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ABSTRACT
Many businesses and governments outside of North America do not have the current technologies needed to fully implement e-government. Our research combines older EDI technology with current telecommunications to produce a hybrid Internet EDI model for e-government, illustrated with standard taxation processes. This model enables e-government for all businesses and governments at a level that is reasonable and will work for them. Many countries are still using old technologies and need to make them work with newer ones. In particular in the public service, many systems have been in place for many years and there is minimal money to upgrade or revamp systems extensively. Our solution allows these governments to get reasonably up-to-date with minimal time and money. Background is provided on traditional EDI issues, the Internet and e-government application services, followed by a description of the proposed hybrid architecture, system and administrative requirements, functionality, security features and strengths.

Keywords
EDI, Internet, taxation, e-government.

INTRODUCTION
Electronic Data Interchange (EDI) is a set of standards and protocols defining a mechanism for electronically exchanging data between business applications. EDI tools provide businesses with the ability to obtain uniform, reliable and more accurate transaction documents at a faster rate than paper-based systems. Internet-based EDI is a popular area of current research on EDI and is deemed a promising alternative to pure EDI technology (Angeles et al., 2001; Hale, 2002; Fu et al., 1999). In this research, we examine properties of EDI and propose an Internet EDI solution in e-government, demonstrated with a taxation case study.

The problem for many countries is that their technology infrastructure and their financial resources are not strong enough to support modern e-government solutions. Our research explores suitable available options. We propose a solution that uses relatively inexpensive, ubiquitous technology to allow these governments to enjoy electronic benefits.

The paper begins with sections covering our methodology, traditional EDI, Internet-based EDI, e-government processes and the taxation process. The main contribution is the proposed model of an Internet EDI architecture for e-government. Taxation processes are discussed in relation to the proposed architecture. Finally, we test the model on a small case study, discuss our results and provide suggestions for future research.

METHODOLOGY
Theoretically, this study includes the inductive method of identifying a conceptual categorization of EDI, internet-based EDI and government process characteristics. The second deductive method defines the relationship between those characteristics. Third, a model is developed and proposed to showcase the relationship and finally the model is tested on a small case study.

This research began with an extensive review of the literature in traditional EDI and Internet-based EDI, supplemented with both literature searches and personal interviews providing information on e-government processes. Data was collected and analyzed from internal company documentation, web site information, tax forms, semi-structured telephone interviews, online questionnaire responses, email discussions and follow-up communication. This fact-finding exercise helped to establish the business activities, problems and recommendations for improvement in a taxation environment and also influenced the design of the proposed e-government Internet EDI solution. The model was developed on traditional EDI principles using available, inexpensive technologies. The taxation process was chosen as the focus for discussion and demonstration of the model in the context of a small, underdeveloped country.
TRADITIONAL EDI

For the purposes of this work, we define EDI as a set of standards and protocols for exchanging data. (Damsgaard, 1996; US DOD, 1998) The electronic business documents or messages transferred, such as purchase orders, invoices, or tax forms, are prepared in standard formats based on a defined EDI element dictionary. There are message standards supporting the creation, deletion, update, and status-reporting of business transactions. EDI has been used in many government agencies and industries such as airlines, banking, automotive and retail because of its tremendous benefits over traditional paper-based methods and alternative electronic exchanges. (Canon, 1996; Harris, 1994; Mak and Johnston, 1999)

Common overall benefits are cost savings, time reduction, and higher service quality. Direct, tangible benefits of EDI technology include elimination of redundant manual data entry, leading to fewer workers, reduced errors, and faster information transmission and processing. Original data from the sender can be extracted and uploaded into the recipient’s in-house business application for further processing. This avoids the need for in-house staff to re-key the same data and therefore presents the opportunity for the implementer to enjoy greater savings in administrative and transaction costs and time, as well as an improvement in information accuracy and timeliness. In addition, an electronic system reduces paper handling, postage, printing and storage, improves transaction presentation quality, file durability and storage capacity. The EDI mechanism also offers built-in security, automatic acknowledgement and transaction audit trails. Finally, the use of standards helps to establish uniform communication, eliminate frivolous data, illustrations and data discrepancies, and improve data consistency, which enhances data comprehension and overall interchange success. (Jun, 2003; Li, 1991)

THE INTERNET AND EDI

The Internet is popular for e-commerce due to its low cost, ease of implementation infrastructure and use, established open-standard and transport protocols, platform independence, affordability, convenience and the global connectivity and commercial business opportunities it offers, even to small and medium sized enterprises (SME). (Mak and Johnston, 1997, 1999; Fu et al., 1999) Using open-system Internet standards, a web server and web browser, businesses can exchange documents via e-mail, file transfer protocol (FTP) or Telnet. (Tran, 2000) The Internet, however, unlike traditional EDI connections, is susceptible to outside threats due to its open nature. The web browser and server programs, operating system or network may be vulnerable to attack. Many web service security options are available for safeguarding systems and maximizing confidentiality, authenticity and integrity of data. These include data encryption, hashing algorithms, digital signatures, authentication, authorization, firewalls, proxy servers, and monitoring and logging access. (Tran, 2000)

An Internet-based or Web-based EDI system is a system that supports the transfer of EDI-formatted or EDI-ready documents over the Internet by using open-Internet standards and a web browser. The use of EDI provides standardized data content while the Internet offers standardized user interface and communication infrastructure. Three types of access are allowed using Internet technology: E-mail, HTML forms and distributed application interfaces. This method of communication typically requires either a web form to fill in data or a web interface for viewing and downloading EDI files.

E-GOVERNMENT PROCESSES AND EDI APPLICATIONS

Government agencies perform many of the same activities as companies, often on a larger scale, so EDI technology can be useful for streamlining government processes. Cultural, economical, political, legal, and technical factors have hampered the development of EDI in some adopting countries. High bureaucracy, poor nation-wide technological infrastructure, lack of expertise, resistance to change (paper-based culture), legal restrictions, little use for limited transactions, and so on, contribute to its slower growth in governments in particular. (Erosa, 1999; Farhoomand, 1994) Some factors to be considered at the different macro-levels are: Cultural: Attitude towards change, customs, beliefs, values, norms and language; Geographical: dispersion of agencies, services provided and communication infrastructure, Economical: level of development, demography, membership in regional blocks, nature of competition, impact of telecommunication monopolies, monetary and fiscal policies and business practices; Legal: efficiency of legal system, regulation policies, laws affecting firms and treaties with foreign nations and Political: government stability, foreign policy, government attitudes towards foreign investors, and so on. (Farhoomand, 1994)

Government agencies overcoming implementation barriers include the United States, Canada, Australia, Hong Kong, Mexico and the United Kingdom. For example, the U.S. Department of Defense (DoD) uses EDI for program management and procurement (US DOD, 1998), Hong Kong, Finland and Singapore for international trade (Damsgaard, 1996), Canada and England for taxation (CCRA, 2008; UK 2008), the Mexican government for procurement and for facilitating international trade by encouraging adoption in the private sector in the financial, insurance, transportation and communication industries.

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(Erosa, 1999), and the federal government of Australia for several government purposes, including taxation and customs duties, procurement, transportation, banking and finance, defense, health insurance, immigration, telecommunication and inter-agency schemes. (Clarke, 1994)

The experience of these countries and government agencies reiterates the many uses, benefits and barriers to EDI adoption, especially on a nation-wide setting as well as the importance of formulating standards, creating committees to guide and support this process, developing policies and changing laws to facilitate expansion of EDI in their society. However, most of the documented or published articles on government EDI systems are based on the traditional formal method. With the widespread use of the Internet for communication and e-commerce in government agencies today, it will be interesting and useful to investigate and propose directions for future research in e-government based on Internet EDI.

THE TAXATION PROCESS

Taxation is a standard procedure of the revenue agency in every government. Because of this ubiquity, taxation was chosen as the sample process for our system. Taxation involves the movement of records or forms between the collection department and the taxpayer (customer). The customer may be an organization or an individual with different forms of taxes, such as Corporation Tax, Pay As You Earn (PAYE), Property Tax, Sales Tax and so on. For the purpose of this research, we will focus on the tax return process. Some forms of tax are briefly explained below.

Corporation tax is income tax paid by organizations according to their financial position and business transactions during the taxation period. These returns are prepared based on information from schedules, balance sheets, income statements, statements of retained earnings, and notes. The tax levied may vary depending on the amount of turnover and whether the entity is local, foreign, commercial, non-commercial, profit or non-profit, charitable, government owned or specially exempted (e.g. incentive grants).

Companies that perform commercial activities and charge value-added tax (VAT) to customers also pay sales tax on the goods and services they supply. This form of tax is also known as Goods and Services Tax/Harmonized Sales Tax (GST/HST). Consumption tax is a similar form of tax payable by commercial companies for goods. The customs and excise department usually collect this form of tax on chargeable goods imported into a country or manufactured there.

PAYE is a type of personal income tax collected by employers from employees based on their salary level. The required information is typically obtained from the organization’s payroll system and the individuals themselves. The source of this information is therefore the manual or automated human resource, payroll or other accounting application systems on the earning and deductions entitled to employees during the year.

Typically, resident or non-resident employers, trustees or payers of other amounts, are responsible for making deductions from amounts paid to employees and sending them to the tax collection agency. The basic deductions are for Income Tax, Employment Insurance and Pension Plans. Amounts paid include salaries, wages (including advances), bonuses, vacation pay, or tips. Also included in these amounts are other benefits and allowances such as board and lodging that employers provide their employees.

Corporations and Individuals may also be liable to pay net property tax on movable and immovable or tangible and intangible property such as vehicles, buildings, land, cash, jewelry and pre-stocks, shares, debentures, securities, money loaned with or without security, receivables and any other rights.

In every country, different forms of taxes are usually filed during a particular period of a year using standard tax forms from the local tax agency. Several of these special forms may be required in completing one tax requirement. The tax forms are typically submitted along with supporting personal or company documents. The filing method varies from country to country and some places may even provide varying non-electronic and electronic filing options for their clients, including postal mail, facsimile, electronic file transfers, electronic data interchange (EDI) or the Internet (E-mail). The source of the tax information that is requested may be the taxpayer himself, a third party (e.g. employer, transmitter or other trustee), physical records or in-house financial, payroll or human resource application systems. While some clients may prepare their tax return manually, others may reply on more sophisticated tools such as special tax preparation software or web applications provided by the tax agency, developed in-house or available commercially. Upon completing the tax forms the customer files them back to the tax administration for processing and in response the tax collector issues an acknowledgement. The agency’s reply may take the form of an initially notice of receipt and later a request for more information, adjustments or correction, a request for balance payments or notice of cash refund. The final exchange may involve a payment on either side or a zero-balance notice.
The taxation process involves several exchanges between an internal and external party. It is a compulsory requirement of all citizens that earn money and as such entails a massive and continuous amount of document processing and exchange. It can therefore be seen as an excellent candidate for taking advantage of electronic data interchange in governments. The most popular application of EDI in both the private and public sector, however, is for purchasing, which is one of the first areas of EDI implementation in business. For these reasons EDI, although broadly defined, is frequently thought of in relation to the procurement cycles. (Clarke, 1994) This includes processes or transactions such as quotation, purchasing, delivery, invoicing and settlement, and so on. Despite this trend, the application of EDI in taxation is not unfamiliar to some developed countries. For instance, the adoption of EDI in taxation has been practiced by some agencies in the US, UK, Canada and Australia using VAN-based solutions and electronic filing over the Internet.

INTERNET EDI MODEL FOR TAXATION

Non-EDI-enabled partners may use a Java-capable web browser (with applet and adapters for translation and integration) to exchange EDI documents with an EDI-enabled web server that offers mailbox, security and other valued-added transmission capabilities. (Fu et al., 1999) With many partners, large volumes or frequent transmissions, however, the database mailbox and end-to-end system integration mechanisms of this model may be inefficient. The integration of traditional electronic data interchange, Internet exchange and taxation systems in government offers a potential solution to these problems.

Goals

The main objective of this research is to provide an Internet-based electronic data interchange model that can be adopted by government agencies for taxation purposes. This hybrid model may be extended in scope and sophistication with further research, which should make it even more applicable and useful within industries and government agencies. For this solution to be useful it must offer sufficient synergy from the combined technologies. In this regard, our goal is to design a model that is secure, easy to use and implement, and cost-effective in the long-run. To this end, different implementation suggestions were made for security, communication network, software, message formats, administrative provisions, and so on.

Assumptions

*Tax Collection is done through the Employer.* Employers are responsible for deducting taxes on remuneration from employees on behalf of the government. This information is usually stored in the company's payroll records and is filed annually by the company or employer on behalf of their employees so as to facilitate the individual income tax return process.

*The Internet is accessible to both trading partners.* With the popularity and affordability of the Internet today, it is reasonable to expect the average company to already have established a connection with an Internet Service Provider (ISP). Further, one would expect the relevant telecommunication infrastructure to be in place, including a computer, modem or network interface card and a telephone line for dialing up, direct access or high speed DSL cable, and web browser. A more sophisticated architecture may include a mainframe system, a web server, a third party Internet VAN, a dedicated direct line or private network connection.

*One EDI-enabled Partner is available.* Both partners need not invest in EDI infrastructure. The proposed architecture was designed such that the initiating or major party (e.g. government) provides the gateway to EDI access to the second partner (e.g. SME) such that a client/server relationship is established.

*Government and Companies are willing to invest in the proposed solution.* For this solution to be effective, companies, particularly the tax agency, must be willing to invest in the Internet EDI tax requirements such as a communication medium, EDI and tax preparation software, Internet access, training, security provisions, equipment, and so forth.
THE PROPOSED MODEL

Desirable messaging, maintenance and security properties of the Internet EDI infrastructure include company registration, web server and software certification, EDI message construction and translation, routing and managing inbound and outbound data and documents (including immediate email notification, acknowledgements of receipts and response messages), mailbox querying and transactions reporting, mail management, automated data verification checks to ensure EDI and business rules compliance, simple document and audit control measures to record the successful transmission of data and identify read and unread messages, data security measures for establishing data integrity and authorization such as login security, web server SSL encryption transport, data field locking, producing read-only and turnaround documents, document tracking by logging and temporary archiving for recovery. The web and application servers of the EDI-enabled partner will provide these services.

The proposed model will transmit EDI formatted messages using the Internet as the communication channel. Before transmission can take place the tax agency must determine and announce the EDI standard that they will utilize and accept. The agency can choose to adopt internationally recognized standards for taxation such as EDIFACT and ANSI or develop their own country-specific standard for taxation purposes. The data to be transmitted will originate from either the physical payroll files or in-house applications of the sender. The source data may be physically entered into web templates or electronically imported and converted to relevant data files. The best case scenario would be for the employer to use a payroll or tax preparation software in a generic data format that is accessible by the tax administration. Under this environment the required information for filing tax can be easily extracted from the employers’ electronic records without need for re-entry and then sent to a translator for conversion to the approved EDI format, and vice versa.

Companies that want to use the electronic facility must first gain approval from the Revenue Agency through a registration process. Successful applicants will then be issued with a web access identification code, a password and a secure mailbox for receiving tax-related messages from the agency and for transmitting responses. They will also need to educate themselves about the nature, type and data requirements of the taxation forms and complete electronic testing before going live. Before filing taxes, the employer will need to establish communication with the revenue agency’s web server application using a secure web browser. After successful authentication using the assigned personal identification number (PIN) and password, the user will be required to use the file attachment web page facility to select, encrypt, upload and send saved EDI tax files in a secure manner over the Internet. Since companies are likely to be filing returns for several employees or different kinds of return, an optional batch filing facility is appropriate.

The Revenue Agency, upon receipt of the EDI tax forms, performs initial syntax validation checks and then responds with an acknowledgement message to the taxpayer’s mailbox. Data can then be translated to flat files that can be uploaded into the tax agency’s in-house database. After thorough checks and balances, an EDI message will be sent to the filing company with corrections or positive comments on the tax returns. The receiving customer is expected to make the necessary corrections and re-file or simply submit an electronic acknowledgement of such a notice. Some of these EDI messages may also be attached with triggers that prompt the use of a particular transaction set in response. This interchange process will continue until all returns are accurately filed and relevant payments are made.

The next sections provide further detail about the proposed model’s system architecture and security features as well as a short case study. These topics demonstrate the most significant issues about the model and those of most interest to both researchers and users. The diagram of the system architecture illustrates the model succinctly, followed by written descriptions of architecture components. Security features are identified and explained because of their importance for both confidentiality of government taxation records and use of a public network such as the Internet. The case study presents the highlights of work with a real small, underdeveloped country. Case study details have deliberately been restricted because of confidentiality.
SYSTEM ARCHITECTURE

The architecture depicted in Figure 1 is ideal for an environment where only one trading partner is EDI-enabled (the server) while their non-EDI partner (the web client) is able to communicate using java-capable web browsers and applets. With this approach, the tax agency will utilize a web server EDI-based application and provide a remote front-end translator for clients to use. The server application will act as a gateway for communication by providing services typical of a traditional VAN. This would include translation from flat files to EDI and HTML formats, message management services such as syntax validation checking, security compliance and inbound and outbound message preparation, storage and tracking using dedicated databases, data and mailbox management techniques.

The secure SSL-enabled web server will provide two types of access to registered and authenticated taxpayers. **Partial-EDI Solution** This option is based on EDI-to-HTML and HTML-to-EDI translations and application-to-person integration. Electronic taxation forms and standard messages templates will be provided on the home page for employers to complete by manual entry. The web application will force users to convert the HTML file to EDI format using a downloadable translator applet. They will then be allowed to save, encrypt and send these formatted returns or messages to the tax administration. The tax agency will correspond with employers by sending EDI messages, including automatic

Figure 1. Proposed Architecture of the Internet EDI Model for E-Government
responses or acknowledgements, to their private mailbox. The employers will then use the web translator software to convert the messages to HTML format that is viewable by a browser.

**Full-EDI Solution** This option is based on EDI-to-Generic and Generic-to-EDI translation and application-to-application integration. A more sophisticated and wholesome approach to Internet EDI is to avoid manual data entry and encourage end-to-end file integration. To make this possible, the tax agency’s EDI gateway system should be able to support several generic file formats that clients are already using or are likely to use on their in-house applications. This will entail developing or acquiring translation software or Java adapters that translate between EDI and each of the supported generic formats. The agency should also certify or recommend compatible payroll/tax software or developers that new clients can consider. During registration all clients would be required to pick the file form they utilize from a list of supported generic file types and this information will be saved in the employer profile database for future reference. Clients with proprietary formats not supported would be forced to adopt the partial-EDI solution. Full-EDI equipped clients will use a web browser to view EDI messages in their private mailbox. These emails will be attached with the relevant Java translator applet to be installed for the conversion of these files to flat files that can be read, uploaded and used by the in-house application. The translator would also be required to convert documents generated by the proprietary system to the EDI format suitable for filing to the tax authority to integrate with their internal data after re-conversion. However, this advanced alternative will be more expensive and will require more fine-tuning and collaboration between the trading parties on conversion rules, standard requirements and performance.

**SECURITY FEATURES**

Security of Internet transactions is an important feature in any application over this public network. This model was built on the following security features to avoid compromising the integrity or confidentiality of taxation data.

**Registration** The compulsory application process requires a disclosure of business information from the employer and a declaration to uphold the policy and that the entity is “what it claims to be”. This information can be verified and the company traced using the national company registry database.

**Authentication and Authorization** After registration is approved, the recognized company is provided with an account to access the tax agency’s secure online application. This includes a unique user ID, password, mailbox allocation and an email address that the user is responsible for maintaining. The email account resides with the agency’s gateway system and has restricted users and content. Users are also restricted from making certain corrections to their tax data and biographical data without first consulting the tax agency or submitting a new application. For example: changes to employer’s/user ID, company name, and so on.

**Encryption in SSL Web-server Environment** The model uses key pairs and asymmetric cryptography algorithm encryption as specified by the tax agency. The public key is made available to the registered companies and only the Revenue Agency holds the private key to decrypt tax returns. The secure socket layer (SSL) transport facility for 128-bit encryption is applied since communication will take place over the web.

**Electronic Signatures** The web-assigned PIN number, along with the company registration number and tax year uniquely identifies annual tax returns filed by the same employer and can be loosely considered as an acceptable electronic signature where necessary. However, once feasible, the use of actual digital signatures is the better alternative.

**Transaction Logs and Non-Repudiation Procedures** Log files of received and sent messages are saved by the tax database for back-up purposes and also to provide evidence in case of non-repudiation disputes. The employer is also expected to keep copies of filed forms and also furnish employees with a hard copy of the information reported to the tax authority on their behalf. These manual or electronic tax records should be kept by the taxpayer for a few years as specified by the agency, in case of future tax verification, disclaimers or legal action by the parties involved.

**Anti-virus or Firewall Protection** A good anti-virus or firewall strategy should be put in place to establish trusted, un-trusted and demilitarized zones. It should be capable of detecting, handling and recording attacks of different types (floods, IP spoofing, port scan, IP address sweep, among others) and to block Java/ActiveX/EXE and other potentially harmful files.
CASE STUDY

Researchers examined the Pay As You Earn (PAYE) taxation scheme of a small, third-world country to test the feasibility of the Internet EDI model. The country’s current taxation system includes two somewhat-duplicate computer systems – a large-scale IBM mainframe and a personal-computer-based system – supplemented by significant manual processing. Steps in the taxation process include receipt of information, classification/sorting, identity verification/update, returns registration, assessment and verification, data entry, printing of reports and refund cheques and filing. There are many problems with the existing taxation system: distrust of the multiple processes and systems, duplication of effort, lack of functionality, inefficiency, outdated technology, data inconsistencies, insufficient resources and a negative attitude toward all change. Using the Internet EDI model as a basis for system recommendations, researchers suggested improved data requirements, online Internet systems, open technologies, reliable communications and networking, and updated software, servers and personal computers as resources permitted. The details of this case study have deliberately been restricted because of confidentiality.

CONTRIBUTIONS AND DISCUSSION

As well as the expected benefits of electronic transfer such as speed and accuracy, this proposed solution offers the following strengths.

Hybrid Solution Our approach is not strictly based on the Internet or EDI, like some existing government and research solutions, but rather tries to gain the best of both worlds by retaining the use of EDI principles over a modern transmission medium, the Internet.

Integration Options Both Partial-EDI or Application-to-Person integration and Full-EDI or Application-to-Application integration is permitted depending on the clients’ needs and availability of relevant resources. However, full integration is the more desirable state of an EDI system since both trading parties are able to reap the benefit of having information directly uploaded and accessible to their internal applications.

Wide Target Population The model supports both non-EDI enabled and EDI-enabled trading partners. SMEs or companies without certified payroll software can rely on the use of HTML data entry forms and a translation facility to facilitate the use of EDI by the tax authority. On the other hand, large enterprises that can afford their own EDI set-up or that utilize payroll applications that generate the accepted generic file format can directly interpret and utilize EDI translated data in their in-house application, like the tax authority is able to do.

Security This model provides different levels of data security in striving to maintain the confidentiality and integrity of the transmission, namely: syntax and data validation checking, authentication by login security, authorization using access control, encryption using the web server’s SSL transport, electronic signatures by unique combinations of personal data, document tracking and recovery by logging and archiving.

Portability, Flexibility and Scalability This Internet-based EDI model was built on software engineering principles of reuse, evolution and adaptability. In addition, although it was designed for taxation use by government agencies, it is based on general principles and may therefore be scaled to filing other types of taxes and other procedures within the revenue department or be applied to other government functions and non-government domains. Some of the features and functionality may also be relaxed during the initial phases, when resources are lacking or when effectiveness and efficiency are not paramount.

Case Study Analysis This report briefly documents the current state, problems and recommendations for improving the taxation system in a country where EDI is virtually unknown and the technological-oriented culture is weak. Countries in South America and Africa, for example, represent good candidates for the future adoption of an Internet EDI model as proposed.

Literature on EDI in the Public Sector This research identifies a conceptual categorization of EDI, internet-based EDI and government process characteristics. It theoretically defines the relationship between those characteristics. A proposed model is developed to demonstrate the relationship and the model is tested on a small case study.
CONCLUSIONS AND FUTURE RESEARCH

This research proposes a hybrid architecture model using modern Internet technology to exploit existing investments in well-established EDI technology for e-government use. This hybrid approach works for existing EDI users and provides a promising solution for new users. It also demonstrates how existing concepts and technologies can be viable and sustainable collaboratively.

The Internet EDI model for e-government was tested on part of the taxation system of a small, underdeveloped country. Several affordable, realistic suggestions were made for positive change but time did not allow a full-scale multi-year study of the effect of these recommendations. Future research could include longer-term empirical studies and validation of the proposed model on a number of similar countries. A comparison of procedures, successes and challenges between electronic taxation systems in government and in the private sector could reveal additional enhancements for the model. Variations and comparisons of Internet EDI architectures may also provide interesting future results.

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