From e-trash to e-treasure: how value can be created by the new e-business models for reverse logistics[I]

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Abstract

Reverse logistics, that is, all operations related to the reuse of used products, excess inventory and packaging materials, gain increasing attention globally both for their promising financial potentials, the sustainable growth alternative they offer and the environmental positive impact they have. In this paper, we introduce reverse logistics and we explain how the adoption of e-commerce provides new possibilities to existing business models and what are the new e-business models in reverse logistics that have emerged. We compare these three new e-business models, namely, returns aggregators, specialty locators and integrated solution providers on a number of aspects and identify keys for their competitive advantage. Finally, we discuss conceptual and actual opportunities for these e-business models to thrive and advance and present some e-commerce tools that are being developed with the aim to address the distributed, dynamic and knowledge-intensive aspects of applications that contribute to the advancement of e-businesses in the field of reverse logistics.

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1. INTRODUCTION

In an attempt to classify the new emerging business paradigms in E-commerce, different key parameters like economic control and value integration [Tapscott2000] or purchasing tactics and classes of purchases [Kaplan2000] have been proposed and many e-neologisms have been derived. It is interesting to note, however, that a common characteristic underlining many of the new e-business models has gone undetected, so far. That is, the fact that many successful e-businesses like Onsale, Fairmarket, Aucnet, Bigmachines and Ebay overlap with business processes from the reverse logistics network of markets in refurbished computers, excess inventory in electronics, used cars, used industrial equipment and second-hand consumer products, respectively.

At large, reverse logistics stands for all operations related to the reuse of used products, excess inventory of products and materials including collection, disassembly and processing of used products, product parts, and/or materials. In recent years, reverse logistics popularity has been fueled both by accelerating environmental concern and strong financial incentives. Environmental sensitivity is high in certain EU countries, like Germany and the Netherlands; as a result, legislation acts, also called "producer responsibility laws", require manufactures to develop a policy for the collection and reuse of products at the end of their life cycle. These laws aim to shift waste management costs to producers, reduce volume of generated waste and increase use of recycled materials. In the USA, the driving power for reverse logistics is associated with the realization of the potential value that can be regained from reusing products or parts or recycling materials. As noted in [Lund1998], there are over 70,000 re-manufacturing firms (typical applications include jet and car engines, auto parts and copiers) with total sales of 53 billion (USD). Despite the potential profitability and the existing legislative requirements, there are no integrated decision frameworks to advise decision-makers about the economic viability of various reuse options. On the other hand, this has also created a window of opportunity for new business models, which employed e-commerce as a revolutionary decision-support means. Data mining on customers' knowledge and derivation of their profiles can substitute formal decision making on returns' alternative options and derive value on the spot from what was originally conceived to lay in the fringes of traditional trade.

In this paper, we focus our attention on the relation between reverse logistics activities and e-commerce with the objective to examine and classify e-business models in this field and identify factors for future development. We use an all-inclusive framework of E-business

being defined as sharing business information, maintaining business relationships, operating business negotiations, settling and executing agreements and giving after-sales service by means of telecommunication networks, especially the Internet, in order to achieve business transactions [adapted from EITO99 and Zwass96].

In this context, e-business models and applications in reverse logistics context are examined based on three key characteristics. First, we have examined what are the reverse logistics activities that are facilitated by e-commerce applications. We have identified that some e-businesses focus on reverse logistics integration, that is, they facilitate all reverse logistics activities, whereas some others target mainly the redistribution of used products. Second, we examine e-businesses with respect to what degree of control is enforced upon its participating traders i.e. "laisser-faire" trading communities with minimum restrictions or selecting traders that meet certain requirements. Third, we examine the kind of value these e-business models bring to their customers; i.e. e-businesses in reverse logistics that act as aggregators for suppliers and customers are an effective mechanism for promoting standardized products which can be accurately described through a catalogue reference. In sum, we propose a classification method to identify what kind of electronic markets are related to reverse logistic activities today and what are the driving forces for future development. We are also interested to examine the long-term relationship between E-commerce and the economic aspects of marketplaces in reverse logistics. For that, we have developed e-commerce tools that may provide existing e-business models new potentials for grow.

In our study a series of relevant sites have been examined regarding these aspects. For each of them, we examined how they function in the electronic marketplace and what is their value proposition. Based on the selected key characteristics, we develop a classification of existing e-business models and a comparison that leads to directions for future developments. We conclude this paper with the presentation of some of the tools developed for potential developments of these marketplaces. These are the main directions of this paper, which is structured as follows. In Section 2, we briefly introduce reverse logistics activities. Then we examine what are the new possibilities for business models in reverse logistics with the introduction of Internet. First, we see those which are not exactly new models but have migrated over the Web to incorporate more feasible and viable options for their business processes. Also, we identify three new e-business models centered on reverse logistics activities: the returns aggregators, the specialty locators and the integrated solutions providers. A comparison and future development trends in these e-marketplaces are also included.

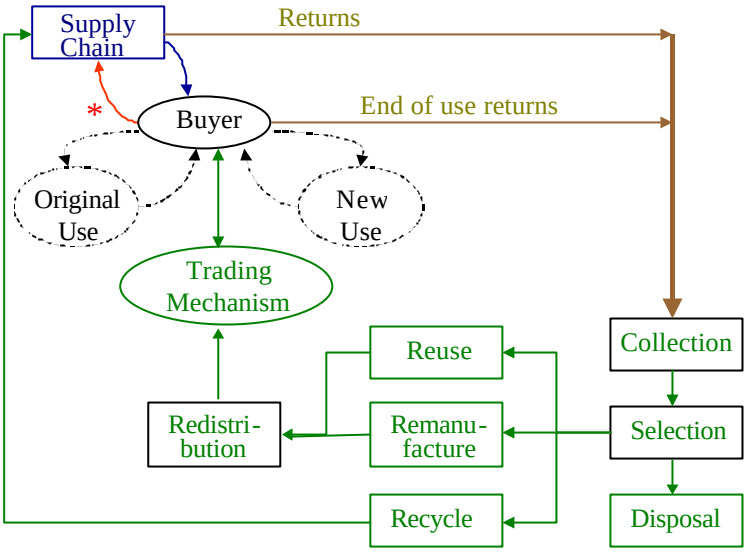

Figure Error! Unknown switch argument. **Reverse Logistics Network**

To demonstrate our point, e-commerce tools are implemented into our prototype for Reverse Logistics in the sector of PCs, briefly described in this paper. An overall view, some directions for future research and development, as well as some speculations about future deployment of E-commerce with respect to reverse logistics are summarized in Section 3.

2. E-business models for Reverse Logistics

Before we examine how the activities involved in a reverse logistics network can be facilitated by e-commerce applications, we outline in this section the main activities within a reverse logistics network and their interconnection to the forward supply chain, also shown in Figure 1.

In a reverse logistics network, reoccurring activities include collection, inspection/separation, reuse, re-manufacturing, recycling, re-distribution and disposal. Thorough overviews on this issue may be found in [Fleischmann1997, Guide2000]. In general, one may notice that reverse logistics networks focus on handling "returns", that is, products or packaging that result from various stages of the supply chain or at the end of use for a product. To illustrate this point, let us bring an example from the computer industry. At first, products are purchased for the value delivered by their original functionality; i.e. a company buys a web server for their e-commerce project. After a while, the product is no longer useful to the original user. In our example, the industry standards have evolved or the company's transactions have increased and that particular server can no longer support them. Frequently, the product is traded in a marked down price once or several times. In Figure 1, this is

denoted by the loop between “original use” and “trading mechanism”. It is worth to point out that through the repetitive changes of ownership, the product is still used in its original functionality. In our example, the computer might be bought from another company or for personal use. Eventually, however, products reach the end-of-use stage. For computers in particular, it is estimated that 500 million PCs will be rendered obsolete by 2007 in U.S.A. Computers are the fastest-growing category of solid waste, as indicated by the Environmental Protection Agency. Furthermore, old PCs contain lead, cadmium, mercury and other heavy metals that are environmental threats, if simply disposed in a landfill.

The main idea for reverse logistics is to promote and support alternative uses for the product. In this example, we can follow reverse logistics principles, when the computer is dismantled in modules that:

i) can be directly reused as spares: CD ROMs, hard disks, the keyboard etc.
ii) can be remanufactured into new products: old chips get used in electronic toys, and
iii) the rest is recycled. It is worth noting that a computer's processor has gold tips, the motherboard is made of copper, fiber glass, and silver and gold connectors, the frame is made of steel and the outer casing is made of plastic.

Anyway, with new or old functionality the product (or parts of it) enters the market again where it may also go through several trading cycles. This concept is denoted by the closed loop between “new use” and “trading mechanism” in Figure 1. Certainly, at some future point in time, the products originated from the initial purchase will reach again the end-of-use return in the reverse logistics network.

There is very extensive research on the structural changes that e-commerce brings in the forward supply chain. Issues on how e-commerce can support reverse logistic were studied in [Kokkinaki2000a, Kokkinaki2000b, Kokkinaki2000c]. In subsection 2.1 of this paper, we identify how e-commerce has introduced new return flows and how it has been used by existing businesses in reverse logistics to expand their alternatives. Furthermore, e-commerce has enabled new business models with respect to reverse logistics, which are presented and compared in subsection 2.2. Based on this, we have identified what e-commerce tools are still missing to advance e-businesses in reverse logistics and we present a few that are being developed in the subsection 2.3.

2.1 Managing a new kind of returns

E-returns refer to a new return flow that emerged through B2C e-commerce's expansion. E-returns concern products that were originally purchased though B2C e-commerce channel and

were not found satisfactory. They are depicted in Figure 2 as the flows that originate from a buyer and direct to an e-tailor or a supply web. E-returns have many similarities to mail order returns, that is, returns of products originally bought through a mail-order catalogue. The reason for returning the product may vary i.e. the item arrived was not the one or it was not in the correct quantity or it did not arrive on time or does not correspond to the expectations of the buyer. E-returns can also be attributed to distance buying itself, because it limits assessment of the product through audio-visual means, only.

Many articles [Brockmann99, Gurin99 Meyer99, Nelson00, Olsen00] refer to the volume of e-returns; however, we only have estimations on the volume, value and handling costs of e-returns. According to (MMH 2000), websites in U.S.A have estimated e-returns to be on average 30% of all purchases and they amount to $11 billion out of which $1.8 billion to 2.5 billion will represent losses. Therefore, efficient and effective handling of e-returns clearly represent a competitive advantage for e-tailors facing competitive parity. Thus far, we have identified the following approaches in handling e-returns.

Proactive minimization of e-returns: An e-tailor may develop a strategy and possibly use IT tools to limit e-returns. The most important aspect to limit e-returns is to increase the efficiency of forward logistics, because it has been observed that as time elapsed between the order and the delivery of the products increases so are the chances to have an e-return. E-tailors may also use IT tools to mine their own or national data on customers, products and returns and make better decisions to limit future returns; an example for this case is (www.thereturnexchange.com/services/verify.htm). Also, software products cross-examine each order for incompatibilities between ordered items and notify the customer accordingly. For example, when one orders a color printer and refill cartridges that do not fit that printer, then the user interface will point out the incompatibility and ask for customer's confirmation. Finally, when customers declare their intention to return some products, they are directed to a WWW interface that minimizes the possibility that the customer returns the product due to some misunderstanding of its functionality.

Minimization of e-returns uncertainty factors: Uncertainty regarding e-returns makes their planning and management a very difficult task. When a customer declares an e-return she is directed to a www interface that collects data on the product's condition, the intended collection method, the time and the place of the return. These collected data support preliminary management for returns. Beyond a passive collection of data, however, the interface can be designed in such a way that would give financial incentives to customers to

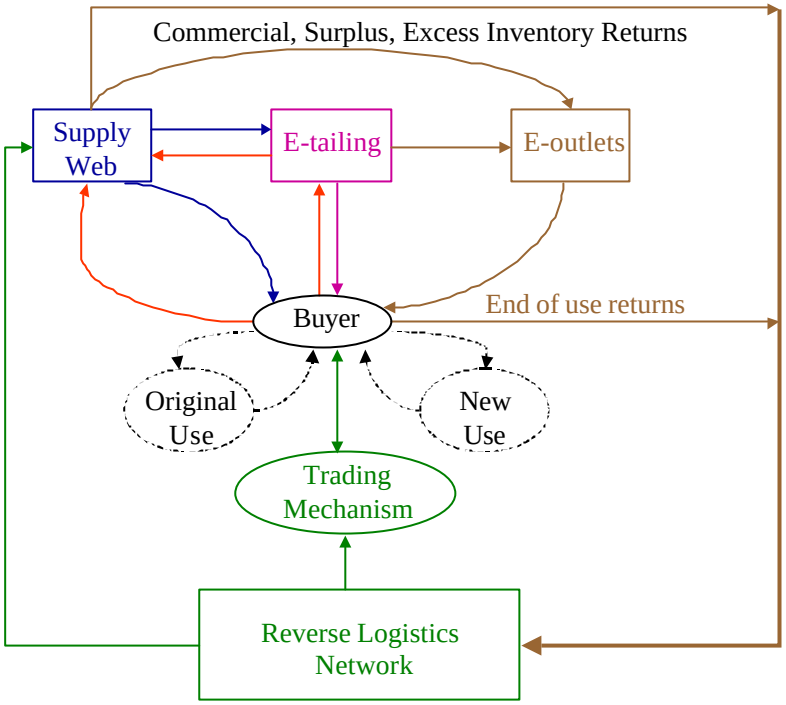

Figure Error! Unknown switch argument. **Return Flows altered through E-commerce**

follow the optimal returns alternative for each case (www.return.com).

Design of Reverse Logistics Network for e-returns: For an e-tailor the decision between developing a reverse logistics network itself or use the services of a third part logistics operator is very important. In-house reverse logistics seems appropriate for those e-tailors that have evolved from mail-order companies, because they can capitalize on their previous experience on returns management. In general, however, third party logistics operators are often employed to provide end-to-end process management to e-tailors. An ever-increasing list of third party logistics operators that can handle returns on behalf of e-tailors may be found at www.fbk.eur.nl/OZ/Revlog. Some representative examples for this case include Genko, the Return.com and the Return Exchange. The potential in this market remains very promising. Issues that need to be further explored include how returns are affected by the length of the time period within which they must be delivered and the design of reverse logistics networks.

E-outlets promote returns generated by e-tailers to the market as shown in Figure 2. E-outlets can function as independent e-businesses (www.fairmarket.com) or as a business unit within a

parent organization (www.dell.com). Their main mission is to develop a market with minimal transaction costs for commercial returns, refurbished products, or excess inventory. E-outlets do not develop any structural decision support system to handle returns. They merely support an e-auction mechanism through which, a fragmented supply meets an equally fragmented demand and a price is dynamically discovered based on a set of published product characteristics. Currently, only a part of returns is forwarded towards e-outlets and only in certain industries.

2.2 New e-business models in reverse logistics

The specification of e-business models related to reverse logistics was based on general e-business models, proposed in [Kaplan2000, Tapscott2000, Wise2000]. Reverse logistics e-business models, as shown in Figure 3, are differentiated based on their degree of inclusion for reverse logistics activities, the level of control exercised upon their trading partners and the kind of added value they offer. We also discuss what are the sectors (if any) that are more suitable for the application of each model, what is their competitive advantages and how they could evolve.

2.2.1 Returns Aggregators

The business model of returns aggregators brings together suppliers and customers, automates the procurement of returns and creates value through high throughput and minimal transaction costs. It is interesting to note that there are on-line marketplaces representing different returns flows, namely production waste (www.metalsite.com), commercial returns (www.qxl.com) and end-of-use products (www.ebay.com), or even the combination of all returns types (www.180commerce.com).

Web design and efficient price setting mechanisms are essential tools for returns aggregators. Through user-friendly and clever web design, returns aggregators aim to increase their visibility and extent their population of participating traders. Moreover, a dynamic price-determining mechanism (often an e-auction) enables high throughput of transactions and the de-fragmentation of a highly fragmented market.

Despite their potentials to become truly global marketplaces, US-based electronic U.S. based returns aggregators (like www.ebay.com and www.onsale.com) concentrate within the North American market, due to their demographics or a managerial decision to simplify their logistics operations. In EU, returns aggregators are country-oriented (www.viavia.nl), as they

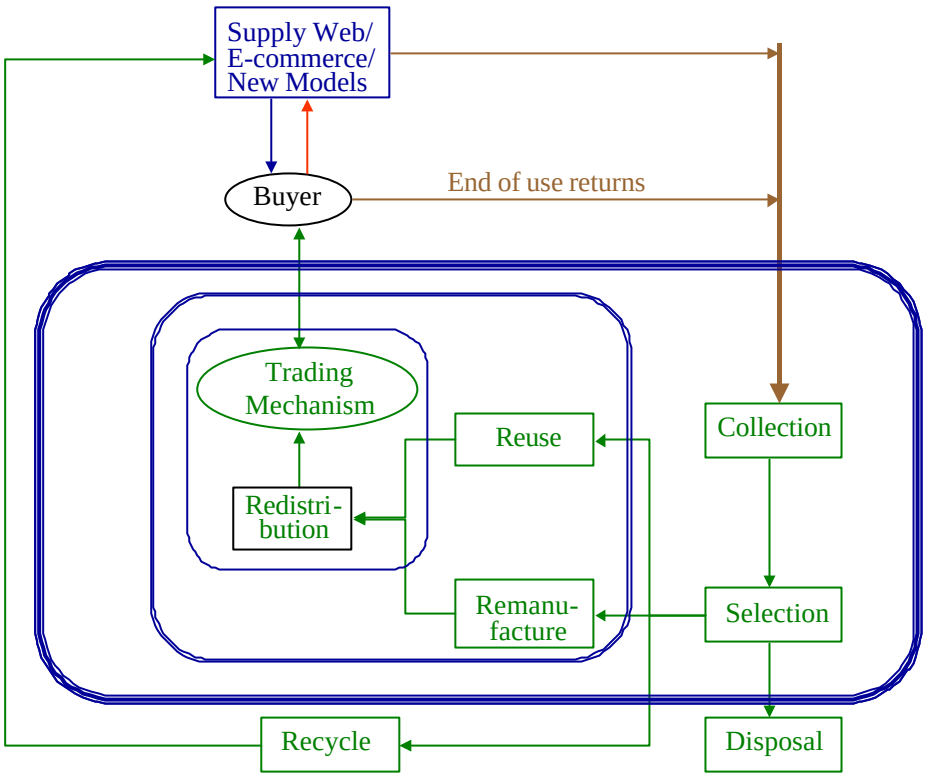

Figure Error! Unknown switch argument. **New e-business models in reverse logistics networks**

tend to cultural, logistic, linguistic and financial diversities between different member states. For example, www.qxl.com offers different content in its sites in UK, France, Netherlands, Germany and Italy.

Driving forces for returns aggregators' development are their potential for market de-fragmentation and their suitability to address the typical issues of returns, namely, their uncertainty regarding timing, quality and current value. By employing auctions to track the demand and set the price, returns aggregators can overcome difficulties associated with conventional means for managing returns. In particular, returns aggregators offer high added value in markets, which have a large number of transactions with low individual transaction value. And finally, the added value of returns aggregators increases with the number of different SKUs they handle, because that increases the critical mass of their potential clientele.

There are some trading communities open only to partners who have established relations through conventional interaction or where new members are introduced after some member's recommendation like (AUCNET) [Lee 1997] for the procurement of used cars in Japan. However, for most returns aggregators, access is open to all buyers, whereas sellers have to

register and pay fees. A price setting mechanism can be available online like in the cases of electronic auctions (www.onsale.com, www.qxl.com) or be subject to interpersonal communication through conventional means (www.viavia.nl, www.classifieds2000.com).

Beyond the described functionality, some returns aggregators like Aucnet or Autodag, its US equivalent, have promoted redesign of business processes in their industry. Within these new e-business models, new processes have been devised to accomplish certified inspection, description and multimedia representation of the cars to be sold. Dealers bid from their computer and transport is arranged between traders. At large, however, logistics aspects of electronic marketplaces cover a great variety of services including inventory management, virtual warehousing, transportation, scheduling and routing, location identification, set up and operational specifications. To simplify their logistics operations, many returns aggregators follow subcontracting third parties to do some or all of the described logistic functions.

Development of returns aggregators has low entry barriers, thus, it is likely to observe an increased number of competitors in the long run. Therefore, implementing value-added services for returns aggregators would contribute to their competitive advantage. From an IT perspective, essential issues include the used product coding and representation, the extension of the single attribute (that is price only) e-auction into a multi-attribute e-auction (service, warranties, add-ons etc) and the dynamic matching algorithms to smooth peaks and valleys of supply and demand. In addition to technical features, to address customer satisfaction, a regulatory infrastructure or legislation may apply. For example, the AucNet system [Lee 1997] provides a standardized rating system for the quality of items featured in this marketplace. New intermediaries, can be associated with the returns-matching-requests model to address conflicts between buyer and seller (e.g. if the goods delivered do not meet the specifications). Finally, new policies for customer satisfaction should be crafted to manage the return of returns in case of unsatisfactory transactions.

2.2.2 Specialty Locators

Whereas returns generators emerge in markets with commodity-like returns, speciality locators are focused in niche markets. Specialty locators are vertical portals for highly specialised used parts or products. Such electronic marketplaces can serve the need for authentic antiques, exact replicas parts or equipment in historic restoration projects or the maintenance process of classic vehicles and boats. Based on this principle, two main characteristics emerge for this model. First, speciality locators are region-bounded and vertically structured, focusing to a limited range of used parts or equipment over a geographical region. Contrary to the previous model, these electronic marketplaces do not

consider their major asset the number of visits they accept, but rather the ability to provide specialised (and thus highly prized) service. Participation of suppliers in speciality locators is usually subject to financial contribution. Besides participation fees, value is generated from reference fees, advertising fees and from mining buyers profiles. This business model has high entry barriers; for someone to entry this business model it requires them to design and impose new standards in a specilized topic, structure of information and market liquidity.

Identification of the part or product in request is a central issue to the success of this business process and it implies the use of a common, unique and unambiguous framework to describe requested products or parts. Standards and structure vary among implementations (www.find-a-part.com, www.bigmachines.com, www.autobytel.com. Identification of a part can be enhanced through oral communication or through the use of web-accessible search engines that are based on some prominent features of the part (brand, description, code etc). Anyway, the specialty locators are mostly used for information dissemination and in this respective, they only address the marketing aspect of electronic commerce.

It is also interesting to note that demand driven dis-assembly may be possible, if a requested part is not directly available, but it is embedded in a unit. Demand driven dis-assembly requires a sufficiently large inventory of used products to satisfy demand and this is often perceived as costly.

Some specialty locators address the issue of preventive or reactive maintenance for heavy industrial equipment, which may operate in geographically remote places and under very stressful conditions. Re-manufacturing industrial equipment is often a closed loop process, in the sense that, users give in a piece of their equipment and some time later they get it back re-manufactured. Severe time constraints and quality guarantees are important factors for re-manufacturing.

Addressing urgency is a determining factor for specialty locators' competitive advantage. In the future we expect that speciality locators will address this point and their competitive advantage will likely shift to provide dynamically customised on-line expertise.

2.2.3 Integrated Solution Providers

The integrated solutions providers go a step beyond facilitating and matching demand and supply of returns. They capitalize on distinctive expertise and offer unique services for handling returns. Furthermore, they actually become the owners of the returns instead of implementing a brokering mechanism as the previous two models. As a result, they may

change the returns to shorten the lifecycle of the returns process, maximizing value recaptured by returns handling. This model aims to forge strong relationships with long-lasting customers in industries where the cost of a return itself may not be high, but its speedy handling is essential to its core business process.

By definition, each integrated solution provider focuses on the reverse logistics network in an industry/sector, i.e. pharmaceuticals (www.returnlogistics.com, www.pharmacyreturns.com) or machine tool manufacturers (www.milpro.com). For example, Returnlogistics provides an integrated solution to authorize, document, pack and ship returns of pharmaceuticals by different manufacturers. Returnlogistics has includes in its web accessible databases 80.000 product descriptions. Assisted by a search mechanism, users specify their returns and select a disposition method (return to OEM, destruction, sell, exchange or donation). Returnlogistics enables returns processors to seamlessly track and document authoriazation for returns and credit managers to eliminate invoices of deduction. Furthermore, it assists users with the appropriate packaging and shipping documentation. Finally, it provides the full range of logistics services including destruction of controlled substances, depackaging and repackaging of products. In the same line of value-added services for returns, Milpro provides a software wizard that guides customers through questions about problematic processes (such as chatter marks) and then recommends particular products, spare parts or equipment.

This model is still in its infancy, probably because it does not view E-commerce as a migration of existing practices and services over a new infrastructure, but, rather, as a new tool to restructure a business activity and offer new services. This e-business model creates value through escrow and processing fees and locking in the customer for add-on services or products.

As a future trend, we underline that an integrated solution provider for reverse logistics could be a niche market by itself. Recent developments with IBM and Dell substantiate this point. IBM promotes integrated solutions for reverse logistics currently in an intra-organizational level, only. IBM plans to centralise all secondary channels of sales into a restricted access exchange and develop an Information Warehouse Database to link components across its divisions. An Intranet application will enable IBM personnel to handle every aspect of reverse logistics operations. Dell also plans to launch a pilot program to bring online their reverse logistics program and make it accessible to customers for ordering new systems and giving away old ones in a one-stop way.

In sum, we view that the described e-business models vary considerably in their inclusion of reverse logistics activities, their level of control and their value generators. We have also identified what we believe will be the evolution of these models in next few years. We have to note, however, that not all returns are suited to e-commerce transactions. Very inexpensive packaging materials and very expensive and complex spare parts will continue to go through conventional processes in reverse logistics networks. The main characteristics of the three e-business models are summarised in Table 1.

Table Error! Unknown switch argument. **An overview outline of E-business modeks in Reverse Logistics**

E-business Models In Reverse Logistics	Reverse Logistics Activities	Control upon Trading Partners	Key Characteristics	Industry Sectors	Competitive Advantage	Profit Generated
Returns Aggregators	Reuse	Open to all	Efficient mechanism for transaction completion	Commoditized returns	Scope and liquidity	Transaction fees Data mining
Specialty Locators	Reuse, Remanufacture	Buyers: Free Suppliers: Participation fees	Complex, Expensive Hard-to-find returns	Restoration, Maintenance	Specialized Knowledge Qualified suppliers Timely results	Participation fees Advertizing
Integrated Solution Providers	Collection, Selection, Reuse, Remanufacture	Free Registration Charges for services	Returns with high impact on Business Processes	Pharmaceuticals, Re-engineered tools, machinery	Technical Expertise One-stop shop	Direct profits Locking-in customers

2.3 New e-commerce tools to advance e-businesses in reverse logistics

In previous subsections, we presented new e-business models for reverse logistics and identified the main issues to be tackled and how services can further improved. Studying the properties of electronic marketplaces also contributes to the identification of the functional and technical requirements for the supporting IT systems.

First, the fragmentation of returns has as a result the processes for e-matketplaces to take place in a distributed manner; thus the systems must enable autonomous processes to operate in interaction. Second, the highly dynamic behavior of returns marketplaces means that IT systems should behave autonomously in a reactive manner and act pro-actively to present proposals, which might have not been directly sought by potential buyers and sellers. Third, the returns domain is very knowledge-intensive; potential buyers and sellers may express themselves in different terms (ontologies), when they formulate description of their offers or requests. Thus, domain-specific knowledge that co-relates different ontologies is an important issue for IT systems supporting electronic marketplaces for returns. Finally, electronic marketplaces for returns should be easy to maintain to accept new buyers or sellers and new returns types that have to be included often. To address these requirements, we have started implementing a prototype in the sector of used PCs, which will be briefly described in this section.

The prototype follows a 3-tier architecture, as shown in Figure 4. A thin client supports browsing. At the middle tier, the application server implements a generic brokering mechanism and communicates with the databases (the third tier) that keep data on instantiations of requests and offers of items, the configuration of PCs, current standards of the market, the prices for PCs and modules etc. Populating the databases with data on different returns would enable the developed e-commerce tools to apply to other types of returns, as well.

The application server involves four main processes, namely the communication process, the matching process, the price estimation process and the recommendation provider process.

The communication process interacts with users. This process analyses incoming information and, if necessary, updates the databases and determines which other processes may need the incoming information. Moreover, this process maintains the outgoing information to other users.

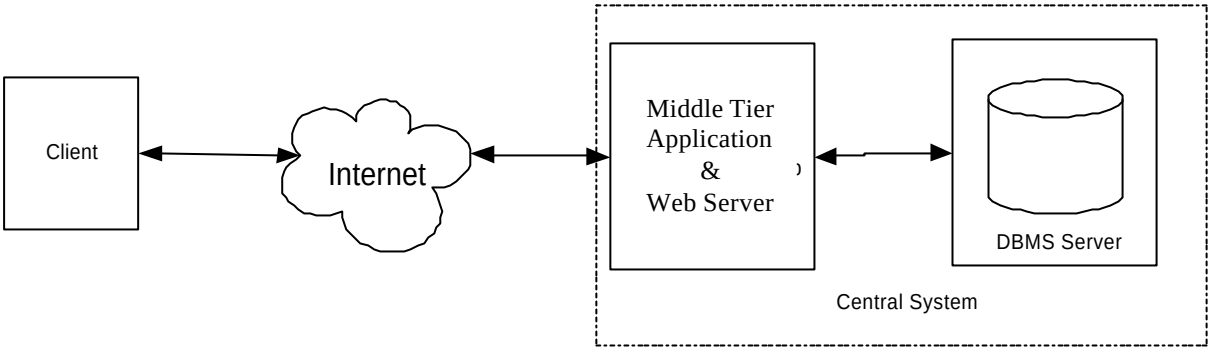

Figure Error! Unknown switch argument. **Physical Architecture of the proposed system**

The matching process supports perfect or near matching of requests and offers. This process receives information from the communication process regarding requests and offers for used PCs. Requests and offers are currently structured with a number of mandatory attributes and a number of optional attributes. For example, mandatory attributes include processor type, RAM memory and hard disk capacity and optional a user may define other attributes, i.e. graphics co-processor. The matching process compares requests considering non-specified attributes as do-not-care conditions. Beyond perfect matches, this process can also give provide near-matches, if this option was explicitly requested by the user or if perfect matches could not be found. Near matches are those that have some attributes (but not all) identical to those specified and the degree of similarity is the ratio of matched attributes over total number specified. Designing qualitative measures of similarity is subject to future advancement. The results of this process are directed to the communication process.

The price estimation process receives information about a PC configuration from the communication process. For every specified attribute, the published price of the corresponding (or similar) module is retrieved from the databases and the total sum is depreciated based on the number of months that this PC has been used. This estimation method should be further improved in future versions of this prototype. Nonetheless, we view that such services (which are currently not provided) are highly valued by users.

The evaluation process addresses the issue of future deployment (reuse, re-manufacture or re-engineer) for a given configuration. The evaluation process compares each specified attribute to the current standards of the market and provides a rating. The recommendation for direct re-use, upgrade or taking apart the PC for recycling is proposed after considering the rating of key attributes, estimated cost for upgrade and estimated cost for buying a new PC. A user can decide whether they wish to buy it for direct reuse, to upgrade it or take away some of the modules that are useful and send the rest for recycling. In case the user decides to upgrade

Figure Error! Unknown switch argument. **Instance from the evaluation process for a PC configuration**

Figure Error! Unknown switch argument. **Instances of matching requests and offers**

the PC, the prototype identifies which are the components that need to be updated and provide recommendations for updates. Figures 5 and 6 present instances from evaluating a used PC and matching requests to offers for used PCs. The prototype is still under development; its functionality, as described in this subsection, aims to provide some overall directions for the e-commerce tools that need to be developed for the advancement of e-businesses in reverse logistics. A demonstration of this prototype is also included in the presentations

5. CONCLUSIVE REMARKS

E-commerce for reverse logistics is an area of web applications that has been active and progressing aggressively, especially in the US, though it has not been explicitly recognised until now. It has given reverse logistics in general and especially re-manufacturing of parts and re-use of surplus goods an important stimulus. However, existing E-commerce models are rather restricted and represent simply the migration of conventionally practices over the Web. Therefore, we expect further development in this area and we believe there are many interesting research issues in this respect.

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