (Fillis, 2003; Stansfield, 2003). At the infrastructure level, many basic ICT resources (computer use, internet access and e-mail use) have already been widely adopted, however the use of the world wide web still lags behind for companies not using e-procurement (Selhofer, 2004). The differences between e-commerce adopters and non adopters are even more significant for IT staff recruitment, ICT training and knowledge acquirement and ICT use at the organisation level (Fillis, 2003; Scupola, 2002). In fact, the strongest barrier to e-commerce take-up by SMEs appears to be a lack of knowledge about the Internet and electronic commerce, which provokes a lack of IT skilled staff and hinders the great majority of small firms, still in the early stages of Internet adoption, to make the leap towards full integration (Stansfield, 2003). The diffusion of various ICT resources and IT activities are estimated for four classes of companies. These classes are obtained by splitting a sample of 4326 European companies involved in

B2B transactions (Selhofer, 2004), according to their current share of e-purchasing. A ratio of adoption (utilisation) has been calculated for each ICT resource (IT activity) and for each class, it is shown in table 1 as the percentage of adopting companies. The basic ICT resources (Computer use, Internet Access availability, E-mail use, WWW use) include various mature ICT resources that can be used independently by each user. On the other hand, the sophisticated ICT resources (Intranet, Extranet, LAN, Wireless LAN) mainly concern the development, management and utilisation of various network typologies. The columns IT training and learning and IT staff recruitment show the percentage of companies engaged in these activities, thus providing a measure of the importance and the investments made for achieving the required IT skills. Finally, the percentage of companies having created their own website gives information about the importance attached to the Internet as a means of communication, collaboration and transaction.

The obtained results confirm the tendencies previously outlined in the literature:

- Non adopters (almost 55% of the sample) show lower utilisations than e-purchasing adopters even for various ICT basic resources (e-mail and World Wide Web);
- Basic ICT resources are widely used by all the companies using e-purchasing (almost 100% of adoption) whatever their share of e-purchasing;
- Weak adopters (22% of the sample) lag behind in terms of ICT resources and utilisation, in particular while focusing on sophisticated ICT resources (Intranet, Extranet, LAN, Wireless LAN) and more challenging activities (IT training, IT staff recruiting, company website development).

Available ICT resources have a positive influence on e-purchasing adoption without being one of its main drivers. Their discriminative power

is decreased by the fact that the differences in ICT resources among companies are less and less prominent in many industrial sectors.

### 2.2.2 e-Commerce (e-Purchasing) Experience

This attribute captures all the past e-commerce experiences of the customer. The pronounced positive impact of previous successful e-commerce experiences is explained by the “learning effect in electronic commerce” (Liang, 1998); the confidence and skills developed across successful e-commerce utilisations decrease some components of customer perceived risk and thus increase customer willingness to adopt e-purchasing. Vijayasarathy states that prior experiences with online shopping have a strong positive effect on future shopping intentions (Vijayasarathy, 2002). Experienced customers are thus more willing to adopt e-purchasing than inexperienced ones. This positive attitude is not restricted to the already known e-suppliers, but also applies to new unknown suppliers, as well as to the purchasing of products not already bought on line.

### 2.2.3 e-Sales Channel Evaluation

While “e-commerce experience” provides a measure of the general attitude of a customer towards e-purchasing, the attribute “e-sales channel evaluation” focuses on a dyadic customer-supplier relationship. According to Choi (Choi, 2004), it constitutes an important factor influencing the willingness to adopt e-commerce. This attribute takes into account the perceived usefulness (relative advantage) and ease of use (simplicity and compatibility) of the available e-sales channels.

The comparison of the perceived quality of various shopping features, between traditional and e-commerce sales channels (Levin, 2003), as well as

Table 1: B2B customer characteristics.

Share e-purch.	Basic ICT resources				Sophisticated ICT resources				IT training and learning			IT staff recruit	Website
	Use comput	Internet Access	E-mail	www	Intranet	Extranet	LAN	Wireless LAN	In house	Third party	Personal learning		
>26%	100	100	100	98.52	63.31	32.25	86.4	36.09	54.70	62.43	81.77	41.44	82.32
5-25%	100	99.70	98.51	95.96	60.84	28.70	80.9	35.43	55.16	61.14	79.37	32.44	83.11
< 5%	100	99.47	99.05	94.01	50.37	18.19	73.6	24.08	50.79	55.42	67.61	21.66	75.50
no	100	92.65	88.51	79.22	34.38	12.42	51.6	15.96	35.14	39.23	48.44	11.91	57.56

among different type of e-commerce sales channels (Choi, 2004; Lowengart, 2001), shows the strong correlations and tradeoffs between the different features and suggests the use of methods providing an overall evaluation of the quality of each sales channel. An approach based on the Conjoint Analysis has been proposed by Canetta (Canetta, 2004) for the evaluation of online customer satisfaction in a B2B environment. It allows estimating the importance of purchasing process modifications, available e-services and customer adoption efforts. A positive e-sales channel evaluation implies a good fit between the features of the available channel and the customer needs; this in turn explains the strong positive influence of this attribute on customer willingness to adopt e-purchasing.

#### 2.2.4 Purchasing Frequency

The decision to adopt a particular e-sales channel is also influenced by the comparison of its perceived usefulness, for instance the transaction costs reduction, with the required customer effort, including the ICT investments and the initial loss of productivity due to the learning effect. Thus, customer purchasing frequency has a great impact on the e-purchasing adoption decision, because only a sufficiently high purchasing frequency leads to the critical mass that makes e-purchasing adoption profitable. Peterson introduces purchasing frequency as one of the three dimensions of his product classification system (Phau, 2000; Peterson, 1997). Subramaniam (Subramaniam, 2002) indicates purchasing frequency as one of the transaction characteristics influencing the impact of “web-based B2B procurement”. Consequently, a high purchasing frequency is considered having a moderate positive impact on e-purchasing adoption.

### 2.3 Purchasing Process Modifications

E-purchasing adoption can induce significant modifications to the customer purchasing process. Therefore, a realistic estimation of the customer perceived usefulness (relative advantage) requires a detailed analysis of the purchasing process modifications caused by the adoption of a particular e-sales channel configuration. The process modification assessment should take into account the production, distribution, inventory management and order-handling processes (Clemons, 2002). Various methods can be used for calculating the impact of process modifications. For instance,

Subramaniam proposes a “framework to quantify and measure the value of B2B e-commerce systems and identify the factors that determine this value” (Subramaniam, 2002). The evaluation of the potential transaction cost savings obtained using various e-sales and e-procurement channels in a B2B market environment is also the main objective of the work of Iliev (Iliev, 2004).

## 2.4 Brand Perception

The impact of brand perception on customer satisfaction and intention to purchase has been confirmed both in the B2B (Bendixen, 2004) and in the B2C (Levin, 2003) marketplace. The moderating effect of brand perception over the perceived risk is particularly important for transactions involving new potential customers, which are characterised by high levels of risk and uncertainty. On the contrary, customers belonging to the current customer base have already acquired knowledge about the product characteristics and the supplier performances during their previous transactions, even if undertaken using traditional sales channels. The following three factors have been identified in order to describe the influence of brand perception: brand awareness, brand reputation, distance.

### 2.4.1 Brand Awareness

It is defined as the degree to which target customers recall a brand or are aware of its existence. Brand awareness is a common measure of marketing communication effectiveness. High brand awareness facilitates e-purchasing adoption, even by customers belonging to market segments not already covered by the current customer base. Brand awareness can reduce perceived risk and uncertainty. For instance, Van den Poel (Van den Poel, 1999) identifies well-known brands as a significant risk reliever for the adoption of e-commerce, just behind money-back guarantee.

### 2.4.2 Brand Reputation

Brand reputation is defined in terms of the perceived quality associated by a customer to a brand. Brand reputation, also called brand image, can improve customer trust and is considered as a moderating factor of perceived risk and uncertainty. For these reasons it has a great positive influence on customer willingness to adopt e-purchasing (Lim, 2003; Clemons, 2002).

### 2.4.3 Distance

Distance describes the difficulty for a potential customer, called *New Customer* in the rest of the paper, to know the seller. It is clearly influenced by the geographical locations of the buyer and the seller, but it also captures the lack of knowledge of a buyer belonging to an industrial sector radically different from those usually targeted by the seller. Distance allows to take into account that the perception of brand related attributes varies across customers and purchasing situations (Mudambi, 2002). Distance has a negative impact on brand perception and tends to hinder e-purchasing adoption.

## 3 RULE-BASED DECISION SUPPORT SYSTEM

The utility of rule-based Decision Support Systems (DSS) in the field of e-commerce is already demonstrated by Zhou, who points out the broad managerial implications of the rules he identified (Zhou, 2004). These qualitative rules can be directly used by decisions makers to support business strategic planning of pure e-commerce and multi-channel retailers. A similar objective is pursued by

the DSS presented in this paper. It allows to classify the success of an e-strategy, in terms of rapidity of sales turnover increase and of maximum turnover, depending on the targeted customers, the sold products and the adopted e-sales channel. The DSS is formalised through a series of "IF... THEN" rules dealing with linguistic variables. The choice of linguistic variables (e.g. low, medium, high) is justified by the qualitative and subjective nature of many of the factors that are linked to customer perception. Moreover, for the company management is simpler providing qualitative estimations rather than gathering e-commerce quantitative data (these are particularly difficult to obtain for activities, such as e-commerce, that are still in their infancy).

In order to keep the sets of rules to an understandable and manageable size, the DSS data are structured into three categories (e-commerce success factors, aggregated factors, output variables) as shown on figure 1. The e-commerce success factors, defined in section 2, appear on the left hand side of figure 1. The aggregated factors called *Product Suitability*, *Customer Propensity*, and *Brand Perception* are obtained by combining the e-commerce success factors. The aggregated factors appear in the central part of figure 1. *Product Suitability* characterizes the facility to which a product can be transacted via e-purchasing.

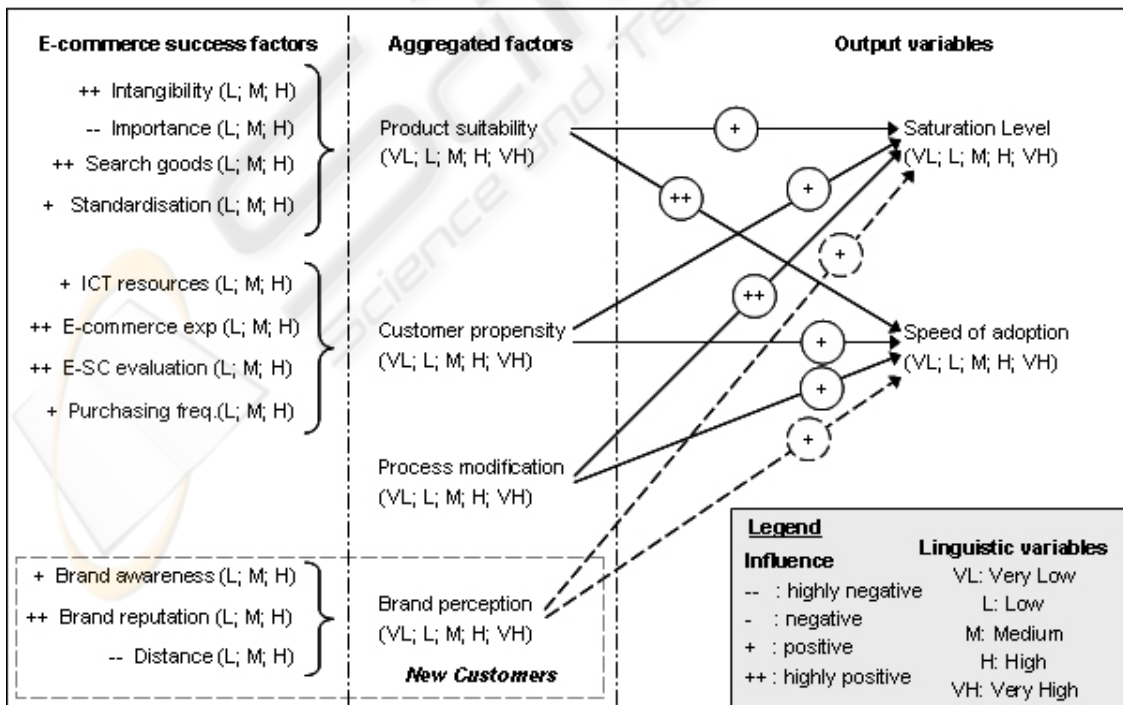


Figure 1: Rule-based Decision Support System structure.

*Customer Propensity* describes the impact of customer e-readiness and of its overall evaluation of e-purchasing in comparison with the traditional channels. *Brand Perception* represents brand awareness and reputation as well as distance impact on the customer perceived risk (it is used only when considering the potential transactions made by the *New Customers*). Finally, *Process Modification* estimates the impact of the purchasing process modifications induced by the e-purchasing adoption (see 2.3).

The output variables, *Saturation Level* and *Speed of Adoption*, shown on the right hand side of figure 1, provide a complete and reliable description of typical e-commerce evolution patterns. They are closely related to the parameters of Diffusion of Innovation (DOI) mathematical models, which are already abundantly used for the description of ICT adoption (Teng, 2002). This allows to easily enrich the DSS, linking the qualitative description to quantitative data. In order to limit the efforts required from the user to fill the inputs and to render at this level the system of rules more understandable only three linguistic levels are used for describing the e-commerce success factors (*low, medium, high*). On the other hand, five levels are used for the aggregated factors and the output variables (*very low, low, medium, high, very high*) in order to better differentiate the e-commerce evolution patterns.

### 3.1 Rule Sets for Aggregated Factors

Each set of rules is constructed starting from the identification of the direction (positive or negative) and of the magnitude of the influence of each e-commerce success factor. The direction and the magnitude of the impact of e-commerce success factors are depicted in figure 1 using the following notation: (++) *highly positive*, (+) *positive*, (-) *negative*, (--) *highly negative*. As an example, in the set of rules leading to the values of the aggregated factor *Product Suitability*, three e-commerce success factors have a positive influence (*degree of intangibility, degree of standardization, degree of membership to the search good class*) while one (*importance*) is negatively correlated to the suitability of a product to be electronically transacted. The most important factors are *degree of membership to the search good class, importance* and *degree of intangibility*, while the factor *degree of standardization* is less influent. This set of rules, defining the values of the aggregated factor *Product Suitability*, results in a full factorial combination of

the levels of the four inputs ( $3^4=81$  rules) described in detail in table 2.

The four e-commerce success factors characterizing the aggregated factor *Customer Propensity* to adopt e-purchasing have all a positive influence. Two factors (*e-commerce experience, e-sales channel evaluation*) are considered the main drivers of customer behaviour. The remaining two factors (*ICT resources, purchasing frequency*) are considered as less important.

The perceived risk for *New Customers* is clearly higher than for customers that already know the supplier and its products. Thus, a supplementary aggregated factor (*Brand Perception*) is introduced in the case of *New Customers*. It accounts for the negative effect of *distance* (--) and the positive effect of *brand reputation* (++) and *brand awareness* (+) on the new customers' behaviour.

### 3.2 Rule Sets for Output Variables

For customers belonging to the current customer base, only three aggregated factors are considered (*Product Suitability, Customer Propensity* and *Process Modification*) for the determination of the *Saturation Level* and of the *Speed of Adoption*. *Saturation Level* is mainly determined by the perceived usefulness. thus the main adoption driver is *Process Modification* (++)), which captures the purchasing company long term benefits resulting from the utilisation of the e-sales channels. The other factors, *Product Suitability* (+) and *Customer Propensity* (+), reinforce the positive effect of *Process Modification* but contribute to *Saturation Level* in a lesser manner. In fact, these two factors are mainly related to the risk perception and tend to have a more significant impact on short term decisions. *Product Suitability* (++) is considered as the most important factor fostering e-commerce *Speed of Adoption*, because product e-commerce suitability drastically decreases customer perceived risk. A positive influence characterizes also the relationship between *Speed of Adoption* and *Customer Propensity* (+) as well as that concerning *Process Modification* (+). For *New Customers*, the aggregated factor *Brand Perception* should also be taken into account. The latter has a positive influence in both the sets of rules, but it is never the most important adoption driver (+).

All the rule sets are developed and formalised according to the format presented in table 2 and are available upon request to the first author.

Table 2: DSS rules for the aggregated factor Product Suitability.

Inta	Imp	Sear	Stan	Pr	Inta	Imp	Sear	Stan	Pr	Inta	Imp	Sear	Stan	Pr
L	L	L	L	L	L	M	L	L	VL	L	H	L	L	VL
L	L	L	M	L	L	M	L	M	L	L	H	L	M	VL
L	L	L	H	M	L	M	L	H	L	L	H	L	H	VL
L	L	M	L	M	L	M	M	L	L	L	H	M	L	VL
L	L	M	M	M	L	M	M	M	L	L	H	M	M	L
L	L	M	H	M	L	M	M	H	M	L	H	M	H	L
L	L	H	L	M	L	M	H	L	M	L	H	H	L	L
L	L	H	M	H	L	M	H	M	M	L	H	H	M	L
L	L	H	H	H	L	M	H	H	M	L	H	H	H	M
M	L	L	L	M	M	M	L	L	L	M	H	L	L	VL
M	L	L	M	M	M	M	L	M	L	M	H	L	M	L
M	L	L	H	M	M	M	L	H	M	M	H	L	H	L
M	L	M	L	M	M	M	M	L	M	M	H	M	L	L
M	L	M	M	H	M	M	M	M	M	M	H	M	M	L
M	L	M	H	H	M	M	M	H	M	M	H	M	H	M
M	L	H	L	H	M	M	H	L	M	M	H	H	L	M
M	L	H	M	H	M	M	H	M	H	M	H	H	M	M
M	L	H	H	VH	M	M	H	H	H	M	H	H	H	M
H	L	L	L	M	H	M	L	L	M	H	H	L	L	L
H	L	L	M	H	H	M	L	M	M	H	H	L	M	L
H	L	L	H	H	H	M	L	H	M	H	H	L	H	M
H	L	M	L	H	H	M	M	L	M	H	H	M	L	M
H	L	M	M	H	H	M	M	M	H	H	H	M	M	M
H	L	M	H	VH	H	M	M	H	H	H	H	M	H	M
H	L	H	L	VH	H	M	H	L	H	H	H	H	L	M
H	L	H	M	VH	H	M	H	M	H	H	H	H	M	H
H	L	H	H	VH	H	M	H	H	VH	H	H	H	H	H

INPUT (3 levels) Imp = importance; Inta = Intangibility; Sear = Search goods class; Stan = Standardisation  
 OUTPUT (5 levels) Pr = product suitability for e-purchasing  
 LEVELS VL = very low; L = low; M = medium; H = high; VH = very high

#### 4 ANALYSIS OF THE ICT SERVICES SECTOR

In order to demonstrate the benefits of the proposed DSS, it has been applied to the analysis of a company belonging to the ICT services (ICTS) sector. The qualitative value of the output variables, obtained applying the DSS rules to the e-commerce success factor values, are compared with quantitative data concerning its current e-sales. This allows determining if the DSS results are consistent with the observed e-commerce evolution.

The example of Cisco Systems (CS), as the worldwide leader in networking for the Internet supplying both physical products (routing and switching systems) and services, is presented and analysed with respect to the developed DSS factors and rules. CS mainly works for big companies in the telecommunication sector. The characteristics of the aggregated factors are:

##### Product Suitability

- High degree of intangibility of many of its products (e.g. software) and high contribution of services;
- Medium importance: these products/services concern mainly consulting and outsourcing activities and are thus not directly connected to the customer core competencies and value proposition;
- High degree of membership to the search goods class;
- High degree of standardization of its products (e.g. telecommunication) and services.

According to the DSS rules (table 2) the factor *Product Suitability* takes the value *Very High*.

##### Customer Propensity

- High ICT adoption, in particular considering the enhanced technologies (WAN, remote access, etc.);
- Standard Internet applications (e-mail, WWW) reaching saturation level;
- High use of broadband that renders online transactions more pleasant;



- High percentage of companies already using e-purchasing in one of its several forms;
- Very positive evaluation of the e-sales channels implemented by CS that go beyond the transactional aspects, also supplying end-to-end supply chain visibility and real-time information about lead times and available to promise products;
- At least medium purchasing frequency, because the customers can purchase on line different products/services due to the wide offer of CS (more than 22000 SKUs).

Based on these statements the aggregated factor *Customer Propensity* assumes the value *Very High*.

#### Brand Perception

CS is a well-known company. Moreover, it has a good reputation as an e-commerce champion. Furthermore, it has at its disposal a worldwide production and distribution network. For these reasons its *Brand Perception* is *Very High*.

#### Process Modification

In general, the assessment of e-purchasing is very positive; two third of the companies belonging to the ICTS sector consider that it has a positive impact on their activities. This is particularly true for the case of CS, which provides its customers with enhanced tools for reducing transaction process inefficiencies. It also provides a private e-marketplace that reduces the order cycle time while increasing the percentage of accurate on-time shipments. Therefore, the value *Very High* is assigned to the aggregated factor *Process Modification*.

#### Output variables

Applying the DSS rules, we obtain the qualitative value *Very High* for both output variables, *Saturation Level* and *Speed of Adoption*. This implies that the steady state share of e-sales for this company is close to 100% and that this share has already reached a significant value. The indication provided by the DSS perfectly complies with the situation of CS that since 2001 transacts 90% of its business over the web, reaching an online orders rate of 96% in 2006 (Kuppens, 2006).

#### ICT services (ICTS) sector overview

The application of the DSS gives meaningful results to predict the e-commerce adoption process for a given enterprise belonging to the ICTS sector as shown in the example of CS. The validity of the DSS results can be further assessed comparing the overall description of the ICTS sector to those of other industrial sectors. In fact, the analysis carried out on the data of a survey conducted in 2003

(Selhofer, 2004) show that the ICTS sector is characterised by the highest percentage of e-sales adopters. The saturation level for this sector, measured as the percentage of companies involved in e-sales activities, is above 31%. On the other hand, the saturation level of the overall sample, which also includes other nine industrial sectors, is about 17%. This value drops below 15% if the ICTS sector is not considered. The higher e-commerce potential (saturation level) and the faster speed of adoption in comparison with other sectors are moreover confirmed by the value of the e-sales share reached in 2003, calculated as the percentage of the monetary value of e-commerce transactions. The latter reaches almost 4% for the ICTS sector while the overall sample average is below 2% (1.6% not considering the ICTS sector), thus demonstrating how the e-commerce take-off has already happened in this sector but still lags in other industrial sectors.

## 5 CONCLUSIONS AND PERSPECTIVES

The proposed DSS has been developed in order to qualitatively predict the success of an e-selling strategy. It provides a complete framework supporting the identification and the description of the set of e-commerce success factors that characterise a specific company. These factors are arranged according to four dimensions: product features, customer characteristics, process modifications and brand perception. The choice to rely upon various dimensions ensures a better understanding of the company environment than that provided by previous incomplete frameworks, which covers only subsets of these dimensions. The development of a rule-based DSS defined using linguistic variables facilitates the users in the assessment of the characteristics of the e-sales evolution.

The proposed DSS can be considered as a first attempt to predict the e-sales evolution and to explain the factors influencing it. The further step, currently under development, aims to complement the qualitative description of the e-commerce evolution with quantitative information. The latter, collected through case study analysis of companies involved in e-commerce, will be formalised relying upon Diffusion Of Innovation theory in order to provide mathematical models for the e-commerce evolution quantitative prediction.

## ACKNOWLEDGEMENTS

The authors thank the Swiss Agency of Promotion and Innovation for the financial support of this work, under the grant 6066.1 (e-Fulfillment).

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