CLOUD COMMERCE – A DESIGN SCIENCE ENDEAVOR TOWARDS NEXT GENERATION ELECTRONIC COMMERCE

TAN WEE KEK

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National University of Singapore, 2007

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NATIONAL UNIVERSITY OF SINGAPORE

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ABSTRACT

Cloud computing possesses numerous technical and business advantages that make it highly attractive to organizations in need of dynamically scalable and highly reliable computing resources. Its wide spread adoption has also motivated researchers to examine various technological issues, business issues, applications and other general issues underpinning cloud computing. Despite this concerted effort, there remains a paucity of research exploring new application frontiers, in particular consumers' cloud-based services. Even electronic commerce, one of the most important and widely use applications on the Internet, has till date witnessed only a transition from a more traditional service provision model to a cloud-based one but without gaining any real innovation.

This thesis proposes a novel electronic commerce platform known as Cloud Commerce that is conceptualized and developed around the various concepts of Cloud Computing such as Platform-as-a-Service and Software-as-a-Service. Cloud Commerce is a true location transparent "website-less" platform that allows the selling and buying of products across multiple websites, channels and media. In a nutshell, a seller only needs to make a one-off effort to describe a particular product item in rich details and subsequently reuse the same product information to create multiple sale offers across different websites, channels and media. A buyer can use a single Cloud Commerce account to make purchase on any websites, channels and media. Several technological innovations are at the core of this platform. For instance, Cloud Commerce features an open product schemas and information repository known as Productpedia that uses XML-

based data standards as well as a set of RESTful web service-based Open Application Programming Interface for anyone to build new tools around it.

A design science research strategy is proposed to conceptualize, design and develop a fully functional prototype for Cloud Commerce. As part of the build process of design science, a comprehensive set of design science artifacts have been meticulously produced. These artifacts include constructs, models, methods and instantiations. Thereafter, two research models based on established behavioral theories that can be used to evaluate the adoption and use of Cloud Commerce will be developed. These research models will lay the theoretical foundation for a rigorous evaluate process that will be undertaken as part of future research. The proposed evaluate process will consist of a series of two empirical studies that will be conducted in which Cloud Commerce will be deployed for live use in a field setting. Through these empirical studies, the feasibility of Cloud Commerce as an electronic commerce platform will be established.

In the first research model, I extend an integrated theoretical model of Technology Acceptance Model and Theory of Task-Technology Fit to examine users' adoption and use of Cloud Commerce for online buying and selling of product items. A key focus of this research model is to determine whether the various tools provided by Cloud Commerce are indeed suitable for supporting buyers' and sellers' tasks. In the second research model, I extend the Theory of Planned Behavior using various knowledge sharing theories such as individual motivational theory, social capital theory and social exchange theory to investigate users' intention and actual behavior with regard to the contribution of product knowledge to Productpedia. A key focus of this research model is identifying and validating various salient beliefs that explain why a buyer or seller may or may not want to contribute to the building up of product knowledge in Productpedia.

Towards the end of this thesis, practical and theoretical contributions will be discussed. A detailed plan for future research will also be outlined.

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CHAPTER 1: INTRODUCTION

1.1 Background and Motivation

Cloud computing is commonly defined as the processing of data using a large pool of easily usable and accessible computing resources (e.g., hardware, software, development platforms and/or services) whose physical location is transparent to the end user (Clarke 2010; Young and Tate 2009). These virtualized computing resources are dynamically scalable and highly reliable thus rendering them suitable for running computing applications of any scale (Vaquero, Rodero-Merino, Caceres and Lindner 2009). Moreover, cloud computing removes the hassles of ownership and maintenance from the end user. This makes cloud computing attractive even to large business organizations. Beyond the technical perspective, cloud computing is very much a new business innovation. It combines prior concepts such as grid computing, utility computing and virtualization into a computer resources sharing business model characterized by a pay-per-use pricing model (Vaquero et al. 2009). Other pricing model such as flat-fee and fixed fee are also commonly adopted (Koehler, Anandasivam and Ma 2010). The ultimate objective is of course to provide business organizations with a readily available pool of quality and reliable computing resources that are inexpensively priced.

Given the attractive technical and business propositions of cloud computing, it is hardly surprising that its adoption has been gaining momentum. Indeed, recent studies conducted by influential information technology advisory and consultancy companies such as Gartner and Forrester Research have consistently identified cloud computing as one of the top technology priorities of global businesses (Gartner 2010; Gartner 2011) with a potential market value well in excess of USD $200 billion by the year 2020 (Ried and

Kisker 2011). Globally, leading technology giants such as Hewlett-Packard have rolled out cloud computing focused strategies and solutions to help business organizations get on the bandwagon (Choudhury 2011).

Amidst this excitement, researchers have devoted significant efforts towards understanding various technological, business, application and other general issues underpinning cloud computing. According to an in-depth literature review conducted by Yang and Tate (2009), much of this endeavor has focused on technological issues such as performance, network and data management as well as business issues such as cost/benefit, pricing and legal problems. Research studies proposing or implementing new and innovative applications on cloud computing platforms are few and far between. In fact, Yang and Tate (2009) found only six such articles and even these focused only on scientific applications such as processing of large data collected from sensors and search engine applications. Even more forward looking researchers such as Marston, Li, Bandyopadhyay, Zhang and Ghalsasi (2011) have mostly focused on issues such as cloud computing economics, strategies, policies and regulations. While they have also suggested the need to examine cloud computing technology adoption and implementation, little is mentioned of the importance of exploring new application frontiers. This is despite the fact that they have identified an opportunity for cloud computing to give rise to innovative services. Such a trend contrasts sharply with the widespread proliferation of consumer cloud computing applications (Claburn2011; Conlon 2011).

Most consumer cloud computing applications may be classified as Software-as-a-Service (SaaS) whereby software or solutions are delivered to the end consumers as services delivered through the Internet, i.e., the cloud (Ambrose and Chiravuri 2010). Before the advent of SaaS, a consumer would typically purchase software product off the shelf from a brick-and-mortar shop and subsequently install it on a computer. On the contrary,

today's consumers would likely utilize cloud services such as office productivity software (e.g., Google Docs), emails (e.g., Gmail), blogs (e.g., WordPress and Blogger), online music stores (e.g., iTune), and cloud storage such as online drives (e.g., DropBox and Microsoft SkyDrive) or photo albums (e.g., Flickr). Electronic commerce, one of the most important and widely use applications on the Internet involving the buying and selling of products and services, has also swiftly catch on with the cloud computing evolution. Cloud-based solutions such as eBay ProStores and Amazon Webstore provide businesses with a low cost and fast option to implement full featured electronic commerce websites that are highly reliable and scalable.

However, there is an important difference between existing cloud-based consumer services such as cloud storage when compared to cloud-based electronic commerce – **location transparency** (Figure 1.1). In cloud storage, the consumer is able to access the files that are stored in the cloud infrastructure regardless of his/her physical location typically using client software installed on a computing device. In existing cloud-based

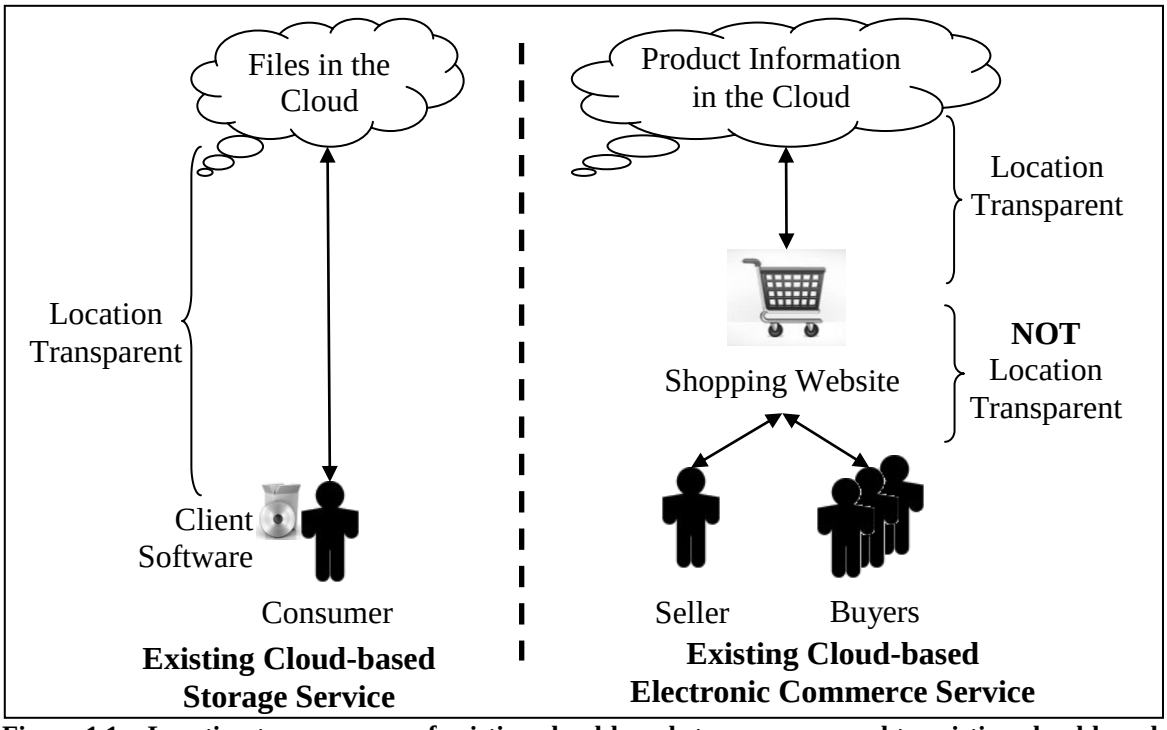


Figure 1.1 – Location transparency of existing cloud-based storage compared to existing cloud-based electronic commerce.

electronic commerce, although the product information exists in the cloud infrastructure transparently to the seller and buyers, they must ultimately access this information through a shopping website in which the location is not transparent. More specifically, the seller can only manage the product information through the website and the buyers can only buy the products through the website. This is despite the fact that the website may be accessed anywhere via a web browser and Internet connection.

The negative implications of location non-transparency in cloud-based electronic commerce can be examined from the two perspectives of seller and buyer. The seller is essentially locked in to sell the products through a single channel, i.e., the website provided by the cloud service provider. This limits the visibility of the products to potential buyers, suffering from the same pitfall as a traditional brick-and-mortar shop. Even though techniques such as online advertising, search engine optimization and search engine marketing may be employed to market the products, potential buyers must ultimately go to a single website to make purchase. In the traditional brick-and-mortar context, this is analogous to advertising in the mass media such as newspaper and television to induce consumers to walk into the shop to make a purchase. In a similar fashion, buyers potentially suffer from a drop in utility to the extent that they might miss out on products that are only sold through a particular website or channel. Although comparison shopping websites exist to help consumers search and aggregate product information from multiple websites (Tan 2003), the scope often does not include other channels such as blog shops, classified advertisements, social networking sites and mobile commerce applications, which are gaining increasing prominence.

In summary, mainstream electronic commerce websites, regardless of whether they are business-to-business (B2B) (e.g., Alibaba.com), business-to-consumer (B2C) (e.g., Amazon.com) or consumer-to-consumer (C2C) (e.g., eBay), all share a similar

characteristic. That is, the commerce activities revolve around a particular website. However, this presents a major obstacle that prevents sellers from sharing their product information across websites and channels, and more importantly prevent buyers from aggregating and comparing product information across diverse sources. Existing electronic commerce services based on cloud computing infrastructure essentially suffer from the same pitfall.

The primary research objective of this thesis is to conceptualize and develop a proof of concept prototype demonstrating a **true location transparent** cloud-based electronic commerce service platform known as **Cloud Commerce**. Cloud Commerce is conceptualized and developed around the various concepts of Cloud Computing such as Platform-as-a-Service and Software-as-a-Service. The secondary research objective of this thesis is to examine the viability of such a cloud-based electronic commerce service platform with a specific emphasis on its adoption by sellers and buyers.

1.2 Research Paradigm

This thesis focuses on the design science paradigm, which traces its root to the engineering and sciences of the artificial (Simon 1996). Design science is fundamentally a problem solving paradigm that has been widely adopted in information systems research (Hevner, March, Park and Ram 2004). Scholars have long acknowledged its importance towards generating innovative ideas, practices, technical capabilities and products that lead to more effective and efficient design, implementation, use, and management of information systems (Denning 1997; Tsichritzis 1998). Design science research is especially suited to the electronic commerce domain because it affords a systematic approach towards creating new applications yet mitigates the associated risks (Ball 2001).

Design science in information systems research typically consists of two processes, namely build and evaluate (March and Smith 1995). Build refers to the construction of an information technology artifact that addresses specific business needs. Emphasis is placed on ensuring that the artifact works in order to demonstrate feasibility. The artifact must then be scientifically evaluated. The evaluate process involves the assessment of the artifact's performance against some purposefully developed criteria. Typically, computational and mathematical methods are used to evaluate the quality and effectiveness of artifact although empirical techniques may also be employed (Hevner et al. 2004). In fact, empirical techniques are especially useful for non-mathematically represented artifacts (March and Smith 1995). However, the empirical techniques must be sufficiently rigor to the extent that data is collected and analyzed according to the natural science methodologies (Jenkins 1985).

Design science research typically leads to four types of output namely constructs, models, methods and implementations (March and Smith 1995). Constructs describe the problems within a specific domain and specify the applicable solutions. They may be highly formalize or informalize depending on the domain. Model is a set of propositions specifying the relationships among constructs. Model describes how things are and may need to capture the structure of reality. For instance, using Entity-Relationship constructs to represent the data requirements of an information system is a model that serves dual purposes: 1) solutions to the information requirements analysis; and 2) problem definition to the information system design task. Method is a set of steps prescribing how a task should be performed. It is based on the constructs and models defined for a specific domain. For instance, system development methods construct a representation of user needs, transform these needs into system requirements and follow by system specifications. The system specifications are transformed into codes that eventually

manifest as the software artifact that is used to solve a specific problem. Instantiations operationalize the constructs, models and methods into the actual artifact that is used in the intended environment. In this regard, instantiations demonstrate the feasibility and effectiveness of the associated models and methods. It is possible for an instantiation to precede the specification of the underlying constructs, models and methods. For instance, an information system may be developed out of necessity based on the intuition and experience of the business users.

A distinct but complementary paradigm to design science is behavioral science, which has its root in natural science research and seeks to develop theories that explain or predict organizational and social phenomena related to a specific business need or problem (Hevner et al. 2004). Although behavioral science focuses on truth whereas design science focuses on utility, both truth and utility are closely related. A piece of information technology artifact may possess utility because of some hitherto unknown truth while a theory may not have been sufficiently developed to provide design guidelines for an artifact. In general, the evaluate process may help to identity weaknesses in the theory or artifact for further refinement.

This thesis adopts the design science research framework and guidelines put forth by Hevner and his colleagues (2004) to build a proof of concept prototype for Cloud Commerce. In addition, theorectical research models based on behavioral science will be developed to lay the foundation for evaluating the viability of Cloud Commerce through an empirical field experiment. This evaluate process is consistent with the mandate of design science and will reveal rich insights on the phenomena underpinning the adoption and use of Cloud Commerce.

1.3 Research Overview

The research in this thesis is spread across two parts that are organized around the two design science processes. In the first part, I will review the extant literature on electronic commerce to identify the needs of online buyers and sellers for a truly location transparent and multi-channel electronic commerce platform. I will then outline the key features that such a platform should provide. Whenever possible, existing electronic commerce websites and services will be discussed in detail to highlight their strengths and weaknesses. This approach also serves to provide guidelines for designing Cloud Commerce. Thereafter, I will proceed to explain the various design science artifacts that have been produced based on the identified design guidelines. The first part of this thesis thus covers the build process of design science.

The second part of this thesis will focus on developing research models using established behavioral theories that can be used to evaluate the adoption and use of Cloud Commerce. In the first model, the Technology Acceptance Model (Davis 1989) is integrated with the theory of Task-Technology Fit (Goodhue and Thompson 1995) for examining the adoption and use of Cloud Commerce for online selling and buying. In the second model, we extend the Theory of Planned Behavior (Ajzen 1988; Ajzen 1991) with various knowledge sharing theories for examining Cloud Commerce community users' intention to contribute product knowledge to facilitate online selling and buying. An overview of my research strategy is depicted in Figure 1.2.

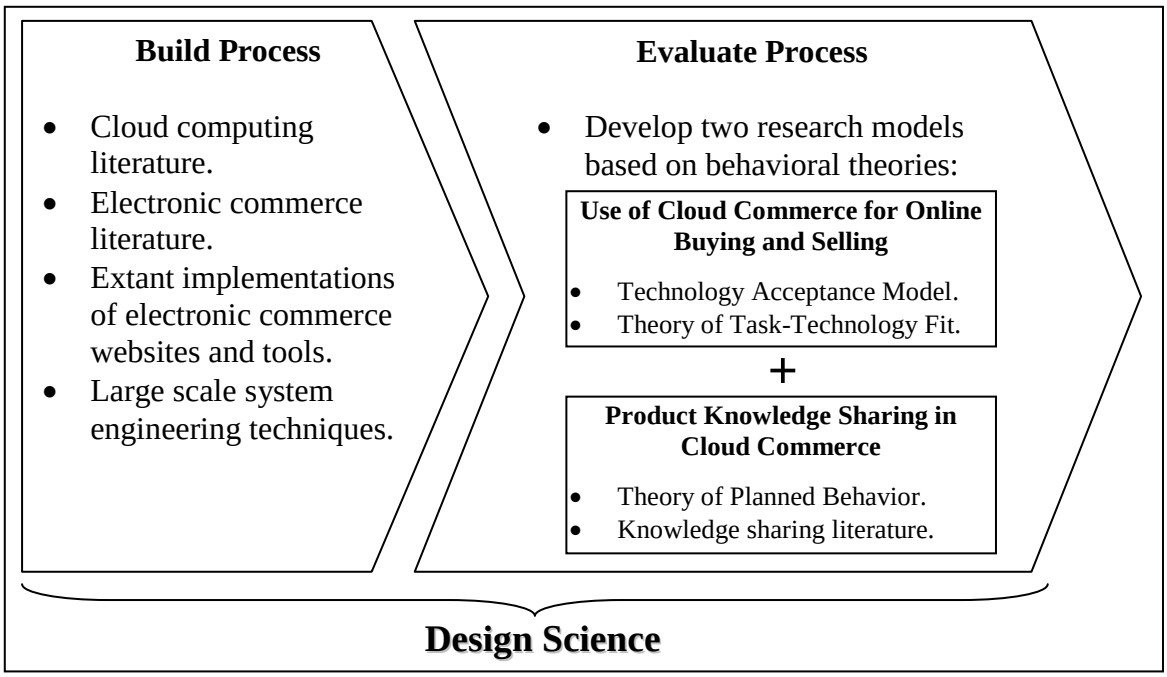


Figure 1.2 – Overview of research strategy.

1.4 Organization of Thesis

The remaining of this thesis is organized into five chapters. In Chapter Two, I will analyze the requirements of a true location transparent "website-less" electronic commerce platform that facilitates the buying and selling of products across multiple websites, channels and media. This platform will be build upon the power and flexibility provided by cloud computing. I will also delineate the design characteristics of Cloud Commerce in detail.

In Chapter Three, I will describe the various design science artifacts that have been developed in this research. There are altogether four sets of artifacts, namely constructs, models, methods and instantiations. These artifacts have been carefully designed and developed based on the requirements identified in Chapter Two.

In Chapter Four, I will put forth an integrated theoretical model synergizing the Technology Acceptance Model and the theory of Task-Technology Fit. A set of twelve

hypotheses has been developed, which may be used to empirically validate the proposed model and help us understand users' adoption and use of Cloud Commerce.

In Chapter Five, I will present an extended model of the Theory of Planned Behavior based on various knowledge sharing theories. This model may be used in conjunction with a set of eighteen hypotheses to investigate users' propensity to contribute product knowledge to Cloud Commerce.

Finally, I will conclude by discussing the practical and theoretical contributions of this research in Chapter Six.

CHAPTER 2: REQUIREMENTS ANALYSIS AND DESIGN OF CLOUD COMMERCE

2.1 Introduction and Overview of Prior Research

The idea of conceptualizing and building Cloud Commerce partly arises from my prior research on the use of personal blogs for electronic commerce activities (Tan, Tan and Teo 2008; Tan, Tan and Teo 2009). Specifically, it has been observed in recent years that bloggers have actively used their personal blog to sell a wide variety of products. While some bloggers use their blogs as an online platform purely for selling merchandise, other bloggers have made an elaborate attempt to build their commerce endeavors around their personal interests or hobbies. In fact, my research has shown that bloggers are generally more inclined towards using their blogs for commerce activities under three conditions: 1) the blog is used to discuss the blogger's interests or hobbies; 2) the products being sold are closely associated with the blogger's interests or hobbies; and 3) the blog readers, i.e., the potential buyers, share similar interests or hobbies with the blogger (Tan et al. 2009).

However, even though blog shop presents an attractive Consumer-to-Consumer (C2C) electronic commerce alternative, there are associated pitfalls. For instance, a blog shop typically has a very narrow customer base that is built around word of mouth. Although techniques such as search engine optimization and search engine marketing exist, it remains a challenge for a small blog shop to reach out to its targeted customer segment. Increasing a blog shop's reach via alternative C2C electronic and mobile channels presents a non-trivial challenge of product information management, i.e., replicating and maintaining multiple sets of product information across different channels. In addition,

unlike users of established C2C electronic commerce websites such as eBay, blog shop owners do not have access to an integrated set of tools for managing their businesses.

From a buyer's perspective, on the one hand, shopping on a single blog shop lacks product variety. On the other hand, shopping across multiple blog shops could be a taxing task because different blog shops may display the product information in vastly different formats and it is not feasible to compare across multiple blog shops. Moreover, within a vertical blog community (e.g., philatelic, comics, electronic gadgets, etc), both bloggers and visitors do not have a consensus of how product information should be described. This hampers community members from buying and selling to each other. Beyond C2C electronic commerce, Business-to-Consumer (B2C) electronic commerce sellers are often "locked in" by the particular websites that they use and cannot actively sell their merchandise through other channels. For instance, a company selling through its own flagship website may face problem expanding to alternative platforms such as social networking sites, auction websites or even mobile smartphone due to product information management problem.

This thesis proposes the Cloud Commerce platform that aims to achieve four key objectives. First, makes it possible for B2C and C2C electronic commerce sellers to create, maintain and reuse product information that can be standardized and is shareable. The product information will reside in the cloud and is accessible from any location and via any computing device. Second, facilitates sellers to solicit, close and fulfill orders based on the product information in the cloud. This means that the transaction information will reside in the cloud too. Third, helps buyers to search, browse and compare product information residing in the cloud seamlessly using any medium/channel, and eventually to checkout from the cloud. Fourth, enables any third party individual and vendors to freely develop a wide variety of tools (e.g., desktop applications, full fledge

websites, mobile websites, native mobile smartphone applications, social networking site applications, blog plugins and web mashups) to create and manipulate the product and transaction information residing in the cloud. In gist, the Cloud Commerce platform will make it a reality for sellers to market their merchandise through any medium/channel and buyers to buy anything that he or she fancies through any medium/channel, i.e., **a next generation "website-less" world of electronic commerce**.

The proposed Cloud Commerce platform epitomizes the best practices of Web 2.0 and Web 3.0 (Hendler 2009; O'Reilly 2005). Specifically, the Cloud Commerce platform will follow a layered web service architecture to provide a user-centered, interactive and collaborative electronic commerce ecosystem. In addition, it adopts a semantic web approach to enable third party tools to be built around the product and transaction information residing in the cloud. At the core of the Cloud Commerce platform is the ontology for describing the semantics of the product and transaction information together with the associated ownership information, which we propose to be implemented using Extensible Markup Language (XML) and is potentially transformable to the Resource Description Framework (RDF). The product schema portion of the ontology will be made open-source so that it may be maintained by the community in a collaborative fashion.

My prior research on blog shop has also led me to devise a preliminary RDF-based approach, known as Blogger eXchange Framework (BXF), to describe products and services. This approach allows a blog community to formalize the description of products of interest to the community. Bloggers affiliated with the community may then use the description template to "advertise" their own items in the form of a RDF document. Figure 2.1 shows how BXF will look like in a typical blog used in the study conducted by Tan et al. (2009). Listing 2.1 shows the underlying RDF document. Cloud Commerce will adopt similar concepts but with significant enhancements.

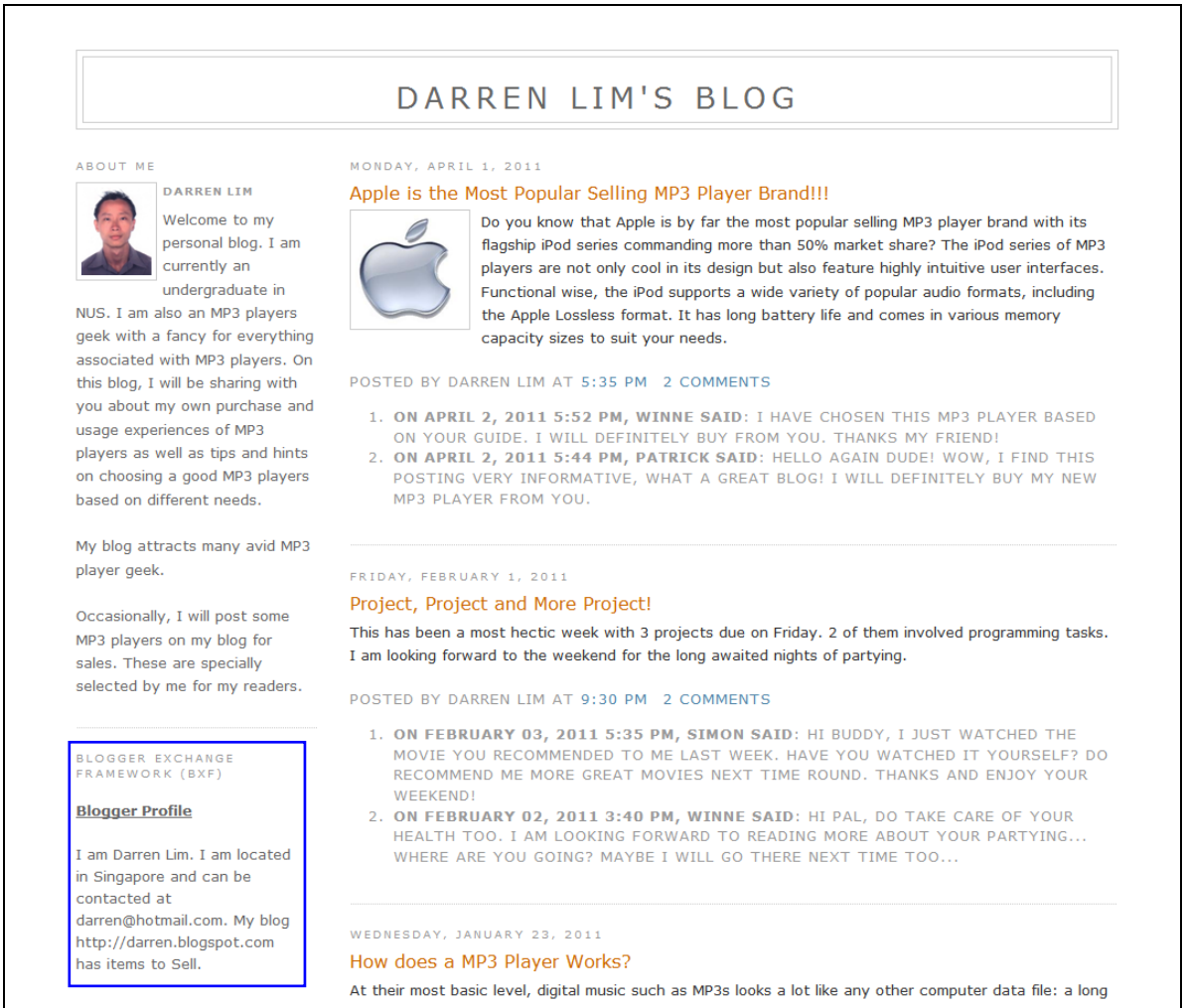
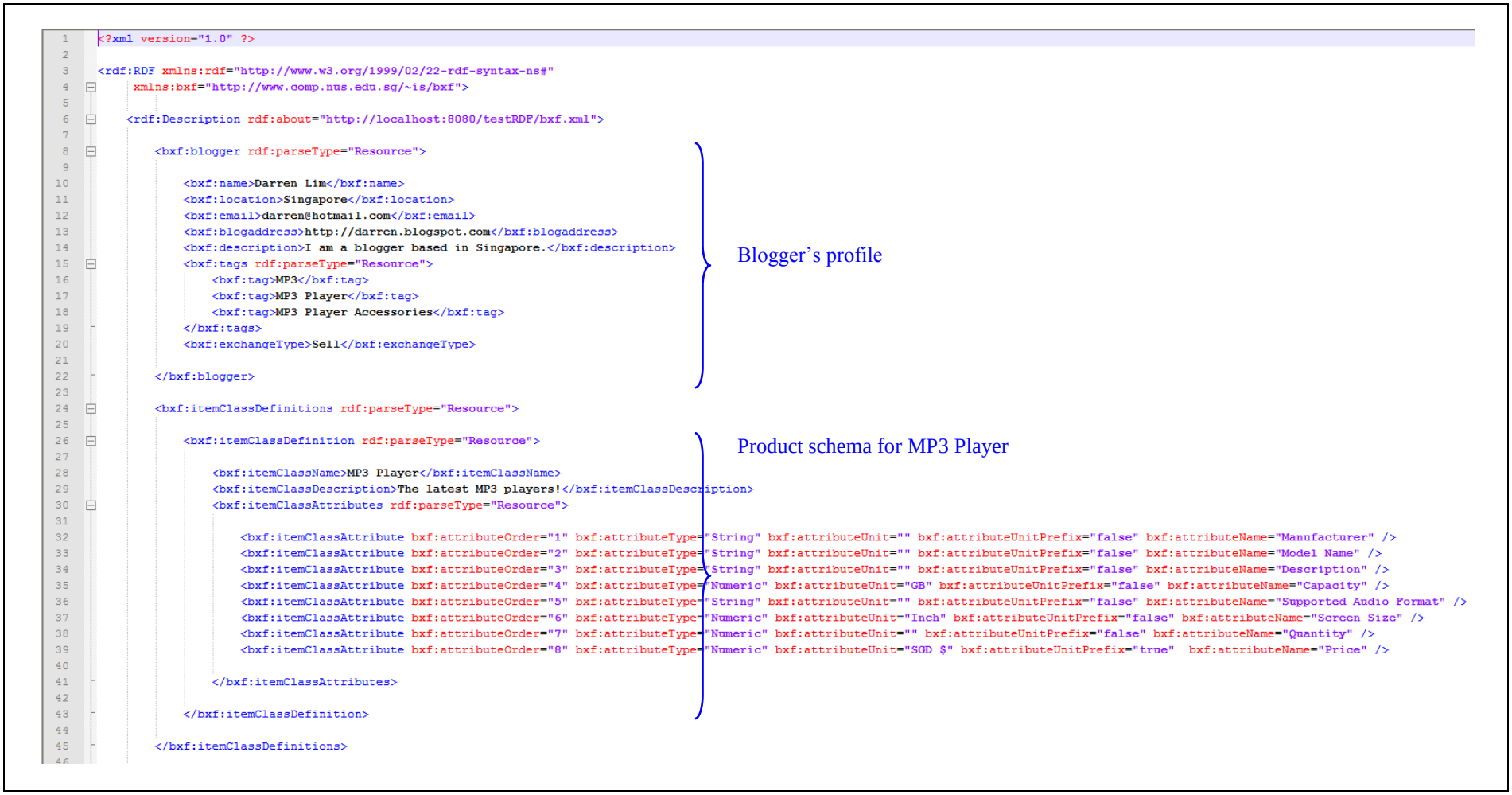


Figure 2.1 – BXF as used in a typical blog.




```
<?xml version="1.0" ?>

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:bxf="http://www.comp.nus.edu.sg/~is/bxf">

   <rdf:Description rdf:about="http://localhost:8080/testRDF/bxf.xml">

      <bxf:blogger rdf:parseType="Resource">

         <bxf:name>Darren Lim</bxf:name>
         <bxf:location>Singapore</bxf:location>
         <bxf:email>darren@hotmail.com</bxf:email>
         <bxf:blogaddress>http://darren.blogspot.com</bxf:blogaddress>
         <bxf:description>I am a blogger based in Singapore.</bxf:description>
         <bxf:tags rdf:parseType="Resource">
            <bxf:tag>MP3</bxf:tag>
            <bxf:tag>MP3 Player</bxf:tag>
            <bxf:tag>MP3 Player Accessories</bxf:tag>
         </bxf:tags>
         <bxf:exchangeType>Sell</bxf:exchangeType>

      </bxf:blogger>

      <bxf:itemClassDefinitions rdf:parseType="Resource">

         <bxf:itemClassDefinition rdf:parseType="Resource">

            <bxf:itemClassName>MP3 Player</bxf:itemClassName>
            <bxf:itemClassDescription>The latest MP3 players!</bxf:itemClassDescription>
            <bxf:itemClassAttributes rdf:parseType="Resource">

               <bxf:itemClassAttribute bxf:attributeOrder="1" bxf:attributeType="String" bxf:attributeUnit="" bxf:attributeUnitPrefix="false" bxf:attributeName="Manufacturer" />
               <bxf:itemClassAttribute bxf:attributeOrder="2" bxf:attributeType="String" bxf:attributeUnit="" bxf:attributeUnitPrefix="false" bxf:attributeName="Model Name" />
               <bxf:itemClassAttribute bxf:attributeOrder="3" bxf:attributeType="String" bxf:attributeUnit="" bxf:attributeUnitPrefix="false" bxf:attributeName="Description" />
               <bxf:itemClassAttribute bxf:attributeOrder="4" bxf:attributeType="Numeric" bxf:attributeUnit="GB" bxf:attributeUnitPrefix="false" bxf:attributeName="Capacity" />
               <bxf:itemClassAttribute bxf:attributeOrder="5" bxf:attributeType="String" bxf:attributeUnit="" bxf:attributeUnitPrefix="false" bxf:attributeName="Supported Audio Format" />
               <bxf:itemClassAttribute bxf:attributeOrder="6" bxf:attributeType="Numeric" bxf:attributeUnit="Inch" bxf:attributeUnitPrefix="false" bxf:attributeName="Screen Size" />
               <bxf:itemClassAttribute bxf:attributeOrder="7" bxf:attributeType="Numeric" bxf:attributeUnit="" bxf:attributeUnitPrefix="false" bxf:attributeName="Quantity" />
               <bxf:itemClassAttribute bxf:attributeOrder="8" bxf:attributeType="Numeric" bxf:attributeUnit="SGD $" bxf:attributeUnitPrefix="true"  bxf:attributeName="Price" />

            </bxf:itemClassAttributes>

         </bxf:itemClassDefinition>

      </bxf:itemClassDefinitions>
```

Listing 2.1 – Sample RDF document for the BXF shown in Figure 2.1.

```
        <bxf:items rdf:parseType="Resource">

            <bxf:item rdf:parseType="Resource">
                <bxf:itemClass>MP3 Player</bxf:itemClass>
                <bxf:itemIdentifier>001</bxf:itemIdentifier>
                <bxf:itemAttributes rdf:parseType="Resource">
                    <bxf:itemAttribute bxf:itemAttributeName="Manufacturer" bxf:itemAttributeValue="Apple" />
                    <bxf:itemAttribute bxf:itemAttributeName="Model Name" bxf:itemAttributeValue="Apple iPod Touch 2010 (8GB)" />
                    <bxf:itemAttribute bxf:itemAttributeName="Description" bxf:itemAttributeValue="The iPod Touch is the best iPod yet, offering all the fun of the iPhone experience without a carrier
                    <bxf:itemAttribute bxf:itemAttributeName="Capacity" bxf:itemAttributeValue="8" />
                    <bxf:itemAttribute bxf:itemAttributeName="Supported Audio Format" bxf:itemAttributeValue="Apple Lossless, WAV, MP3, AIFF, Audible, AAC" />
                    <bxf:itemAttribute bxf:itemAttributeName="Screen Size" bxf:itemAttributeValue="3.5" />
                    <bxf:itemAttribute bxf:itemAttributeName="Quantity" bxf:itemAttributeValue="10" />
                    <bxf:itemAttribute bxf:itemAttributeName="Price" bxf:itemAttributeValue="200" />
                </bxf:itemAttributes>
            </bxf:item>

            <bxf:item rdf:parseType="Resource">
                <bxf:itemClass>MP3 Player</bxf:itemClass>
                <bxf:itemIdentifier>002</bxf:itemIdentifier>
                <bxf:itemAttributes rdf:parseType="Resource">
                    <bxf:itemAttribute bxf:itemAttributeName="Manufacturer" bxf:itemAttributeValue="Creative" />
                    <bxf:itemAttribute bxf:itemAttributeName="Model Name" bxf:itemAttributeValue="Creative Zen (16GB)" />
                    <bxf:itemAttribute bxf:itemAttributeName="Description" bxf:itemAttributeValue="I am hard-pressed to find anything not to like about the Creative Zen." />
                    <bxf:itemAttribute bxf:itemAttributeName="Capacity" bxf:itemAttributeValue="16" />
                    <bxf:itemAttribute bxf:itemAttributeName="Supported Audio Format" bxf:itemAttributeValue="WAV, MP3, ADPCM, WMA, Audible, AAC" />
                    <bxf:itemAttribute bxf:itemAttributeName="Screen Size" bxf:itemAttributeValue="2.5" />
                    <bxf:itemAttribute bxf:itemAttributeName="Quantity" bxf:itemAttributeValue="5" />
                    <bxf:itemAttribute bxf:itemAttributeName="Price" bxf:itemAttributeValue="250" />
                </bxf:itemAttributes>
            </bxf:item>

        </bxf:items>

    </rdf:Description>

</rdf:RDF>
```

A product item of class MP3 Player described based on the above schema.

A product item of class MP3 Player described based on the above schema (Figure 2.1 bottom panel).

Listing 2.2(con't) – Sample RDF document for the BXF shown in Figure 2.1.

A set of primary platform services will allow individual and organizational users to fully create, maintain and share these semantics from the cloud. A user can employ any available platform or add-on services and tools to accomplish these tasks without having to acquire any hardware, software or website. Another complementary set of secondary platform services will provide search and recommendation capabilities for the products offered in the cloud. This will allow any user to search the cloud of product information including support for autonomous recommendation agents, i.e., online shopping agents that can independently perform product brokering and merchant brokering based on a consumer's predefined needs (Maes, Guttman and Moukas 1999). Access to the platform services will be via a set of Open Application Programming Interface (Open API) based on RESTful web services, a type of software architecture for distributed systems using the Hypertext Transfer Protocol and the concept of representational state transfer. Open API in the current context thus refers to a set of web services that enable websites to interact with each other to exchange data and share functionalities such as retrieving product schema and creating product information. A high-level overview of the Cloud Commerce platform is shown in Figure 2.2.

2.2 Theoretical Background

Electronic commerce has evolved in tandem with some of the most well known pioneer websites such as Amazon and eBay (LeClaire 2005). From the humble beginning of the "one-click ordering" concept, electronic commerce has witnessed major developments leading to affordable and easy-to-use solutions enabling global entrepreneurs to capitalize on the Internet to establish highly successful online businesses. In particular, order fulfillment technologies such as integrated shipping and online payment have been the

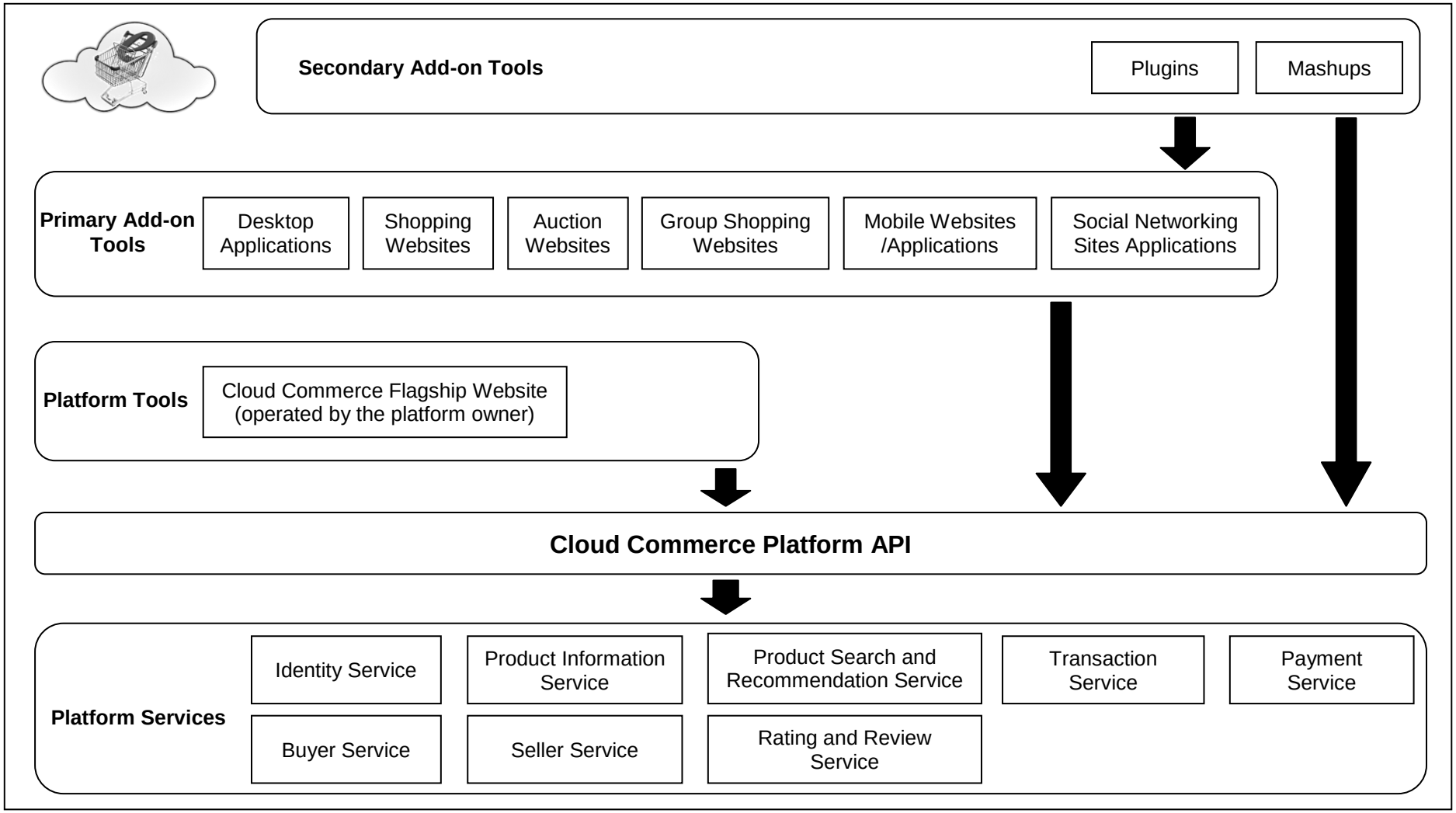


Figure 2.2 – High-level overview of the Cloud Commerce platform.

cornerstone underlying the wide spread adoption of electronic commerce. Practitioners and researchers alike have predicted the rise of next wave of technologies that would greatly enhance product visibility and ease of use, which will ultimately benefit buyers and sellers (LeClaire 2005; Zwass 1996).

Researchers such as Chu, Leung, Hui and Cheung (2007) who have traced the different web-eras of electronic commerce over the past two decades appeared to concur with this macro development trend. The pre-web period prior to 1990 was characterized by closed commerce activities between two parties using technologies such as electronic data interchange (EDI). The reactive web-era of early 1990s saw the adoption of the World Wide Web (WWW) and search engines to provide functionalities such as product listing and cataloging. However, buyers were not able to purchase from the sellers mostly due to the lack of secure information transmission. This problem was resolved by the mid 1990s with the advent of well-established cryptography systems leading to the interactive web-era. This era was characterized by a two-way negotiation of buy-sell transactions. In addition to transaction formation and negotiation, various technologies were invented to support personalized buying and selling. The late 1990s to early 2000 saw the transition towards the integrative web-era distinguished by an emphasis towards integration and interoperability of various electronic business processes such as electronic supply chain management and electronic customer relationship management among different websites. Chu and his colleagues (2007) emphasized that the integrative web-era is only possible if information can be shared among electronic commerce websites. To achieve information sharing, it is necessary to have a standardized way of representing information, e.g., XML, such that it may be readily extracted, used and reused. In particular, XML-based web services hold the promise towards enabling online business processes that facilitate sharing and reuse of information among websites.

However, the current integrative web-era consists of mainly third party websites that help to integrate cross-organizations electronic commerce processes. At this juncture, there is a lack of electronic commerce website or technology that takes an integrative approach towards creating a consumer oriented marketplace that researchers have been calling for (Zwass 1996). Such a marketplace would provide a comprehensive set of information, services and goods to help convert web surfers from browsers into consumers. Cloud Commerce aims to provide sellers and buyers with a ubiquitous multi-media/channels platform that maximizes product visibility and accessibility, providing a perfect fit to the notion of a consumer marketplace.

Electronic commerce may be classified into three meta-levels (Zwass 1996), namely infrastructure, services, and products and structures. Infrastructure refers to the hardware, software, databases and computer networking that collectively provide support for online buying and selling. Services refer to those that enable finding and delivery of product information together with support for price negotiation and transaction fulfillment, e.g., electronic payment systems. Products and structures refer to the direct provision of products and services to individual and organizational customers, e.g., online shopping, Internet banking and stock brokerage. Cloud Commerce focuses on providing the necessary software infrastructure to support multi-media/channels buying and selling of products. It will also incorporate a limited payment service.

The core functionalities of electronic commerce may be broadly classified into three categories: 1) user registering; 2) price negotiation; and 3) transactions fulfillment (Chu et al. 2007). However, a more detailed classification of electronic commerce functionalities consisting of seven categories (Jhingran 2000) will be adopted in designing Cloud Commerce. User management involves two aspects of registering customers to shop on a website and managing employees who operate the website, e.g., maintaining the product

catalog and fulfilling orders made by registered customers. Content management from a seller's perspective involves managing the product catalog. This is a key focus of Cloud Commerce, which not only proposes a standardized way of describing products but also how the product information will be stored in the cloud and reused by the seller across multiple media and channels. From a buyer's perspective, content management may refer to how a consumer browses the product information and aggregates information from multiple sources for comparison. The standardized approach toward product description allows organizations adopting Cloud Commerce to provide recommendation agents that will help consumers in product brokering and merchant brokering (Xiao and Benbasat 2007). Merchandising refers to the placement of online advertisements, launching of up-sell or cross-sell promotions, and making product recommendations to consumers. Negotiations in its most basic form involves a fixed price selling model although negotiated deals typified by auctions, reverse auctions, contract-based pricing and group buying are increasingly popular. Cloud Commerce provides an avenue for sellers to implement multiple forms of negotiation and to place the transactions in the cloud. Coupled with the cloud-based content management, an online seller will be able to achieve true location transparent multi-media/channels electronic commerce capability. Order fulfillment involves the handling of sales taxes, shipping instructions and delivery instructions. Cloud Commerce allows an online seller to define order fulfillment templates that may be reused across multiple sales media or channels. Payment processing typically refers to B2C payment options such as credit card. Online payment intermediaries such as PayPal and Amazon Payments already exist and Cloud Commerce objective is not to reinvent the wheel. Rather, Cloud Commerce will provide a supporting payment service that will allow a seller to accept payment from buyers across multiple sale media and channels using one of these intermediaries. Service and support is

concerned with the provision of after sales services such as defect repairing and warranty claims.

In the following sub-sections, I will elaborate on the potential problems faced by a cloud-based electronic commerce platform such as Cloud Commerce with regard to each of the electronic commerce functionalities together with the proposed solutions.

2.3 User Management

A user can concurrently take on the role of buyer, seller and even developer using the Cloud Commerce API to create add-on services and tools. The role of administrator, however, is kept distinct since an administrator is tasked with the daily operation and maintenance of Cloud Commerce and does not participate in any user activity, at least not in the role/identity of an administrator. The identity service in Cloud Commerce for user management will be modeled after current implementations of open identity information management services on the Internet such as Facebook Connect (http://www.facebook.com) and OpenID (http://openid.net). Facebook Connect allows Facebook members to login to third party websites or applications using their Facebook account. Upon successful login, members will be able to interact with their Facebook friends and post information on Facebook while using third party providers' services. OpenID allows an individual to use an existing account with a service provider such as Google to login to the websites of other service providers, e.g., Yahoo, without the hassle of having to create new usernames and passwords (see Figure 2.3). It is essentially a distributed identity management approach that potentially provides user with a safer and easier method to surf the Internet.

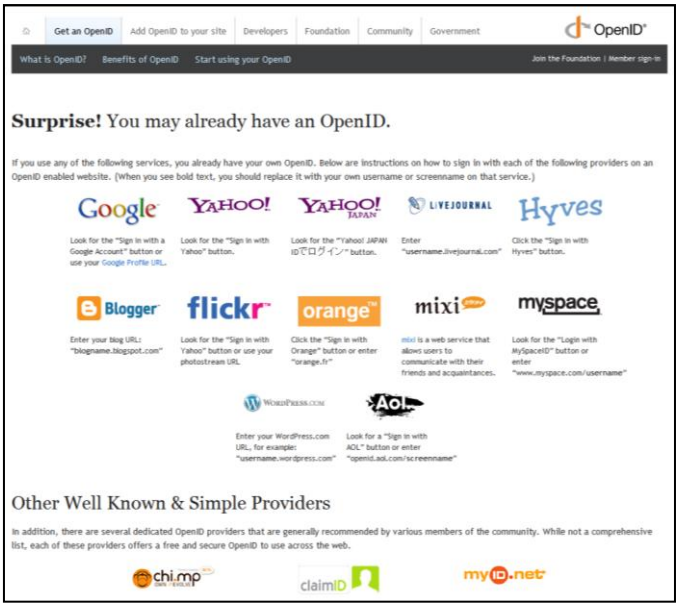


Figure 2.3 – Major websites on the Internet that support OpenID (Source: http://openid.net).

Cloud Commerce's identity service will adopt the Facebook Connect's approach although support for OpenID may be considered in the future. Essentially, a single Cloud Commerce account will allow a user to buy and sell through login to any websites or applications powered by Cloud Commerce. A user will also be able to login to the Cloud Commerce's flagship website to utilize resources such as documentation, support forum and to participate in the community-based collaborative maintenance of the product schemas. The Cloud Commerce account will allow user to specify a unique 32 characters alphanumeric username, including underscores and at most one period.

The identity service will also provide functionalities to authenticate third party websites or applications accessing the Cloud Commerce API. Each Cloud Commerce account will have a unique identifier that will serve as the API key or token for the developer. This identifier will be a type 4 pseudo randomly generated universally unique identifier (UUID). Finally, the seller service and buyer service allow each user to maintain additional profile information that will aid in the selling and buying process.

2.4 Content Management

Providing consumers with online tools to search and filter product information has long been highlighted as a critical success factor for electronic commerce (Adam et al. 1996). Unfortunately, this is a non-trivial task because online vendors use vastly different product descriptions, albeit rich in information, and nonstandard formats to present these descriptions. Consequently, designing and implementing useful online tools to help consumers find products and services that meet certain attributes or for merchants to locate potential buyers of a particular trait has proven to be an elusive challenge (Adam et al. 1996).

Researchers acknowledging product information heterogeneity as a major impediment factor to business information exchange have proposed two general approaches to resolve this problem (Ng, Yan and Lim 2000). The first approach is standardization, which involves creating common vocabulary and protocol to be adopted by all parties involved in a business exchange. The United Nations Standard Product and Services Codes (UNSPSC) (http://www.unspsc.org) provide a global standard to classify products and services in a hierarchical fashion. For instance, MP3 players or recorders is a commodity classified under the more general class of audio and visual equipment, which itself is part of the consumer electronics family within the domestic appliances and supplies and consumer electronic products segment. UNSPSC however does not define the attributes for describing each commodity. eCl@ss (http://www.eclass.de) is a competing standard originating in Germany for product classification and description. Similar to UNSPSC, eCl@ss aims to facilitate information exchange between customers and their suppliers. eCl@ss is superior to UNSPSC because it attempts to provide a set of attributes to describe each product class. However, when compared to commercial shopping websites such as CNET Shopper.com (http://shopper.cnet.com), the predefined set of attributes is

often less rich in details. See Figure 2.4 for sample UNSPSC and eCl@ss entries of MP3 player and Figure 2.5 for a MP3 player product listing on CNET Shopper.com.

52000000	Domestic Appliances and Supplies and Consumer Electronic Products	52160000	Consumer electronics	52161500	Audio and visual equipment	5

52161543	MP3 players or recorders	MP3 Players/Recorders are mainstream portable audio equipment that records digital music for playback.

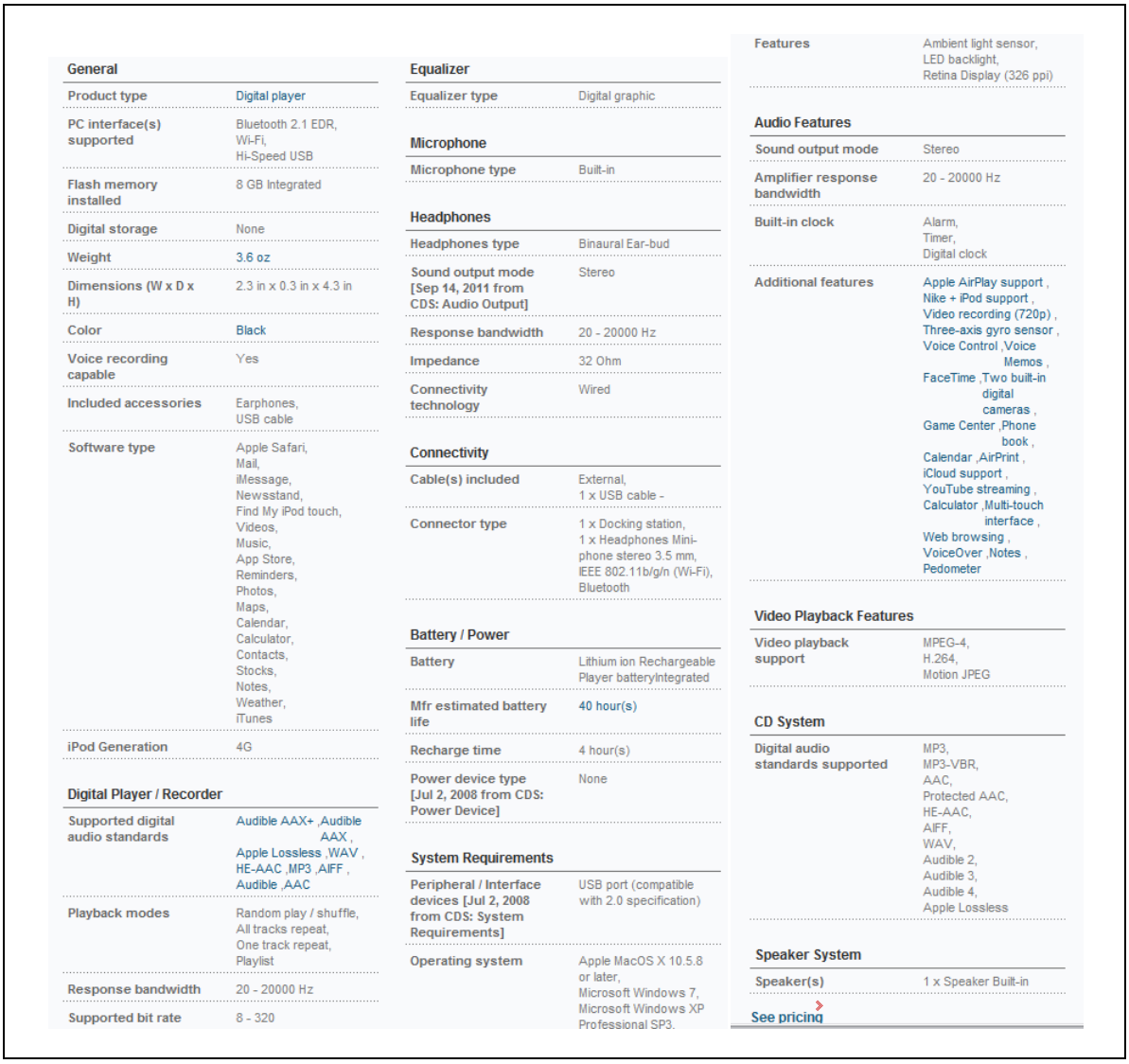
UNSPSC entry for MP3 player.

Classification:	19-08-10-09 MP3 player, MP3 recorder [ACL512005]
Preferred name:	MP3 player, MP3 recorder
Definition:	-
Keywords:	MP3 player MP3 recorder Multimedia player MP3-Spieler
Properties:	

AAD931002 - customs tariff number (TARIC)
AAF507001 - REACH registration present
AAF508001 - SVHC included
AAF927001 - USB connection present
AAI532001 - fast memory capacity/ROM
AAK412001 - storage medium
AAL409001 - card reader present
AAL515001 - color display present
AAM028001 - radio receiver present
AAO187001 - Description of SVHC substance
AAO188001 - Weight of the contained material
AAO189001 - On-line reference info REACH
AAO190001 - On-line reference security data sheet
AAO191001 - RoHS attention of conformity
AAO192001 - description of battery
AAO193001 - Categorie
AAO221001 - Product check date according to RoHS
AAO222001 - Product check date according to SVHS
AAO223001 - Type of Battery
AAO663001 - GTIN
AAO676001 - Manufacturer product number
AAO677001 - Manufacturer name
AAO735001 - Supplier name
AAO736001 - Supplier product number
AAO847001 - Product type description
AAP805001 - Product name
AAQ326001 - additional link address
BAD875004 - Net weight

eCl@ss entry for MP3 player.

Figure 2.4 – Sample UNSPSC and eCl@ss entries for MP3 player.



General	
Product type	Digital player
PC interface(s) supported	Bluetooth 2.1 EDR, Wi-Fi, Hi-Speed USB
Flash memory installed	8 GB Integrated
Digital storage	None
Weight	3.6 oz
Dimensions (W x D x H)	2.3 in x 0.3 in x 4.3 in
Color	Black
Voice recording capable	Yes
Included accessories	Earphones, USB cable
Software type	Apple Safari, Mail, iMessage, Newsstand, Find My iPod touch, Videos, Music, App Store, Reminders, Photos, Maps, Calendar, Calculator, Contacts, Stocks, Notes, Weather, iTunes
iPod Generation	4G

Digital Player / Recorder	
Supported digital audio standards	Audible AAX+ ,Audible AAX , Apple Lossless ,WAV , HE-AAC ,MP3 ,AIFF , Audible ,AAC
Playback modes	Random play / shuffle, All tracks repeat, One track repeat, Playlist
Response bandwidth	20 - 20000 Hz
Supported bit rate	8 - 320

Equalizer	
Equalizer type	Digital graphic

Microphone	
Microphone type	Built-in

Headphones	
Headphones type	Binaural Ear-bud
Sound output mode [Sep 14, 2011 from CDS: Audio Output]	Stereo
Response bandwidth	20 - 20000 Hz
Impedance	32 Ohm
Connectivity technology	Wired

Connectivity	
Cable(s) included	External, 1 x USB cable -
Connector type	1 x Docking station, 1 x Headphones Mini-phone stereo 3.5 mm, IEEE 802.11b/g/n (Wi-Fi), Bluetooth

Battery / Power	
Battery	Lithium ion Rechargeable Player batteryIntegrated
Mfr estimated battery life	40 hour(s)
Recharge time	4 hour(s)
Power device type [Jul 2, 2008 from CDS: Power Device]	None

System Requirements	
Peripheral / Interface devices [Jul 2, 2008 from CDS: System Requirements]	USB port (compatible with 2.0 specification)
Operating system	Apple MacOS X 10.5.8 or later, Microsoft Windows 7, Microsoft Windows XP Professional SP3.

Features	Ambient light sensor, LED backlight, Retina Display (326 ppi)

Audio Features	
Sound output mode	Stereo
Amplifier response bandwidth	20 - 20000 Hz
Built-in clock	Alarm, Timer, Digital clock
Additional features	Apple AirPlay support , Nike + iPod support , Video recording (720p) , Three-axis gyro sensor , Voice Control ,Voice Memos , FaceTime ,Two built-in digital cameras , Game Center ,Phone book , Calendar ,AirPrint , iCloud support , YouTube streaming , Calculator ,Multi-touch interface , Web browsing , VoiceOver ,Notes , Pedometer

Video Playback Features	
Video playback support	MPEG-4, H.264, Motion JPEG

CD System	
Digital audio standards supported	MP3, MP3-VBR, AAC, Protected AAC, HE-AAC, AIFF, WAV, Audible 2, Audible 3, Audible 4, Apple Lossless

Speaker System	
Speaker(s)	1 x Speaker Built-in

See pricing

Figure 2.5 – Sample product listing for a MP3 player on CNET Shopper.com website.

The second approach is integration (Ng et al. 2000), which involves building mappings among product attributes from different product descriptions. In the context of integration, heterogeneity among different product schemas can be classified as either attribute naming conflicts or missing attributes. For instance, product schema A may describe MP3 player with three attributes of manufacturer name, storage capacity and battery whereas product schema B may describe MP3 player with only two attributes of company name and disk space where manufacturer name and company name are synonyms, and storage capacity and disk space are synonyms. Additionally, product schema B has a missing attribute to describe the type of battery used by the MP3 player. These problems are

further complicated if the product schemas are multi-level trees (Ng et al. 2000). For instance, MP3 player may have a higher level attribute known as memory storage, which is sub-divided into storage type and storage capacity.

Cloud Commerce's content management attempts to resolve the product information heterogeneity problem by adopting a standardized approach. Specifically, Cloud Commerce will provide a XML-based service, i.e., product information service, for its community of users to define and maintain product schema in an open and collaborative fashion similar to how articles on the Internet's largest free encyclopedia Wikipedia (http://www.wikipedia.org) is created and maintained. That is, to build upon the collective wisdom of Cloud Commerce's community of buyers, sellers and developers to create and maintain a useful product schema library just like how Wikipedia's volunteers have come together to maintain the hundreds of thousands of quality articles (Liu and Ram 2011). Cloud Commerce's flagship websites and applications as well as all third party websites and applications will utilize this set of standardized XML-based product schemas to exchange product information. The added benefit of an open and collaborative approach is to allow users of the Cloud Commerce community to create a rich set of attributes for each product category of interest to them, and presumably one in which they possess the relevant expertise. Ultimately, Cloud Commerce will be powered by a product schemas library that is as comprehensive as global standards such as UNSPSC and eCl@ss, and as rich in details as private product schemas such as those used by CNET Shopper.com.

Cloud Commerce's product information service will use a single-level tree product schema model. To illustrate with the earlier MP3 player example, there will be one level of two distinct attributes, one each for memory storage type and another one for memory storage capacity instead of a first level memory storage attribute followed by two second

level attributes of storage type and storage capacity. Design provisions will be made to enable integration with users' existing product schemas or descriptions by making all attribute optional and allowing the definition of aliases for each attribute. For instance, in my earlier example where product schema A has three attributes of manufacturer name, storage capacity and battery; another seller using product schema B can choose to omit battery when describing his/her product item with Cloud Commerce and to use aliases for manufacturer name and storage capacity.

After the schema for a specific product category is defined, a seller will be able to use it to describe a particular item that he/she wants to sell. The same seller can publish the same piece of product item information on different electronic commerce websites or applications that use Cloud Commerce's product information service without having to reenter the information every time. Another seller who intends to sell the same item does not need to reinvent the wheel by describing the item's attributes from scratch. Rather, the new seller can conveniently reuse the information published by the first seller. Of course, different sellers can collaborate to maintain the same piece of product item information. For instance, a third seller might add in information for a new attribute that the first seller has initially omitted. This approach greatly simplifies the content management tasks that need to be performed by a seller. The product schema and item information also benefit buyers to the extent that they will have access to a set of rich and comprehensive information to make an informed purchase. Potential buyers may also use these information to specific his/her preferences to perform advanced search (see the next section on merchandising).

In gist, Cloud Commerce's product information service will create an open product schema and information repository. Just as how Wikipedia, a free and collaborative online encyclopedia, is maintained by voluntary writers and editors using an open editing

model (Wikipedia 2012); this repository will be maintained by the community of Cloud Commerce users using an open model. Any registered user may create a new product category and its associated schema, or edit existing schemas. Users who have deep domain knowledge of certain product categories may volunteer to become Cloud Commerce's "editors". These "editors" will help to ensure the correctness and integrity of the repository data and to resolve conflicts.

The product information from the open product schema and information repository can then be used by a seller to create inventory items for sales across the platform. For example, if a user wants to sell Apple iPod Touch MP3 players, he will be able to create an inventory item record with its own stock keeping unit code using the product description already defined in the repository. Essentially, each user has a centralized warehouse in the cloud for managing all the inventory items that he/she has available for sales. Without this centralized warehouse, a user will need to manually monitor his/her inventory items on different websites, channels and media. This approach greatly reduces the cost and effort involved in selling across multiple websites, channels and media. Management of a seller's inventory items is performed by the seller service.

The centralized warehouse concept also maximizes the selling opportunity window and concurrently minimizes the probability of over selling. For instance, suppose a seller has 10 Apple iPod MP3 players that he wants to sell on two websites, Website A and Website B. In a decentralized warehouse approach, the seller would probably place 5 MP3 players for sales on each of Website A and Website B. On the one hand, if there are many customers who want to buy more than 5 pieces of MP3 players on Website A but less so on Website B, this will not be possible and the seller has to incur the lost sales opportunities. On the other hand, if the seller attempts to minimize the probability of forgoing a potential sales opportunity, he could place 6 MP3 players for sales on each of

Website A and Website B. However, if there are many customers on Website A and Website B who want to buy all 6 MP3 players "available" on each of the two websites, the seller will end up in an oversold position. The seller will not be able to fulfill orders for the oversold MP3 players and risk incurring a bad reputation. Both scenarios could be avoided using a centralized warehouse approach as depicted in Figure 2.6.

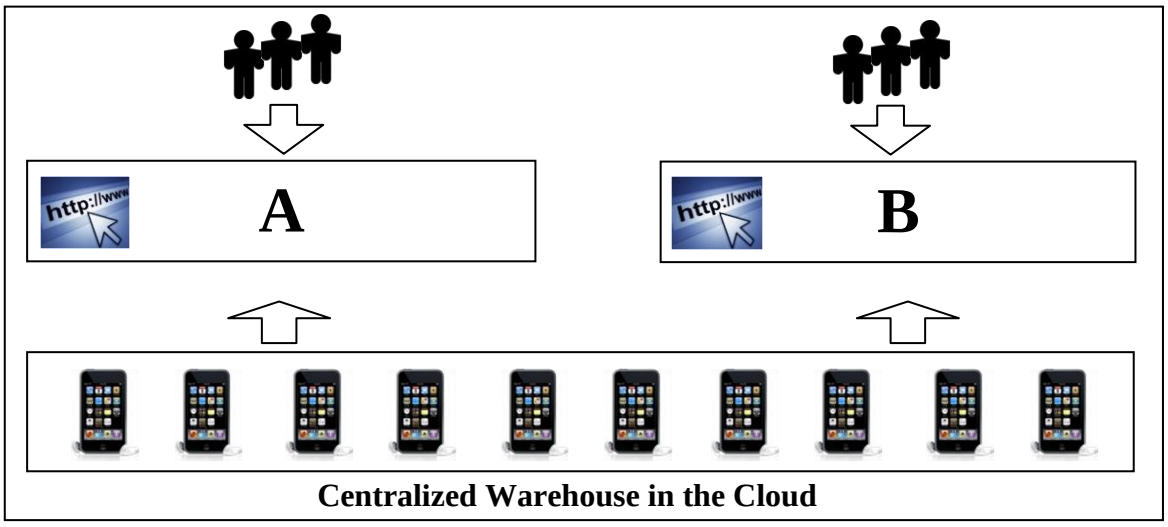


Figure 2.6 – Centralize warehouse approach for managing inventory items as provided by Cloud Commerce seller service.

2.5 Merchandising

Cloud Commerce will allow sellers to embed product information into any third party websites thus negating the need for online advertisement placement. To facilitate up-selling and cross-selling, sellers will be able to specify related product categories for a particular target category in the product schema as well as indicate related product items for a particular target item. For instance, a seller could specify MP3 player accessories such as earphone, headphone and carrying case as the related product categories. Furthermore, for a particular MP3 player such as Apple iPod Touch, a seller may indicate an Apple In-Ear Headphone as the cross-sale product. These merchandising features are commonly found in extant shopping websites and will certainly be supported in Cloud Commerce.

Of greater interest is the provision of recommendations to consumers. A product brokering recommendation agent is a piece of online software that 1) assists a consumer in eliciting interests or preferences for products and services, either explicitly or implicitly; and 2) makes recommendations of which product items are suitable for the consumer (Guttman, Moukas and Maes 1998; Xiao and Benbasat 2007). Recommendation agent is also capable of performing merchant brokering by recommending to the consumer which online merchant to buy a specific product item from based on criteria such as price, shipping and merchant's reputation (Guttman et al. 1998; Pedersen 2000). Autonomous recommendation agents can typically perform product brokering and merchant brokering independently based on a consumer's predefined preferences (Maes et al. 1999). In other words, an autonomous recommendation agent is potentially more useful since it can 1) look out for new product items as and when they are added by a merchant; 2) perform the actual purchase transaction on behalf of the user.

In order for recommendation agent to function effectively, researchers have emphasized the importance of having ontology standards to describe product information so that different agents can search across different websites to make the best recommendations to consumers (Nwana, Rosenschein, Sandholm, Sierra, Maes and Guttmann 1998). For autonomous agents, this problem is even more acute as they are expected to independently complete the purchase transaction instead of merely making recommendation. Thus, autonomous agents will require standards that unambiguously and universally define goods and services, consumer and merchant profiles, value-added services, secure payment mechanisms and even inter-business electronic forms (Maes et al. 1999).

The standard to describe goods and services is already encompassed in Cloud Commerce's product information service. However, in order to facilitate effective recommendation, especially using the content filtering technique that offers recommendations based on consumers' preferences for product attributes (Ansari, Essegaier, and Kohli 2000), it is insufficient to simply describe an item's product attribute values. Rather, it must be possible to define whether the product attributes are comparable. Thus, Cloud Commerce's product information service will also allow the community to define the data type of an attribute and level of measurement. For string and numeric attributes that are nominal in nature, Cloud Commerce will allow users to provide free text values or predefined values such that a recommendation agent can perform text searching. For attributes that are ordinal in nature, Cloud Commerce will allow users to specify a list of predefined values together with the intrinsic ranking or ordering. For scale attributes, users will be able to define the measurement units and the conversion scaling factors. For instance, if a product category has an attribute storage capacity that is measured with the unit byte, the measurement units of byte, kilobyte, megabyte and gigabyte may be defined with the respective scaling factor of 1024 for converting each smaller unit to the next immediate bigger unit.

In summary, Cloud Commerce will provide a product search and recommendation service for buyers to obtain product and merchant recommendations based on their preferences and the product information provided by the sellers via the product information service. A noteworthy feature is that a buyer may specify a product recommendation request and place it in the cloud such that new recommendations or results will be returned to the buyer as and when new items are put up for sales by sellers regardless of the medium or channel. Moreover, buyer may optionally let Cloud Commerce completes the purchase transaction. More details will be discussed in the next sub-section on negotiation.

2.6 Negotiation

Negotiation typically involves determining the terms of a transaction such as price and shipping/handling fees (Maes et al. 1999). Use of a fixed price model typically negates the need for negotiation. But even in fixed price sale, it is necessary to describe the transaction details. Existing electronic commerce ontology such as GoodRelations (http://purl.org/goodrelations) provides a mechanism to describe the transaction and other commercial aspects (Figure 2.7). GoodRelations may be used in conjunction with eClassOWL (http://www.heppnetz.de/projects/eclassowl), which allows product type and features to be described. eClassOWL itself is based on eCl@ss. My prior implementation of BXF also allows a seller to indicate the price of the product (see Listing 2.2).

```
<div xmlns="http://www.w3.org/1999/xhtml"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:gr="http://purl.org/goodrelations/v1#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/"
  xmlns:pto="http://www.productontology.org/id/">

  <div typeof="gr:Offering" about="#offering">
    <div rev="gr:offers" resource="Super Electronic Store#company"></div>
    <div property="gr:name" content="Apple iPod Touch" xml:lang="en"></div>
    <div property="gr:description" content="Apple iPod Touch" xml:lang="en"></div>
    <div property="gr:hasEAN_UCC-13" content="123" datatype="xsd:string"></div>
    <div property="gr:validFrom" content="2012-01-23T00:00:00Z" datatype="xsd:dateTime"></div>
    <div property="gr:validThrough" content="2012-01-31T00:00:00Z" datatype="xsd:dateTime"></div>
    <div rel="foaf:depiction" resource="http://www.super.com.sg/123.png"></div>
    <div rel="gr:hasPriceSpecification">
      <div typeof="gr:UnitPriceSpecification">
        <div property="gr:hasCurrency" content="USD" datatype="xsd:string"></div>
        <div property="gr:hasCurrencyValue" content="100.00" datatype="xsd:float"></div>
        <div property="gr:hasUnitOfMeasurement" content="C62" datatype="xsd:string"></div>
      </div>
    </div>
    <div rel="gr:hasBusinessFunction" resource="http://purl.org/goodrelations/v1#Sell"></div>
    <div rel="gr:acceptedPaymentMethods" resource="http://purl.org/goodrelations/v1#PayPal"></div>
    <div rel="gr:availableDeliveryMethods" resource="http://purl.org/goodrelations/v1#UPS"></div>
    <div rel="foaf:page" resource="http://www.super.com.sg/viewProduct.php?id=123"></div>
    <div rel="gr:includes">
      <div typeof="gr:SomeItems pto:MP3_player" about="#product">
        <div property="gr:name" content="Apple iPod Touch" xml:lang="en"></div>
        <div property="gr:description" content="Apple iPod Touch" xml:lang="en"></div>
        <div property="gr:hasEAN_UCC-13" content="123" datatype="xsd:string"></div>
        <div rel="foaf:depiction" resource="http://www.super.com.sg/123.png"></div>
        <div rel="foaf:page" resource="http://www.super.com.sg/viewProduct.php?id=123"></div>
      </div>
    </div>
  </div>
</div>
```

Figure 2.7 – Sample GoodsRelation product listing generated using the GoodsRelation Snippet Generator (http://www.ebusiness-unibw.org/tools/grsnippetgen).

Cloud Commerce's will provide a transaction service for negotiation. This service offers two unique propositions. First, it allows sellers to describe a fix price sale offer or transaction as per existing ontology such as GoodsRelation. But Cloud Commerce goes beyond existing ontology by allowing a seller to describe the desired negotiation

mechanisms such as typical price bargain, auction, and group buying offer. Second, it allows a buyer to describe a reverse auction offer. Similar to the joint usage of GoodsRelation and eClassOWL, the use of Cloud Commerce's transaction service in conjunction with the product information service will provide a complete electronic commerce ontology or standard that can be utilized by the product search and recommendation service.

2.7 Order Fulfillment

Although existing ontology such as GoodsRelation allows the seller to describe order fulfillment information such as a link to the product details web page, payment method and delivery method, there is neither any existing standard protocol nor implementation mechanism that facilitates order fulfillment in a distributed cloud-based environment. Cloud Commerce aims to bridge this gap with the transaction service by utilizing the negotiation or offer information described and stored in its cloud to facilitate actual transactions. This is, of course, done in conjunction with the product information service.

A possible scenario is depicted in Figure 2.8. This scenario also serves to illustrate how Cloud Commerce's product information service and transaction service come together to allow buyers and sellers to interact freely. In this scenario, Seller E describes an auction for 10 units of the Apple iPod Touch MP3 player. This auction is then stored into the cloud whereby Cloud Commerce's auction engine will "count down" the auction and process incoming bids. Several noteworthy points are highlighted here. First, any potential buyers may view the auction listing through any third party websites or applications developed with the Cloud Commerce API from wherever they are located, i.e., true location transparency. Second, a potential buyer can place a bid for the auction, again through any third party websites or applications. This is a marked improvement

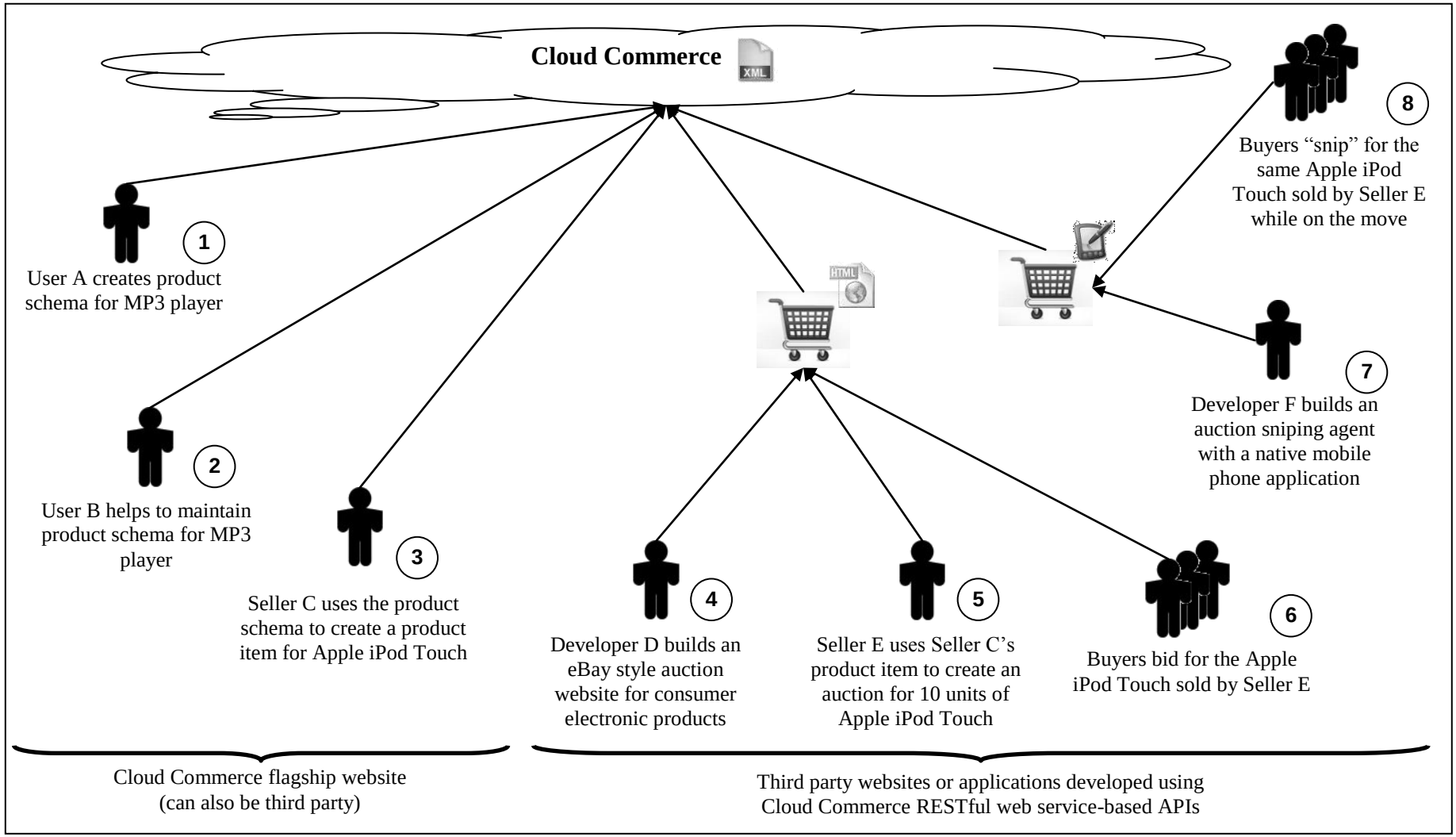


Figure 2.8 – Scenario illustrating how Cloud Commerce's product information service and transaction service works together to allow seller to create an offer in the cloud and for buyers to buy directly through the cloud.

from existing standards such as GoodsRelation, which simply provides a link to the auction listing page.

Although established auction websites such as eBay (https://www.x.com/developers/ebay) do provide its own API, they are restricted to eBay and not of an open nature that is advocated by Cloud Commerce. Other existing services such as Tackthis (http://tackthis.com) adopt an open approach but suffer from three major pitfalls. First, Tackthis does not allow a seller to describe the product with category specific attributes information. A seller is only able to provide a free text product description (see Figure 2.9). Second, Tackthis only supports fixed price selling. Third, Tackthis is essentially still a closed service supporting only a fixed number of media/channels whereas Cloud Commerce is a full-fledged open platform with an open product schema library and a set of API for unlimited expansion capability.

Figure 2.9 – Sample screenshot of Tackthis's content management feature.

2.8 Payment Processing

Integrating online payment into the buying process has always been an important consideration since the advent of electronic commerce (Zwass 1996). Most major electronic commerce websites on the Internet such as eBay and Amazon provide an integrated online payment solution to support their commerce activities, i.e., PayPal (http://www.paypal.com) and Amazon Payments (http://payments.amazon.com) respectively. Although Cloud Commerce is not intended to be an independent online payment service provider, it will provide a seamless payment service via a third party to buyers and sellers. This will ensure that the entire electronic commerce transaction can be performed in the cloud.

Cloud Commerce's payment service also relieves third party shopping websites/applications developers of the hassle of having to integrate their systems with third party payment service providers. This is often a non-trivial task. For instance, both PayPal and Amazon Payments rely on a technique known as instant payment notification (IPN) to inform the seller's website the completion status of the payment, typically a credit card transaction. With Cloud Commerce's payment service, a seller or developer needs only to specify their PayPal account email and delegate the IPN processing to Cloud Commerce, for example.

2.9 Service and Support

While service and support is concerned with the provision of after sale services such as defect repairing and warranty claims (Jhingran 2000), it may also be used by buyers to perform post-purchase product evaluation (Guttman et al. 1998). Just as recommendation consists of product brokering and merchant brokering, a buyer will be able to rate both the product that is purchased and the merchant whom he/she has bought the product from.

Such ratings and their associated review comments, known as electronic word-of-mouth, are made available to other potential buyers and can exert a significant impact on the success or failure of the product (Hennig-Thurau and Walsh 2003-4).

Most large scale shopping websites such as Amazon.com provides a comprehensive rating and review system for buyers to leave their electronic word-of-mouth. However, potential buyers can only view reviews for a particular product that are posted on the same shopping website but not on other external sources. Moreover, in the case of a comparison shopping website, buyers are usually only able to rate merchants affiliated with the website but not others. For instance, for the same product of Apple iPod Touch (8 GB Black) MP3 player, users of Amazon.com and users of CNET Shopper.com will see different sets of reviews, i.e., four and a half star from 3009 reviews versus three and a half star from 67 reviews respectively (Figure 2.10). Cloud Commerce's product search and recommendation service together with the rating and review service will allow users to rate products (that they had bought) and merchants (whom they had bought from) across any websites/channels/media and use this global rating database in its autonomous recommendation agent.

Figure 2.10 – Sample product reviews of Apple iPod Touch (8 GB Black) MP3 player on Amazon.com and CNET Shopper.com.

2.10 Summary

The design characteristics of Cloud Commerce are summarized in Table 2.1. Cloud Commerce will provide five platform services altogether. They will be made available to developers via a set of RESTful web service-based API. They will collectively implement the full stack of electronic commerce functionalities (Chu et al. 2007; Jhingran 2000). Cloud Commerce offers superior design characteristics compared to the current generation of electronic commerce websites/services/platforms. Its community of users will potentially enjoy true location transparent multi media/channels selling and buying of products and services. In gist, Cloud Commerce will meet researchers' call for a standard that unambiguously and universally define goods and services, consumer and merchant profiles, value-added services and secure payment mechanisms (Maes et al. 1999).

Electronic Commerce Functionality	**Cloud Commerce**		**Existing Electronic Commerce Website Design Characteristics**
	Service	**Design Characteristics**	
User Management	Identity Service Seller Service Buyer Service	• Single account and secured single sign-on. • Open identity management.	• Similar to Cloud Commerce
Content Management	Product Information Service Seller Service	• Standardized product schema. • Open and collaborative management. • Facilitates integration with existing product schema. • Supports rich attributes. • Supports nominal, ordinal and scale attributes with measurement units definition.	• Standardized product schema. • Close management.
Merchandising	Product Search and Recommendation Service	• Cross-sites heterogeneous product and merchant brokering. • Supports autonomous recommendation agents.	• Own-site product brokering. • Cross-sites merchant brokering.
Negotiation	Transaction Service	• Standardized ontology to describe various offers such as fixed price, price bargain, auction, group buying and reverse auction.	• Standardized ontology to describe fixed price offer.

Electronic Commerce Functionality	**Cloud Commerce**		**Existing Electronic Commerce Website Design Characteristics**
	Service	**Design Characteristics**	
Order Fulfillment	Transaction Service	• Standardized ontology to describe order fulfillment information. • Supports actual transactions based on offers described with standardized ontology. • Supports autonomous agents.	• Standardized ontology to describe order fulfillment information.
Payment Processing	Payment Service	• Supports seamless payment in the cloud via third party payment service providers.	• Full fledge online payment service.
Service and Support	Product Search and Recommendation Service Rating and Review Service	• Rate products on any websites/channels/media. • Rate any merchants across any websites/channels/media. • Rating information incorporated into cross-sites heterogeneous and autonomous recommendation agent.	• Rate products on single website. • Rate own and affiliated merchant websites. • Rating information incorporated into localized recommendation agents.

Table 2.1 – Cloud Commerce design characteristics.

CHAPTER 3: DESIGN SCIENCE ARTIFACTS OF CLOUD COMMERCE

The design science research guidelines prescribed by Hevner, March, Park and Ram (HMPR) (Hevner et al. 2004) have often been used by scholars to analyze and evaluate design science research (Arnott and Pervan 2012). In accordance with HMPR's design as an artifact guideline, "design science research must produce a viable artifact in the form of a construct, a model, a method or an instantiation" (Hevner et al. 2004, pp. 83, Table 1). These four types of design science artifacts were first proposed by March and Smith (1995) and their definitions were further clarified by Hevner et al. (2004). Constructs are the concepts that form the research domain's vocabulary. Models are a set or propositions or statements expressing relationships among constructs. Methods are a set of steps used to perform a task. Instantiations are realized information systems built according to the specification of the three preceding artifacts.

In a comprehensive review of 362 design science research papers published in 14 journals, Arnott and Pervan (2012) found that the majority of these research papers have focused on one artifact, i.e., the primary artifact, with slightly less than 10% of the papers reporting an additional secondary artifact. None reported a third significant artifact. The authors attributed this observation to the word count limit of printed journal articles. Another noteworthy finding was the fact that two-third of these papers have focused on instantiations as the design artifacts. The authors viewed this trend positively since instantiations implicitly embodied a construct, a model or a method, and more importantly demonstrated that the design ideas have been implemented in concrete forms rather than exist as mere abstract entities. This research follows the best practices in the

extant design science literature and also attempts to improve them. Specifically, this research will deliver one set of artifacts for each of construct, model, method and instantiation. Each higher-level artifact builds upon the lower level artifacts in an implied linear hierarchical manner (Arnott and Pervan 2012). In particular, the instantiation artifact involves a fully functional prototype of the Cloud Commerce platform together with various shopping applications that consume its RESTful web services-based Open API. Collectively, the instantiation artifact demonstrates the viability of a Cloud Commerce user concurrently selling and buying across multiple websites, channels and media, and also embodies all the lower level artifacts.

3.1 Constructs

Ontology development is an approach commonly used in design science research that focuses on construct artifact (Nazir Ahmad, Badr Abd. Badr, Colomb and Ibrahim 2012). An exemplar research in this area is the work of Wales, Shalin and Bass (2007) on the development of a naming convention and a related ontology for science work and distant robotic rover action in the NASA Mars Exploration Rover mission. The developed ontology was used for sharing and identifying information among mission teams and software tools.

Ontology is a formal representation of knowledge as a set of related concepts within a domain. It is intended to facilitate interoperability among various information processing applications (Colomb 2006). In our context, we attempt to define an ontology for a full-fledge electronic commerce platform that facilitates online selling and buying of products and services across multiple websites, channels and media. The underlying product information is derived from a shared product schemas and information repository built in a collaborative fashion by community members. The ontology is organized along the

seven major dimensions of electronic commerce functionalities (Jhingran 2000). In the ontology that follows, the term "platform" refers to a generic electronic commerce platform exhibiting the characteristics listed in Table 2.1 and designed according to the reference architecture shown in Figure 2.2.

User Management (Figure 3.1)	
Construct	**Description**
User	Represents a user who may assume one or more roles of seller, buyer and developer concurrently.
User Account	Represents the security credential of a User for accessing services provided by the platform or third-party developers.
User Profile	Represents the demographic and social profile of a User.
Seller Profile	Represents an additional set of profile information specific to aid selling.
Buyer Profile	Represents an additional set of profile information specific to aid buying.
Buyer Address	Represents an address of a User that is used when the User buys something. A Buyer Address can be used for delivery address, billing address or both.
Application Key	Represents an application that a User creates with the platform API. An Application Key uniquely identifies the application platform-wide and may be used for access control and resource authorization. An application may be denied access to the platform by disabling its Application Key.
Login Token	Represents a security token that is requested by an application using its Application Key. The Login Token allows a User to login to that application via the platform secured single sign-on.
User Session	Represents a semi-permanent interactive information interchange between a User and the platform API via a specific application. A User Session is created when a User login to an application through the platform secured single sign-on with a valid Login Token. Since a User Session is associated with a particular application, a User may concurrently login to multiple applications.

Table 3.1 – Vocabulary specification for user management.

Content Management and Merchandising (Figure 3.2)	
Construct	**Description**
Product Category	Represents a classification of related product items exhibiting a common set of properties. A Product Category may have zero or one parent Product Category and zero or more child Product Categories. A root Product Category appears at the top-most level of the Product Category tree, i.e., it does not have a parent Product Category. A root Product Category may have zero or more child Product Categories. An ordinary Product Category has a parent Product Category but does not have an associated Product Schema and Product Item. An ordinary Product Category may have zero or more child Product Categories. A leaf Product Category appears at the lowest level of a branch in the Product Category tree, i.e., it has a Parent Category but does not have any child Product Category. A leaf Product Category has an associated Product Schema and may have zero or more Product Items. The platform uses a single-level tree Product Schema model and the name of a Product Category must be unique.
Product Category Instance	Represents an instance of a particular Product Category. When a Product Category is first created, the first instance is created. Whenever significant change is made

	to one or more properties of the Product Category, a new instance is created. For each unchanged property, the new instance will inherit the same value as the previous instance.
Product Category Revision	Represents one change that is made to a Product Category in a particular Product Category Instance. No assumption is made as to whether the change is recorded in a structured or unstructured manner.
Product Schema	Represents the collection of properties describing some aspects of related Product Items that are classified under the associated Product Category. Only a leaf Product Category has exactly one Product Schema.
Product Schema Instance	Represents an instance of a particular Product Schema. When a Product Schema is first created, the first instance is created. Whenever significant change is made to one or more properties of the Product Schema, a new instance is created. For each unchanged property, the new instance will inherit the same value as the previous instance.
Product Schema Revision	Represents one change that is made to a Product Schema in a particular Product Schema Instance. No assumption is made as to whether the change is recorded in a structured or unstructured manner.
Product Attribute	Represents one property describing a particular aspect of related Product Items that are classified under the associated leaf Product Category. A Product Attribute may have one or more predefined Product Attribute Values, i.e., a well specified domain for its range of values. Otherwise, a Product Attribute may take on any valid value as specified by the product attribute type. The product attribute type may be either string for general alphanumeric value or numeric for any types of number. The product scale type may be either nominal if the order of Item Value is not important, ordinal if the order of Item Value is important but the degree of difference is not important, or scale if the order of Item Value and degree of difference are both important. Product value type may be either single value if there can be only one Item Value or multiple values if there can be multiple Item Values for this Product Attribute. A Product Attribute has a Unit Class if the product scale type is scale.
Product Attribute Value	Represents a predefined value in the well specified domain of a particular Product Attribute. A Product Attribute Value must conform to the product attribute type of the associated Product Attribute.
Product Attribute Alias	Represents an alias of a particular Product Attribute that may be used in-lieu of the actual name of the Product Attribute. A Product Attribute may have zero or more Product Attribute Aliases.
Unit Class	Represents a unit of measurement. The symbol for Units in the same Unit Class are either all placed before or after an Item Value of a scale Product Attribute.
Unit Class Instance	Represents an instance of a particular Unit Class. When a Unit Class is first created, the first instance is created. Whenever significant change is made to one or more properties of the Unit Class, a new instance is created. For each unchanged property, the new instance will inherit the same value as the previous instance.
Unit Class Revision	Represents one change that is made to a Unit Class in a particular Unit Class Instance. No assumption is made as to whether the change is recorded in a structured or unstructured manner.
Unit	Represent a multiple of the unit of measurement (as represented by the associated Unit Class). A Unit defines whether the associated Item Values may or may not contain a decimal point. It also defines a symbol as well as a scaling factor for converting to the next immediate smaller Unit.
Product Item	Represents a product item that exhibits the collection of properties specified by the Product Schema of the associated leaf Product Category.

Product Item Instance	Represents an instance of a particular Product Item. When a Product Item is first created, the first instance is created. Whenever significant change is made to one or more properties of the Product Item, a new instance is created. For each unchanged property, the new instance will inherit the same value as the previous instance.
Product Item Revision	Represents one change that is made to a Product Item in a particular Product Item Instance. No assumption is made as to whether the change is recorded in a structured or unstructured manner.
Item Attribute	Represents the property describing a particular aspect that is denoted by the associated Product Attribute.
Item Value	Represent the value of the property that is denoted by the associated Item Attribute. An Item Attribute may have one or more Item Values as specified by the product value type of the associated Product Attribute. It is possible for an Item Attribute to have zero Item Value since all properties are optional.
Product Item Image	Represents an image of the associated Product Item.
Warehouse	Represents the warehouse of the User.
Inventory Item	Represents an inventory item in the User's Warehouse. An Inventory Item is based on a particular Product Item. An Inventory Item has several quantity values defined. Quantity available refers to the number of free items that are available for sales through one or more Listing. Quantity on sale refers to the number of items that are pre-committed for a particular listing, typically auction listing and groupon listing. A fixed price listing does not require pre-commitment of inventory level. Quantity reserved refers to the number of items that have already been sold through listings but have not been physically delivered to the User. Total quantity refers to the number of items that the User has on hand. This is the sum of quantity available, quantity on sale and quantity reserved.
Inventory Record	Represents an inventory record of a particular Inventory Item. An Inventory Record alters one or more quantity values of the Inventory Item.

Table 3.2 – Vocabulary specification for content management and merchandising.

Negotiation (Figure 3.3)	
Construct	**Description**
Listing	Represents a structured description of a particular Inventory Item belonging to a User for sales to other Users. Listing is an abstract super class. A Listing is authorized for sales on zero or more applications, each represented by an Application Key. A Listing is available for sales in one or more geographical regions as specified by one or more Shipping Profiles.
Fixed Price Listing	Represents a kind of Listing in which the associated Inventory Item is sold at a predetermined price that is set by the User, i.e., the seller.
Auction Listing	Represents a kind of Listing in which the associated Inventory Item is sold via a price bidding process with possibly a minimum starting bid price that is set by the User, i.e., the seller. No assumption is made as to the underlying type of auction. It is also possible to have different sub-classes of Auction Listing, one for each type of auction.
Group Buying Listing	Represents a kind of Listing in which the associated Inventory Item is sold as a deal-of-the-day. *Additional kinds of Listing may be defined as necessary.*

Table 3.3 – Vocabulary specification for negotiation.

Order Fulfillment, Payment Processing, and Service and Support (Figure 3.4)	
Construct	**Description**
Shipping Country	Represents a country that a Listing is sold in, i.e., a country where the User, i.e., the seller, will deliver the Inventory Item to.
Shipping Region	Represents a collection of Shipping Countries. Note that the same country can appear in multiple Shipping Regions as distinct Shipping Countries.
Shipping Profile	Represents a structured description of shipping fees and tax for the sales of Inventory Items via Listings. A Shipping Profile is defined for one or more Shipping Regions. This collection of Shipping Regions determines the geographical availability of the associated Listings. The collection of Shipping Regions may not contain duplicated countries even if they exist as distinct Shipping Countries.
Shopping Cart Item	Represents one Listing created by a User, i.e., the seller, which another User, i.e., the buyer, intends to buy on a particular application. The Shopping Cart Item must define the quantity of the Inventory Item associated with the Listing that the buyer intends to buy. The Listing associated with the Shopping Cart Item must be authorized for sales on the application represented by a valid Application Key.
Shopping Cart	Represents a collection or zero or more Shopping Cart Items that a User, i.e., the buyer, intends to buy on a particular application. All the Shopping Cart Items must be from the same seller. A User, i.e., the buyer, may have zero or more Shopping Carts on a particular application but at most one active Shopping Cart for Listings created by a specific seller.
Sales Transaction	Represents a purchase transaction, i.e., a Shopping Cart that has been checkout by a User, i.e., the buyer. No assumption is made as to the underlying checkout mechanism. Different kinds of Listing may be placed onto a Shopping Cart and converted into a Sales Transaction using different mechanism. A Sales Transactions must define the seller status and buyer status for transaction management by the seller and buyer, respectively. The valid values of seller status are pending, payment received, pending shipping, shipped and cancelled. The valid values of buyer status are pending payment, paid, received and cancelled.
Sales Transaction History	Represents a change in seller status or buyer status that is made to a particular Sales Transaction. No assumption is made as to whether the change is recorded in a structured or unstructured manner.
External Payment Request	Represents a structured description of a payment request using a third-party online payment service for a particular Sales Transaction of a specific User, i.e., buyer. This structured payment request allows a User to make online payment for the Sales Transaction from a particular application via the platform payment service. The platform payment service then follows the description to redirect the User to make actual payment on the third-party payment service website. External Payment Request is an abstract super class.
PayPal Payment Request	Represents a kind of External Payment Request using PayPal as the third-party online payment service. *Additional kinds of External Payment Request may be defined as necessary.*
Rating	Represents a rating that denotes a User's, i.e., the seller or buyer, degree of satisfaction with the other User, i.e., the buyer or seller, for a particular Sales Transaction.

Table 3.4 – Vocabulary specification for order fulfillment, payment processing, and service and support.

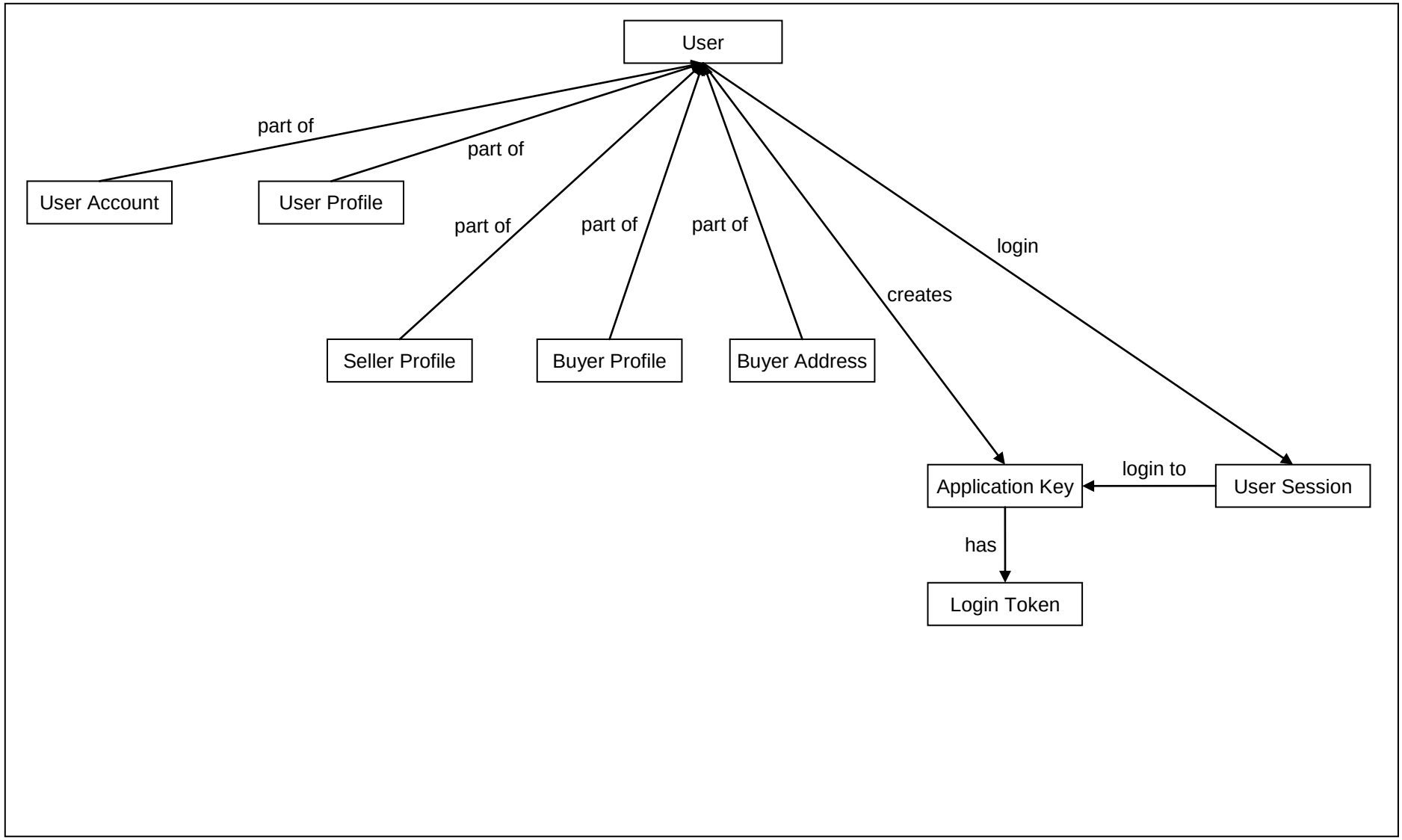


Figure 3.1 – Ontology for user management.

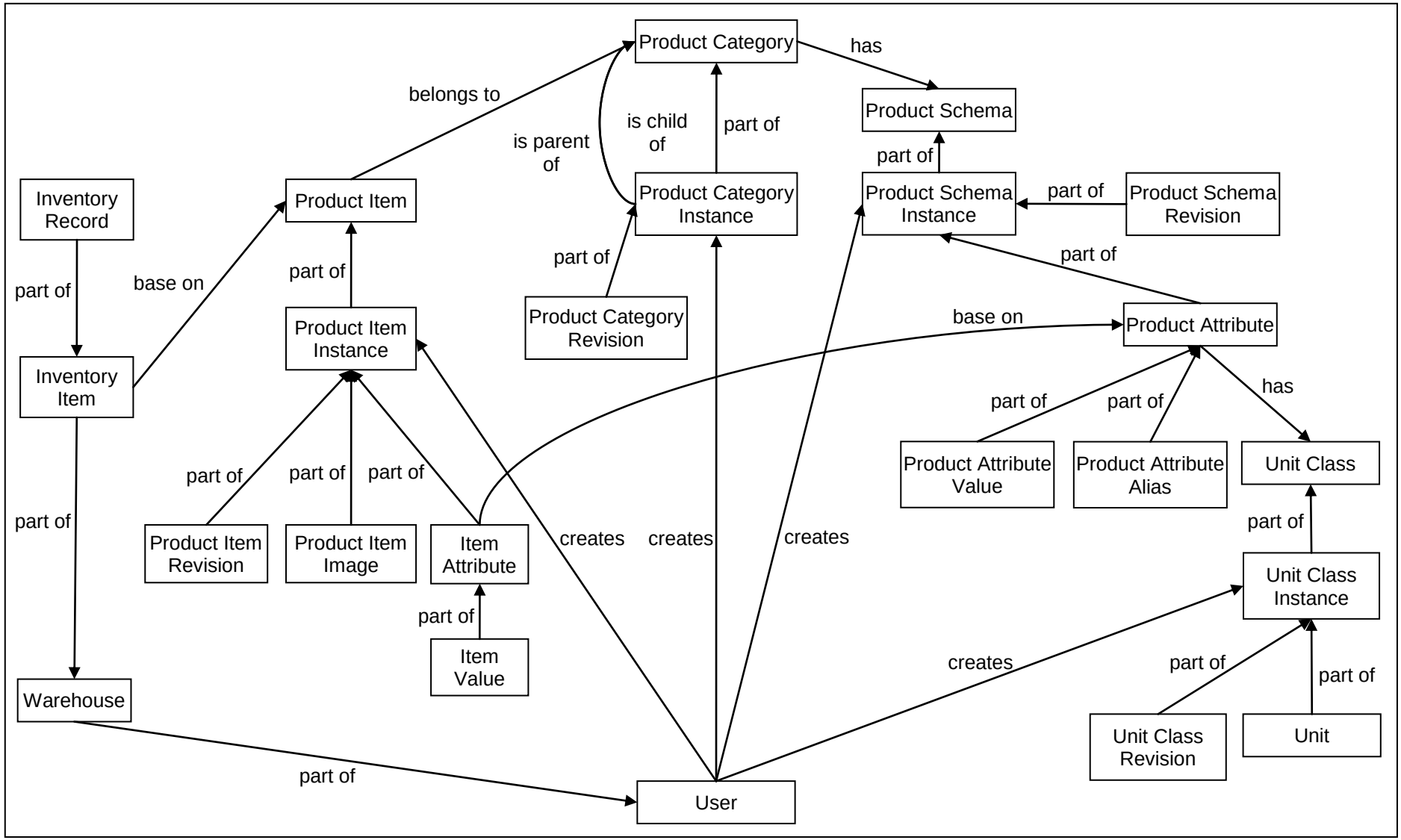


Figure 3.2 – Ontology for content management and merchandising.

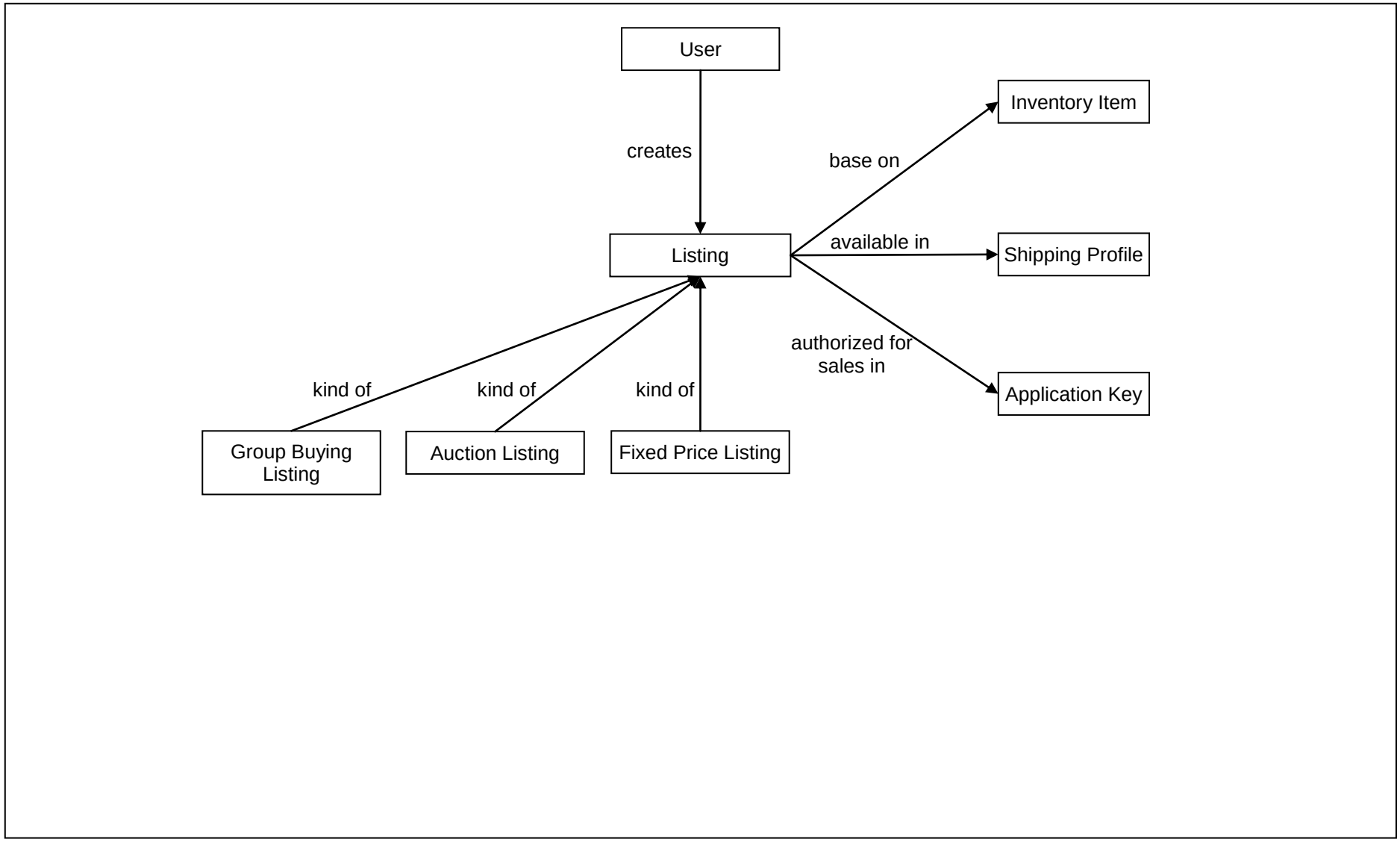


Figure 3.3 – Ontology for negotiation.

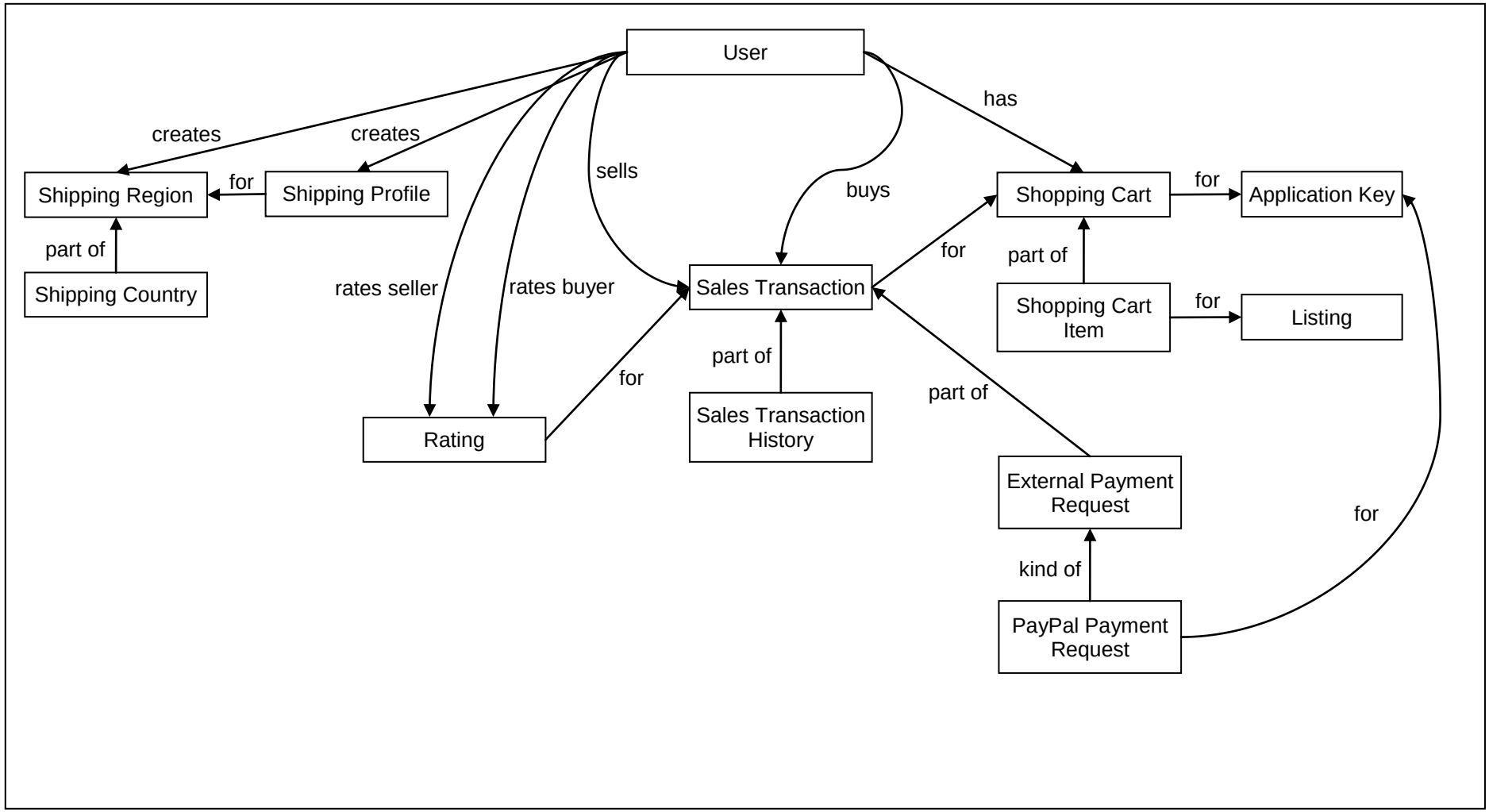


Figure 3.4 – Ontology for order fulfillment, payment processing, and service and support.

3.2 Models

The ontology that has been described in the preceding section forms the foundation to define the relationships among the constructs for a full-fledged electronic commerce platform that facilitates online selling and buying of products and services across multiple websites, channels and media. Unified Modeling Language (UML) is chosen to depict the models as it is the industry standard for object-oriented modeling (Tan, Siau and Erickson 2007). UML class diagram is also more intuitive for depicting superclass and subclass concepts as compared to enhanced entity relationship diagram since it is 1) congruent with the objected-oriented programming paradigm; and 2) independent of the underlying data storage. Object-oriented programming itself is ideal for developing large and complex software system such as the platform proposed in this research.

The UML class diagrams that are presented in this section represent both the solution to the information requirement analysis of the preceding chapter and the problem definition for the information system design task of the instantiation artifact. It essentially serves as reference logical data models for the development of the proposed platform. In accordance with the design characteristics listed in Table 2.1 and the reference architecture shown in Figure 2.2, user management functionalities are provided by the platform identity service and the corresponding models are depicted in Figure 3.5. The platform seller service and buyer service provide additional capabilities for the user to maintain profile information that aid in selling and buying. Models for the seller service are depicted in Figure 3.6 and those for the buyer service are depicted in Figure 3.7.

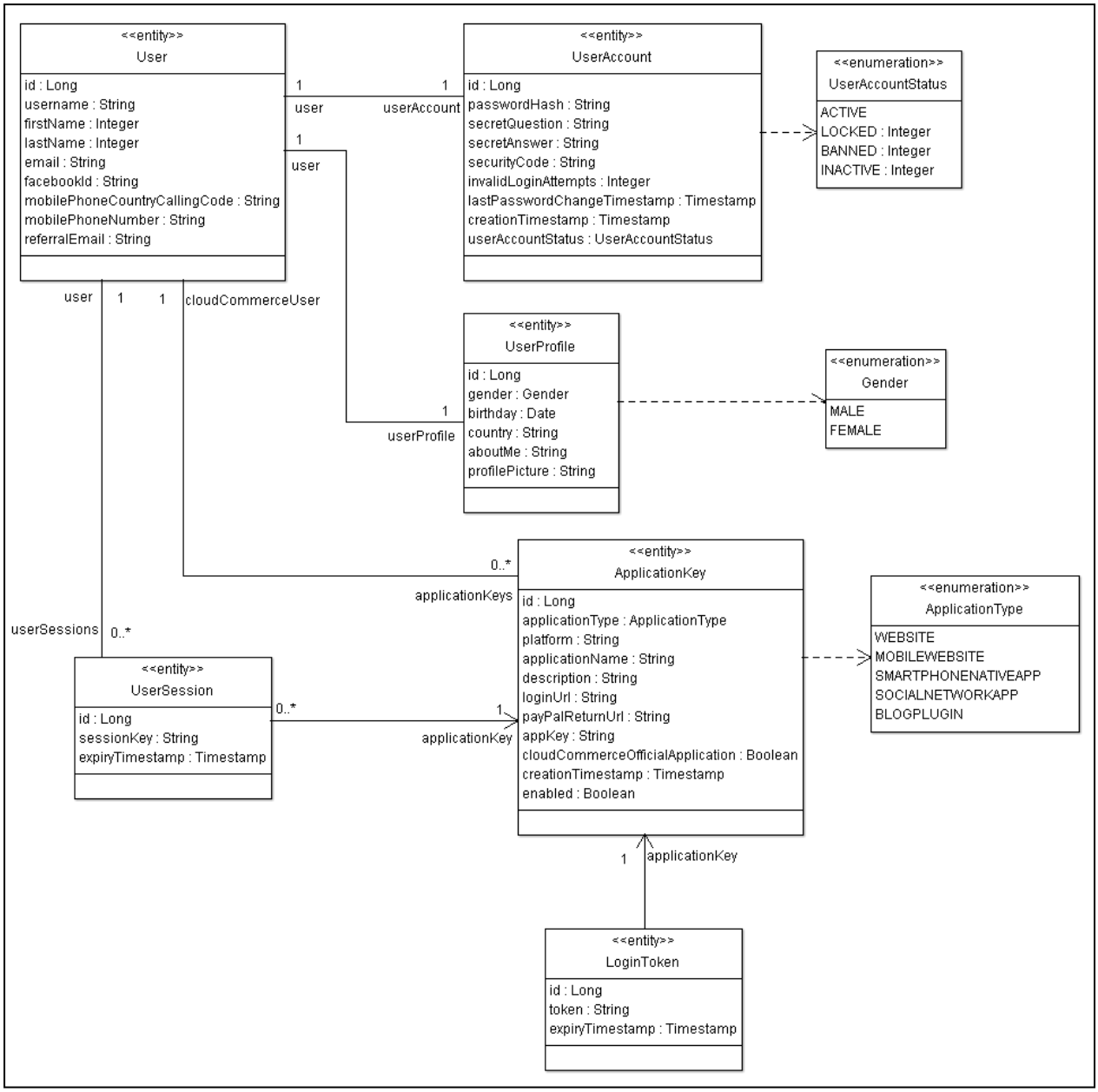


Figure 3.5 – UML class diagram depicting the models for identity service.

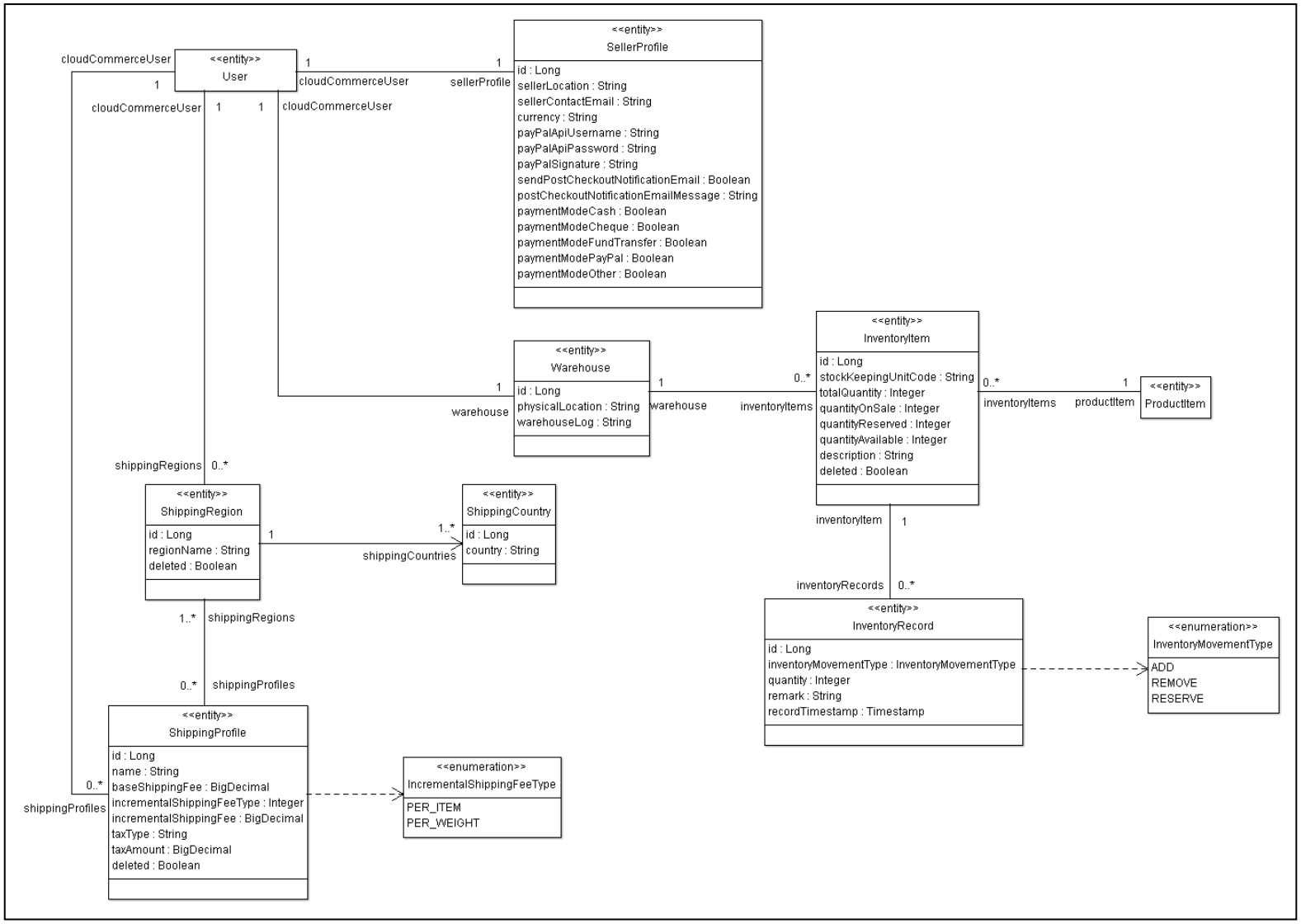


Figure 3.6 – UML class diagram depicting the models for seller service.

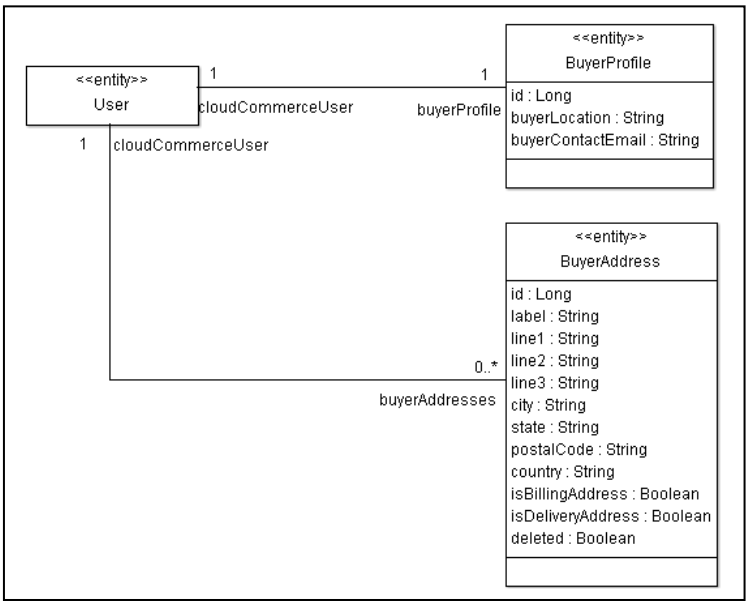


Figure 3.7 – UML class diagram depicting the models for buyer service.

Content management and merchandising functionalities are provided by the product information service and the corresponding models are depicted in Figure 3.8 and Figure 3.9. Product search and recommendation service has not been incorporated in this phase of the research. Negotiation and order fulfillment functionalities are provided by the transaction service and the corresponding models are depicted in Figure 3.10. The platform payment service provides the functionalities for online payment processing. The corresponding models are depicted in Figure 3.11. Finally, part of the service and support functionalities is provided by the rating and review service. The corresponding models are depicted in Figure 3.12.

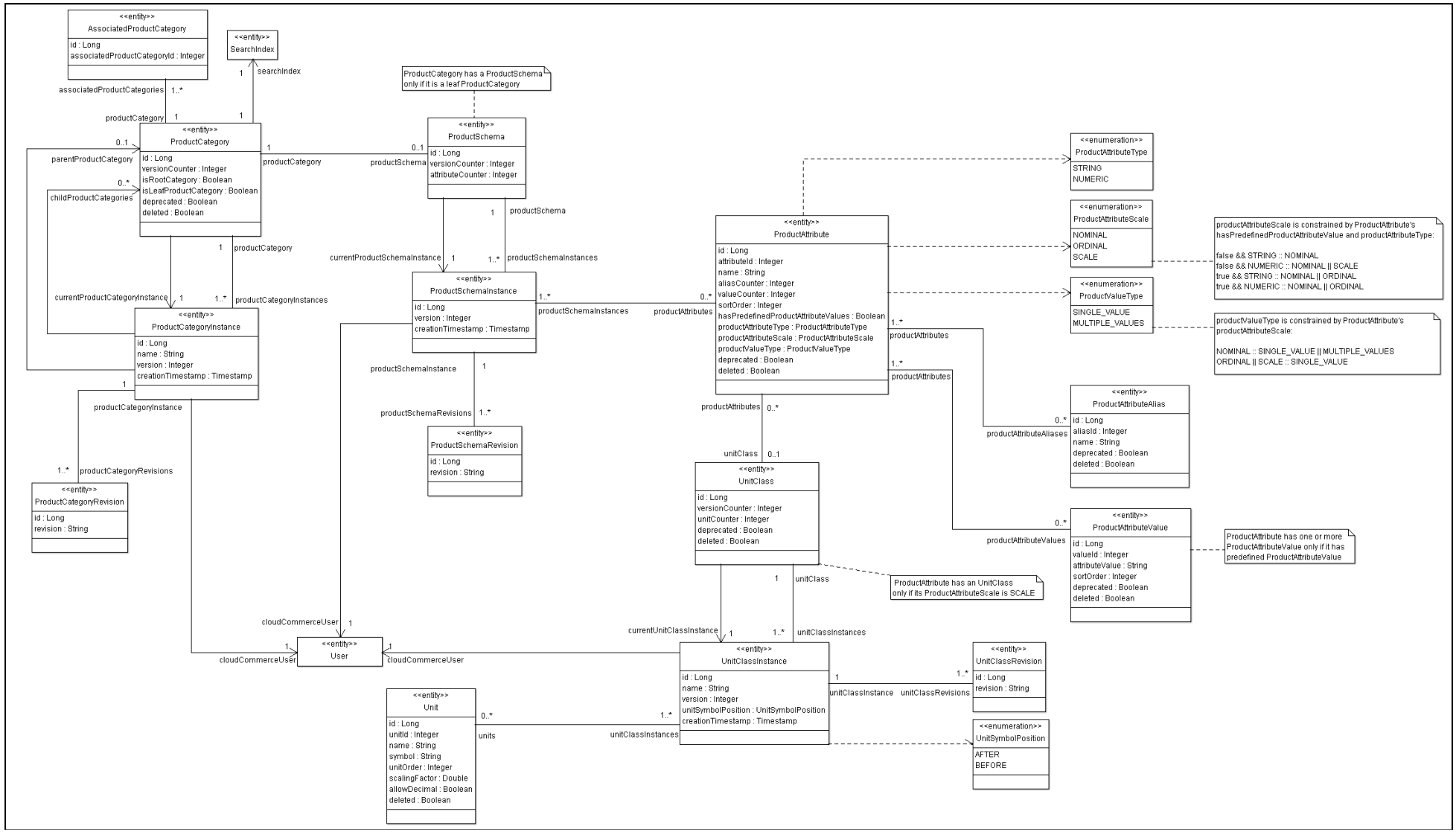


Figure 3.8 – UML class diagram depicting the models for product information service (product schema).

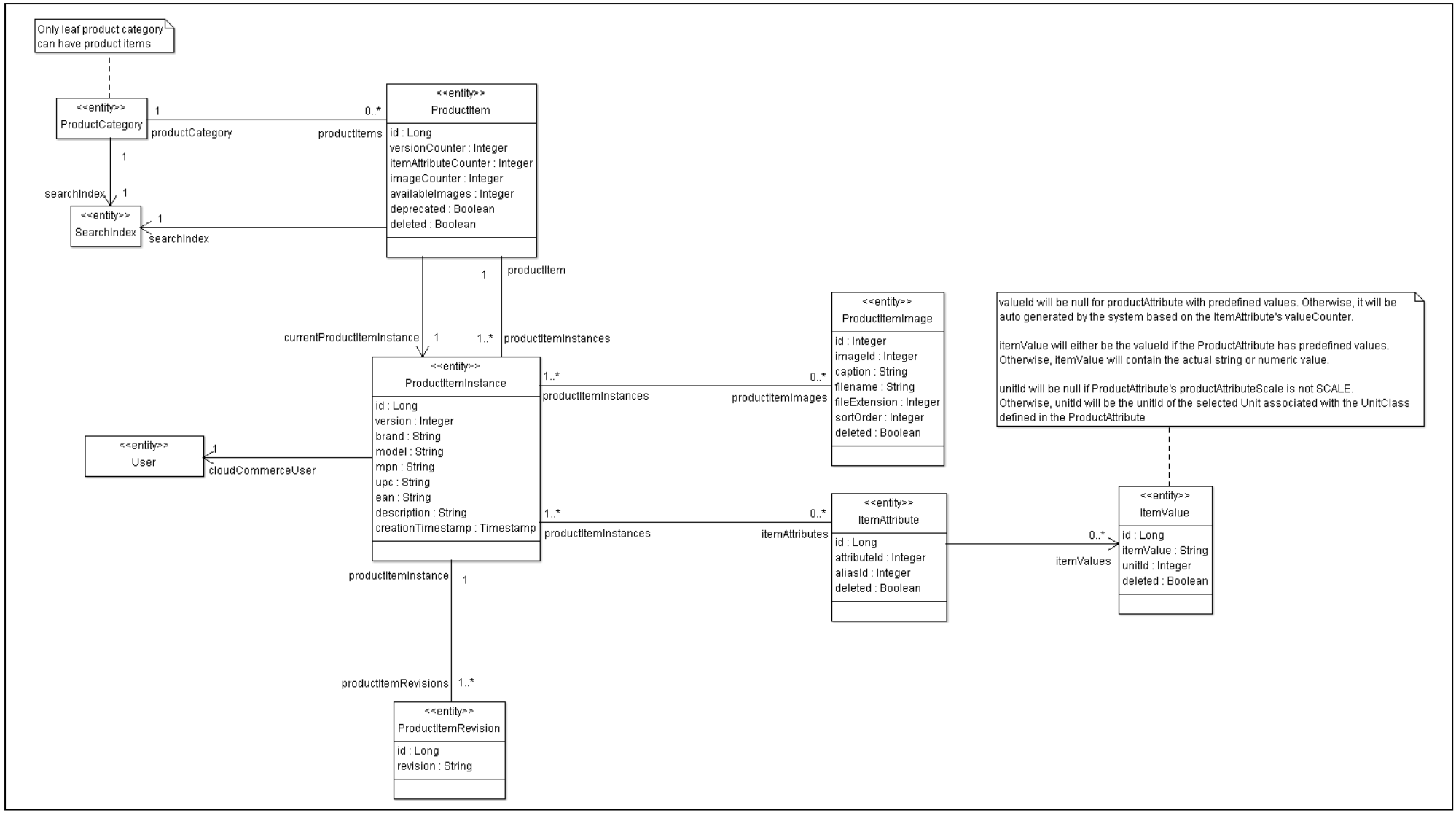


Figure 3.9 – UML class diagram depicting the models for product information service (product information).

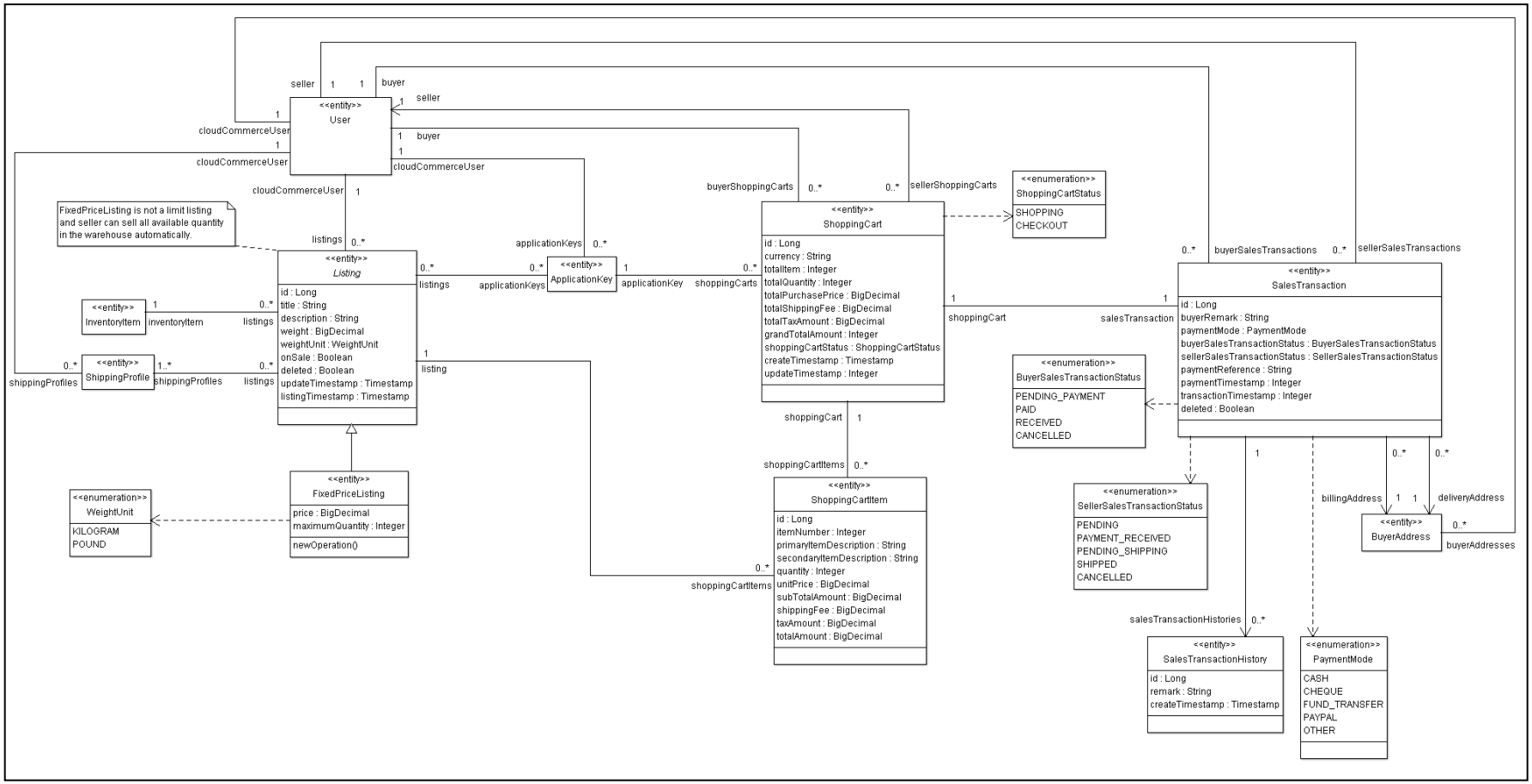


Figure 3.10 – UML class diagram depicting the models for transaction service.

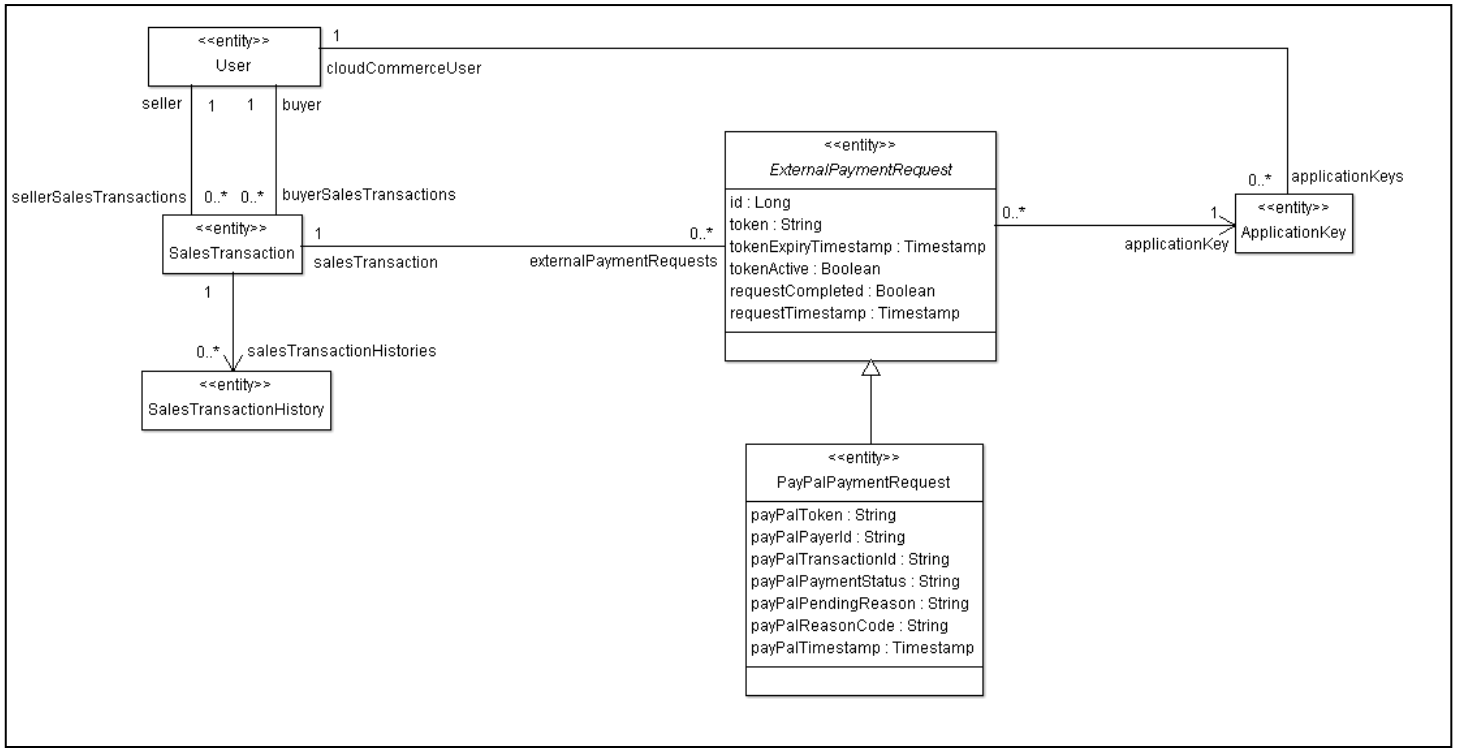


Figure 3.11 – UML class diagram depicting the models for payment service.

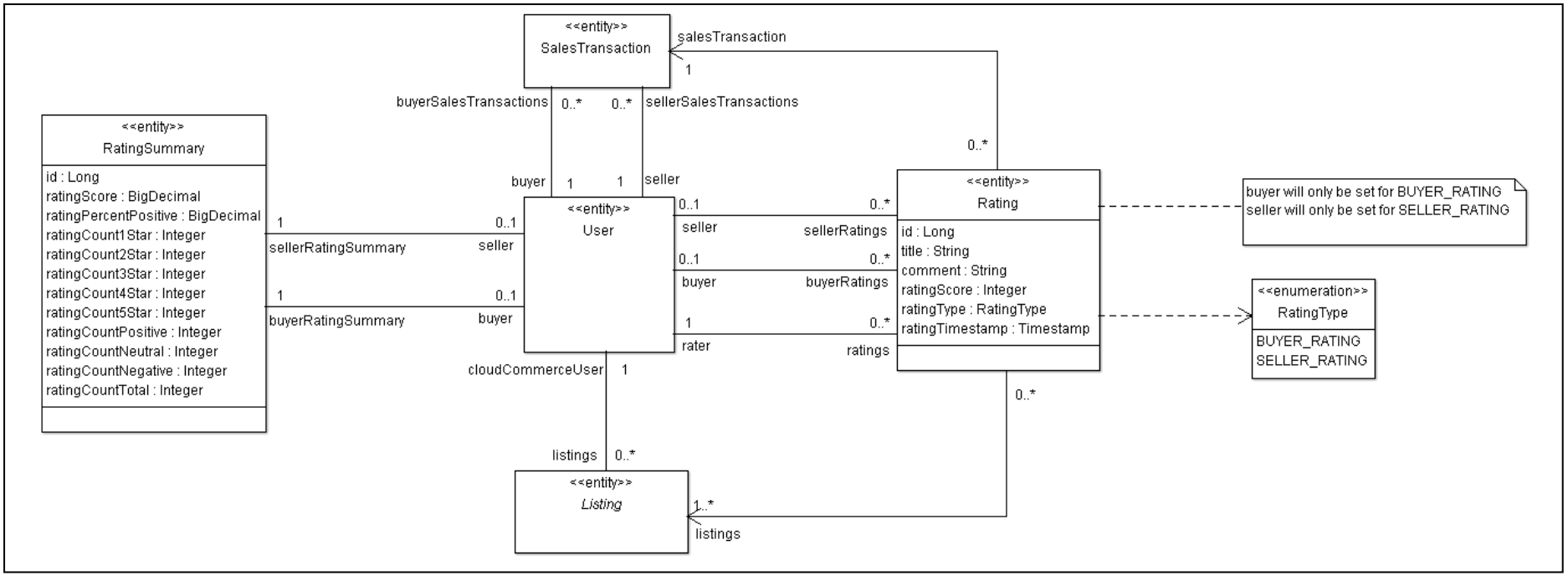


Figure 3.12 – UML class diagram depicting the models for rating and review service.

3.3 Methods

The logical data models produced in the preceding section form the basis for prescribing how various electronic commerce tasks should be performed in a full-fledged platform that facilitates online selling and buying of products and services across multiple websites, channels and media. Since the platform is based on an Open API architecture using RESTful web services, a series of API web service methods are carefully defined that allow an electronic commerce application to interact with each of the platform services to accomplish various seller and buyer tasks. This approach is similar to existing major services such as eBay API (http://developer.ebay.com/common/api) and Amazon Marketplace Web Service (https://developer.amazonservices.com). In conjunction with the API methods, complementary processes are illustrated to provide a reference implementation blueprint.

A high-level process schematic of the platform's overall operation is shown in Figure 3.13. This process supports the scenario depicted in Figure 2.8, which illustrates how Cloud Commerce's product information service and transaction service work together to allow seller to create an offer in the cloud and for buyers to buy directly through the cloud. There are four key activity groups captured in this process schematic. First, the entire community of users is able to participate in a collaborative fashion to create and maintain the open product schemas and information repository. Second, developers can create their own full-fledged electronic commerce applications that harness the functionalities provided by the platform via its Open API. Third, sellers can centrally manage the product catalog, inventory items, shipping information and listings from any applications via the data stored in the cloud. Fourth, sellers and buyers may interact in a distributed

electronic marketplace that spans multiple applications across different websites, channels and media.

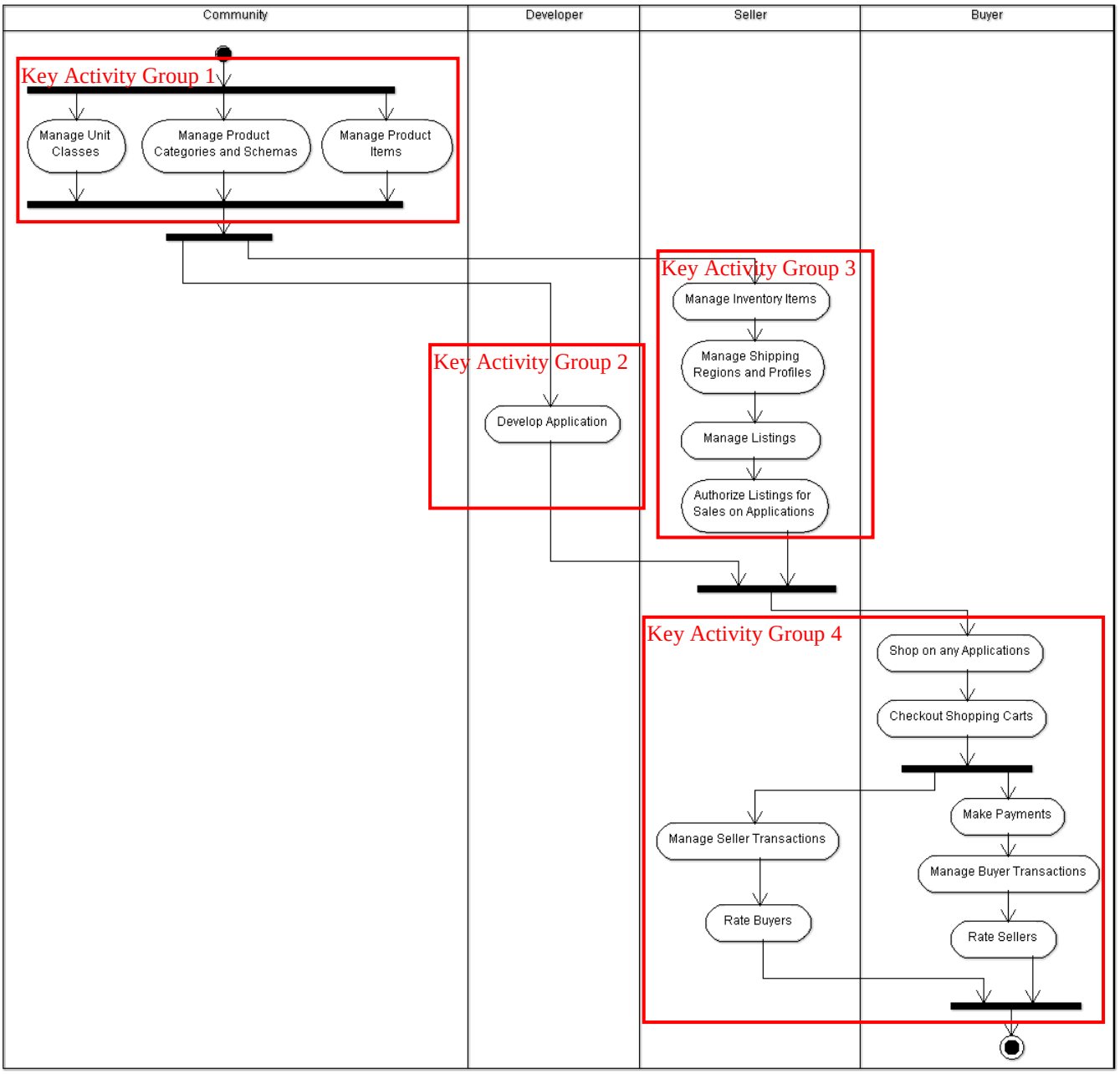


Figure 3.13 – UML activity diagram depicting high-level process schematic of the proposed platform operation.

3.3.1 Identity Service

For security reasons, the platform does not allow an application to update important profile information on behalf of a user via the API. Instead, the user must login directly to the platform main website to perform important account management tasks such as

changing of email and password. The main objectives of the identity service are to allow an application to create new user accounts, retrieve user profiles and request for login tokens. The login token is required for a user to login to the application via the platform secured single sign-on web page. In other words, a user will never disclose his/her account credential to a third party application. This approach is similar to existing services on the Internet such as Facebook Login (http://developers.facebook.com/docs/reference/login) and OAuth (http://oauth.net). The login process schematic is depicted in Figure 3.14.

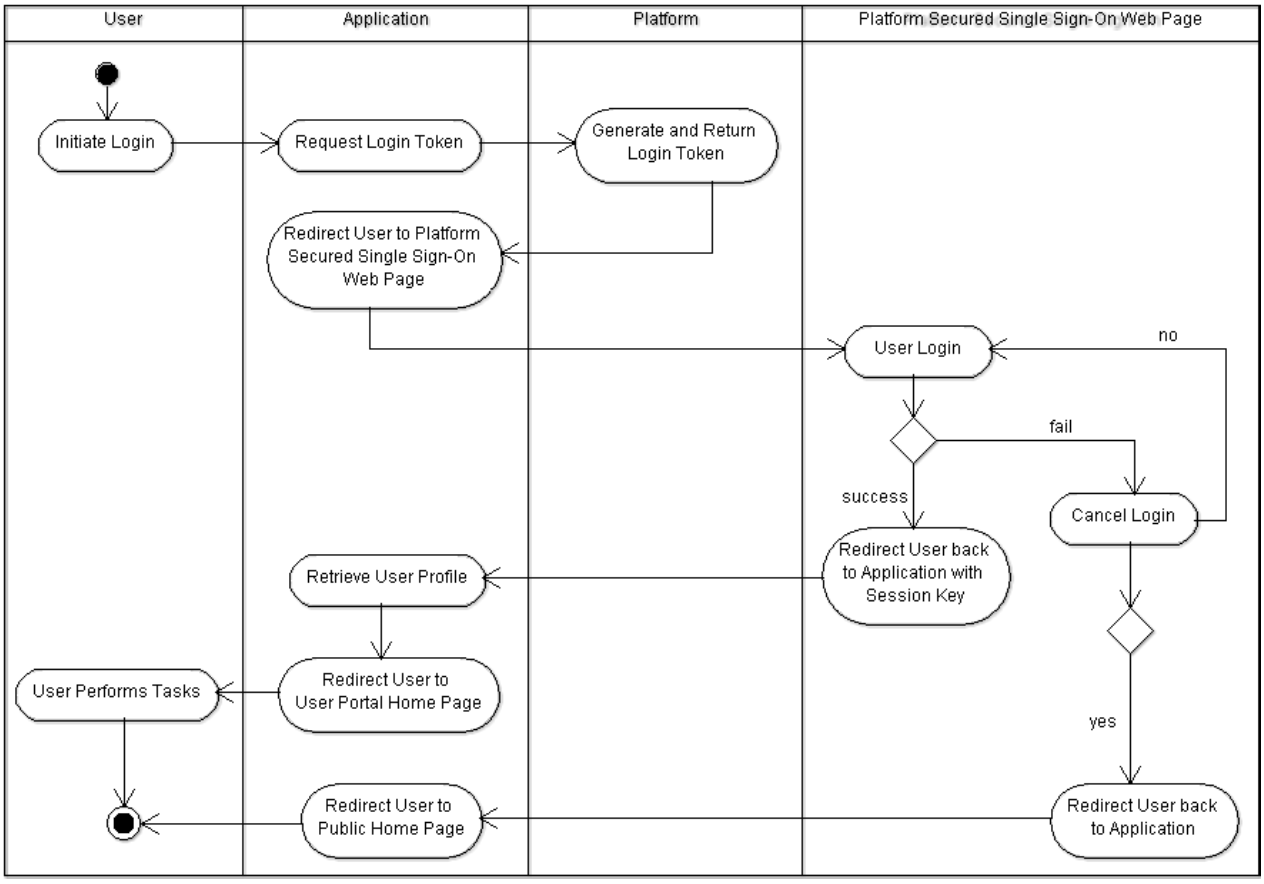


Figure 3.14 – UML activity diagram depicting login process schematic of the proposed platform.

The identity service defines a total of 5 reference methods as listed in Table 3.5.

Identity Services	
API Method Name	**Description**
CheckUsernameAvailability	This method allows client to check whether a username is available for new user registration.

CreateUser	This method allows client to create a new user account. A new user account activation email will be sent to the user upon successful creation.
CreateLoginToken	The platform uses a single account open identity management approach. A user uses a single user account to login to all websites, applications and services powered by the platform. Login is done securely on the secured single sign-on web page. A website, application or service that wants to login a user must request for a login token with this API method. The user must then be redirected to the platform secured sign sign-on web page with this login token. The login token is only valid for one-time use within a certain period of time.
GetUser	This method allows client to retrieve basic information about a user.
DeleteUserSession	This method allows client to delete a user session. This action essentially logout the user from all platform services with regard to the requesting application. If the user is concurrently login through other applications, those user sessions will not be affected.

Table 3.5 – API method specification for identity services.

3.3.2 Product Information Service

The product information service allows community user to maintain the open product schemas and information repository in a collaborative and distributed manner via different applications. Essentially, users contribute to the repository by defining unit classes, product categories, product schemas for leaf product categories and product items. These components collectively constitute a shared product catalog that community users can easily tap on to create sales listings.

Since the repository is a shared and distributed resource, the product information service features several design characteristics to provide for an efficient and orderly management process. First, each unique data record manifests as multiple instances. When a new unique data record is created, the first instance of the data record is created concurrently. Thereafter, whenever significant change is made to the data record, a new instance is created with the revisions incorporated. Thus, the current instance of the data record is always the latest revised instance. Second, all revisions made to each instance of a unique data record are tracked and saved into the repository. However, the reference data model and API methods do not make any assumption as to whether the revisions are tracked in a structured or unstructured manner. Supposedly, if the revisions are tracked in a structured

manner, it is possible to roll back the revisions programmatically. Regardless, it is always possible to roll back the current instance of a unique data record to an earlier instance.

Third, the service allows a unique data record to be marked as deprecated instead of deleted. Since the repository is a shared resource, it may not always be possible to delete an unwanted data record. By marking a specific data record as deprecated, it would signal to community users that they should cease usage of the deprecated data record. Fourth, a unique data record that is no longer used by other associated data record may eventually be permanently deleted. For instance, a product category that no longer has any child product category or product item associated with it may be permanently deleted. In this scenario, it is assumed that community users would delete the associated data records before deleting the primary data record. Another possible scenario occurs when a user accidentally creates a wrong data record. By allowing deletion over and above deprecation, the repository will be prevented from being overloaded with unnecessary garbage data.

To illustrate these four design characteristics, let's take an example of a unit class for the unit of measurement length. When the unit class is newly created by a user, the first instance is also created concurrently with the name "Length" and the unit symbol position set as "before the value". The user then realized that the unit symbol position should be placed "after the value" instead and thus updated the unit class accordingly. This update process will lead to the creation of a second new instance of the same unit class "Length". Thereafter, the user proceeds to add four units to this unit class, namely millimeter, centimeter, meter, and kilometer. Each creation of a new unit will lead to the creation of a new unit class instance. At the end of the creation of the fourth unit, i.e., kilometer, there will be 6 instances of the unique unit class "Length". The current instance of this unique

unit class will be the 6th instance. The generic management process of a data record and its instances is depicted in Figure 3.15.

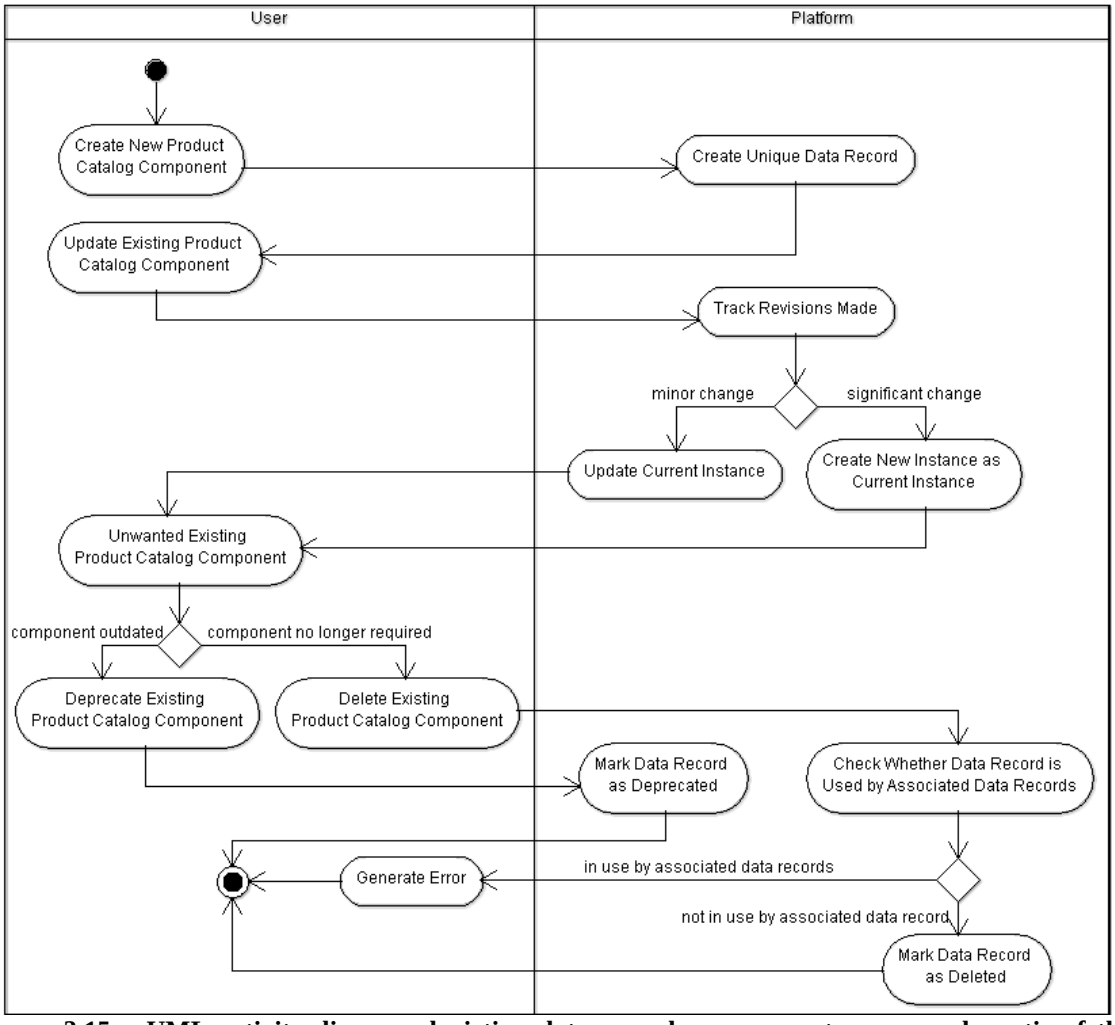


Figure 3.15 – UML activity diagram depicting data record management process schematic of the shared product catalog in the proposed platform.

The product information service defines a total of 47 reference methods for managing different components of the shared product catalog as listed in Table 3.6.

Product Information Service	
Management of unit classes and units	
API Method Name	**Description**
CreateUnitClass	This method allows client to create a new unit class. A unit class is a collection of related units for measuring a specific type of quantitative value. For instance, the length in the International System of Units (SI). This unit class will contain units such as millimetre, centimetre and metre.
GetUnitClasses	This method allows client to retrieve a list of unit classes. Records pagination, sorting and filtering are supported.
GetUnitClass	This method allows client to retrieve a unit class.

UpdateUnitClass	This method allows client to update an existing unit class.
DeprecateUnitClass	This method allows client to mark an existing unit class as deprecated or undeprecated. The unit class will still be available after it has been marked as deprecated.
DeleteUnitClass	This method allows client to permanently delete an existing unit class.
GetUnitClassInstances	This method allows client to retrieve a list of unit class instances (or versions) of a particular unit class. Records pagination, sorting and filtering are supported.
GetUnitClassInstance	This method allows client to retrieve a particular unit class instance (or version) of a particular unit class.
CreateUnit	This method allows client to create a new unit for an existing unit class. Each unit has a scaling factor, which is the multiplier that is used to convert to the next smaller unit. If the unit is a smallest unit or the only unit, scaling factor should be 0. The method also allows the client to specify whether a value of this unit can have a decimal point. If allow decimal is false, only integer value is allowed.
UpdateUnit	This method allows client to update an existing unit.
DeleteUnit	This method allows client to permanently delete an existing unit.
Management of product categories	
API Method Name	**Description**
CreateProductCategory	This method allows client to create a new product category. A product category must be either a root, ordinary or leaf product category. A root product category is at the top level and does not have a parent product category. E.g., Books, Electronics, and Fashion. An ordinary product category has a parent product category but does not have an associated schema and product item. E.g., Books > Textbooks, Electronics > Audio and Video, and Fashion > Clothing. A leaf product category has an associated schema and product items, E.g., Books > Textbooks > Science Textbooks, Electronics > Audio and Video > MP3 Players and Fashion > Clothing > Men's Clothing. A leaf product category is at the lowest level and cannot have any child product category. That is, a leaf product category cannot be a parent product category.
CopyProductCategory	This method allows client to copy an existing product category to create a new one. The newly copied product category will have the exact same set of attributes and schema (if any) as the source product category. The only exception is the product category name, which must always be unique.

GetProductCategories	This method allows client to retrieve a list of product categories. Records pagination, sorting and filtering are supported. The method allows client to retrieve either root product categories only or leaf product categories only. It is also possible to retrieve only the child product categories of a particular parent product category. The retrieval of product categories may be constrained to certain scopes. By default, if no scope is specified or ALL scope is specified, then all the product categories will be retrieved. There are four other scopes that may be specified when calling this method: • INVENTORY_ITEMS - This will return the product categories of inventory items belonging to a particular user. • FIXED_PRICE_LISTINGS_USER - This will return the product categories of fixed price listings belonging to a particular user. • FIXED_PRICE_LISTINGS_APPLICATION - This will return the product categories of fixed price listings authorized for sale on a particular application. • FIXED_PRICE_LISTINGS_APPLICATION_USER - This will return the product categories of fixed price listings authorized for sale on a particular application posted by a particular user.
GetProductCategory	This method allows client to retrieve an existing product category.
UpdateProductCategory	This method allows client to update an existing product category.
DeprecateProductCategory	This method allows client to mark an existing product category as deprecated or undeprecated. The product category will still be available after it has been marked as deprecated.
DeleteProductCategory	This method allows client to permanently delete an existing product category.
GetProductCategory Instances	This method allows client to retrieve a list of product category instances (or versions) of a particular product category. Records pagination, sorting and filtering are supported.
GetProductCategoryInstance	This method allows client to retrieve a particular product category instance (or version) of a particular product category.
Management of product schemas	
API Method Name	**Description**
GetProductSchema	This method allows client to retrieve the product schema of an existing leaf product category.
CreateProductAttribute	This method allows client to create a new product attribute for the product schema of an existing leaf product category.
GetProductAttribute	This method allows client to retrieve a particular product attribute of a product schema for an existing leaf product category.
UpdateProductAttribute	This method allows client to update a particular product attribute of the product schema for an existing leaf product category. Only certain elements may be updated.
DeprecateProductAttribute	This method allows client to mark an existing product attribute as deprecated or undeprecated. The product attribute will still be available after it has been marked as deprecated.
DeleteProductAttribute	This method allows client to permanently delete an existing product attribute.
CreateProductAttributeAlias	This method allows client to create a new alias for an existing product attribute.
UpdateProductAttribute Alias	This method allows client to update an existing alias of a particular product attribute.
DeprecateProductAttribute Alias	This method allows client to mark an existing product attribute alias as deprecated or undeprecated. The product attribute alias will still be available after it has been marked as deprecated.
DeleteProductAttributeAlias	This method allows client to permanently delete an existing product attribute alias.

CreateProductAttribute Value	This method allows client to create a new predefined attribute value for an existing product attribute.
UpdateProductAttribute Value	This method allows client to update an existing predefined attribute value of a particular product attribute.
DeprecateProductAttribute Value	This method allows client to mark an existing product attribute value as deprecated or undeprecated. The product attribute value will still be available after it has been marked as deprecated.
DeleteProductAttribute Value	This method allows client to permanently delete an existing product attribute value.
GetProductSchemaInstances	This method allows client to retrieve a list of product schema instances (or versions) of a particular leaf product category. Records pagination, sorting and filtering are supported.
GetProductSchemaInstance	This method allows client to retrieve a particular product schema instance (or version) of a particular leaf product category.
Management of product items	
API Method Name	**Description**
CreateProductItem	This method allows client to create a new product item based on the product schema of a particular leaf product category.
GetProductItems	This method allows client to retrieve a list of product items. Records pagination, sorting and filtering are supported. The method allows client to retrieve all product items or product items in a particular product category. For the latter, if a non-leaf product category is specified, product items in all leaf product categories under the particular product category recursively will be retrieved.
GetProductItem	This method allows client to retrieve a particular product item together with the associated product schema.
UpdateProductItem	This method allows client to update an existing product item. If the product schema has any new product attributes added, they will be automatically appended to all existing product items of that particular leaf product category, albeit with no item value. This method may then be used to input values for the new item attributes.
DeprecateProductItem	This method allows client to mark an existing product item as deprecated or undeprecated. The product item will still be available after it has been marked as deprecated.
DeleteProductItem	This method allows client to permanently delete an existing product item.
GetProductItemInstances	This method allows client to retrieve a list of product item instances (or versions) of a particular product item. Records pagination, sorting and filtering are supported.
GetProductItemInstance	This method allows client to retrieve a particular product item instance (or version) of a particular product item.
CreateProductItemImage	This method allows client to create a new product item image for a particular product item and to physically upload the image file to the platform file repository.
UpdateProductItemImage	This method allows client to update an existing product item image.
DeleteProductItemImage	This method allows client to permanently delete an existing product item image. A product item image that has been deleted will no longer exist in the current product item instance (or version). Any reference to the deleted image's file path will lead to a default placeholder image informing user that the image is no longer available.

Table 3.6 – API method specification for product information services.

3.3.3 Seller Service

The seller service defines a total of 19 reference methods for managing a user's additional seller profile, inventory items and shipping information as listed in Table 3.7. For security reasons, additional account information for third party online payment services may only be updated via the platform main website.

Seller Service	
Management of seller's profile	
API Method Name	**Description**
GetSellerProfile	This method allows client to retrieve the complete seller profile of a user. The seller profile also specifies the default trade currency used by the seller.
UpdateSellerProfile	This method allows client to update the seller profile of a user.
Management of seller's warehouse	
API Method Name	**Description**
GetWarehouse	This method allows client to retrieve the warehouse of a user.
UpdateWarehouse	This method allows client to update the warehouse of a user.
CreateInventoryItem	This method allows client to create a new inventory item in the user's warehouse. The inventory item is created based on an existing product item, which is managed with the product information service.
GetInventoryItems	This method allows client to retrieve a list of inventory items in the user's warehouse. The method allows client to retrieve all inventory items or inventory items in a particular product category. For the latter, if a non-leaf product category is specified, inventory items in all leaf product categories under the particular product category recursively will be retrieved.
GetInventoryItem	This method allows client to retrieve a particular inventory item from a user's warehouse using the stock keeping unit code.
UpdateInventoryItem	This method allows client to update a particular inventory item in a user's warehouse.
DeleteInventoryItem	This method allows client to delete a particular inventory item from a user's warehouse. An inventory item can only be deleted if the quantity on sale and quantity reserved are both 0. In other words, there must not be any pending sales listing or unfulfilled sales transaction for the inventory item. After an inventory item has been deleted, all associated data records will still be able to reference it as per normal. However, the deleted item will no longer appear in the user's warehouse and cannot be used to create a new sales listing.
CreateInventoryRecord	This method allows client to create a new inventory record for a particular inventory item in a user's warehouse. The inventory record will increment/decrement the total quantity and quantity available of the particular inventory item. For a REMOVE record, the quantity to be removed must be less than or equal to the total quantity and quantity available.
GetInventoryRecords	This method allows client to retrieve a list of inventory records for a particular inventory item in the user's warehouse.
Management of seller's shipping	
API Method Name	**Description**
CreateShippingRegion	This method allows client to create a new shipping region for a user. The shipping region consists of a group of shipping countries.

GetShippingRegions	This method allows client to retrieve a list of shipping regions for a user.
UpdateShippingRegion	This method allows client to update a particular shipping region for a user.
DeleteShippingRegion	This method allows client to delete a particular shipping region for a user. A shipping region may only be deleted if it is not currently used by a shipping profile.
CreateShippingProfile	This method allows client to create a new shipping profile for a user. The shipping profile will specify the shipping fees to be charged for the listings associated with it.
GetShippingProfiles	This method allows client to retrieve a list of shipping profiles for the user.
UpdateShippingProfile	This method allows client to update a particular shipping profile for a user.
DeleteShippingProfile	This method allows client to delete a particular shipping profile for a user. A shipping profile may only be deleted if it is not currently used by a listing.

Table 3.7 – API method specification for seller services.

3.3.4 Buyer Service

The buyer service defines a total of 6 reference methods for managing a user's additional buyer profile and addresses as listed in Table 3.8.

Buyer Service	
Management of buyer's profile	
API Method Name	**Description**
GetBuyerProfile	This method allows client to retrieve the complete buyer profile of a user.
UpdateBuyerProfile	This method allows client to update the buyer profile of a user.
Management of buyer's addresses	
API Method Name	**Description**
CreateBuyerAddress	This method allows client to create a new buyer address for the user.
GetBuyerAddresses	This method allows client to retrieve the buyer addresses of the user.
UpdateBuyerAddress	This method allows client to update a particular buyer address of the user.
DeleteBuyerAddress	This method allows client to delete a particular buyer address of the user. A buyer address may be deleted even if it has already been used by the user to perform some transactions.

Table 3.8 – API method specification for buyer services.

3.3.5 Transaction Service

The transaction service handles three main processes: 1) management of listings; 2) purchase of listings via a shopping cart mechanism; and 3) management of sales transactions from both the seller and buyer perspective.

The proposed platform allows a listing to be sold concurrently across multiple applications in order to maximize the customer reach. This is vastly different from the current approach adopted by major electronic commerce websites such as eBay, Amazon and Qoo10. These websites essentially feature a flagship website (or multiple flagship

websites, one per geographical region) complemented by a separate mobile smartphone app. Thus, sellers are still constrained to selling only to the respective customer base of each service provider. In the context of the proposed platform, a seller can reuse a listing for sales across a heterogeneous range of applications, each with its own customer base. The transaction service utilizes a listing authorization process to facilitate this multi-modal selling mechanism. By default, a listing is authorized for sales on the application in which it is created with. The seller can also login to other applications to retrieve the same listing and authorize it for sales on the current application. For security reasons, an individual application cannot request for a listing to be sold/unsold on other applications other than itself. However, as a matter of convenience, it is proposed that the platform official website should allow a user to authorize a listing for sales on all applications. The listing management process is depicted in Figure 3.16.

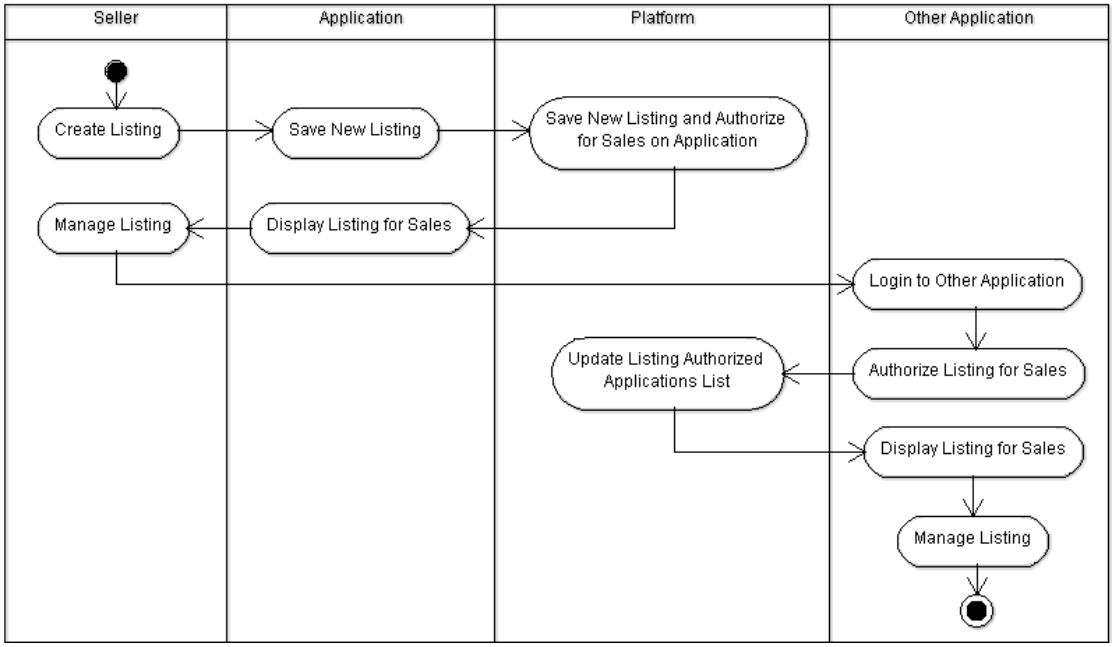


Figure 3.16 – UML activity diagram depicting listing management process schematic of the proposed platform transaction service.

When a buyer shops on an application, listings from a Seller A that the buyer wants to purchase is added to a shopping cart. This shopping cart is uniquely created for the buyer's items belonging to the same Seller A on that specific application. In other words,

if the buyer purchases listings from another Seller B on the same application, a second unique shopping cart will be created. In addition, if the same buyer login to another application and add listings from Seller A to the shopping cart, a third shopping cart will be created for the buyer's listings from Seller A on that different application. The multi-shopping carts approach has several advantages. First, a buyer can concurrently shop for items sold by different sellers. Second, there is a distinct checkout process for the listings belonging to a specific seller. This enables the buyer to initiate a distinct payment to each seller. Third, by associating each shopping cart to a particular application, this approach prevents a malicious application from manipulating the listings that the buyer has added from another application.

If a seller makes a significant change to a listing, e.g., change of price or shipping fee, the platform will automatically remove the listing from all potential buyers' shopping carts. This is to prevent a buyer from checking out a shopping cart with an item that might have its amount payable changed unknowingly. The shopping cart management process is depicted in Figure 3.17.

After a buyer has checkout a shopping cart, a sales transaction will be created. The sales transaction allows both the buyer and seller to track and manage the order fulfillment process. The buyer typically initiates the order fulfillment process by making payment for the sales transaction. Thereafter, the seller will verify the receipt of payment and proceed to ship the items to the buyer. Throughout this process, the buyer and seller will be able to update the buyer sales transaction status and seller sales transaction status, respectively. The process technically ends when the buyer sets the buyer sales transaction status to RECEIVED (though this is not compulsory), indicating that the purchased items have been received in good condition. Either the buyer or seller may cancel the sales transaction at appropriate junctures. For instance, the seller may cancel the sales

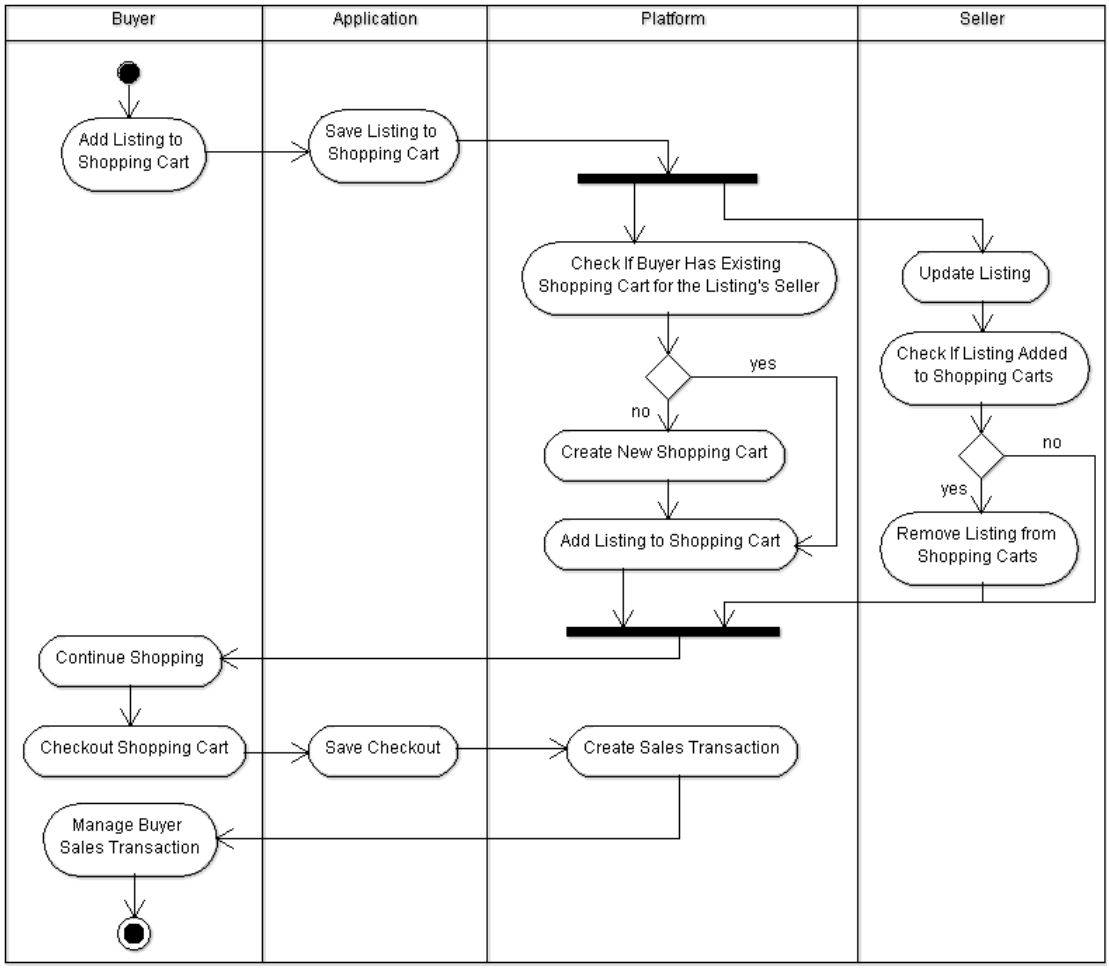


Figure 3.17 – UML activity diagram depicting shopping cart management process schematic of the proposed platform transaction service.

transaction before a buyer has made payment. It is assumed that any exceptional handling of a sales transaction is performed offline.

The platform payment service handles online payment via third party service providers. For offline payment such as fund transfer or cheque, the transaction service provides a basic mechanism for the buyer to enter the payment delivery information so that the seller is able to retrieve this information for verification. The sales transaction management process is depicted in Figure 3.18. The platform may be expanded in the future to cater for other types of selling mechanisms including support for negotiation. For instance, auction listings, group buying listings and reverse-auction listings may be added by

leveraging on the current infrastructure provided by the open product schemas and information repository as well as the centralized inventory warehouse approach.

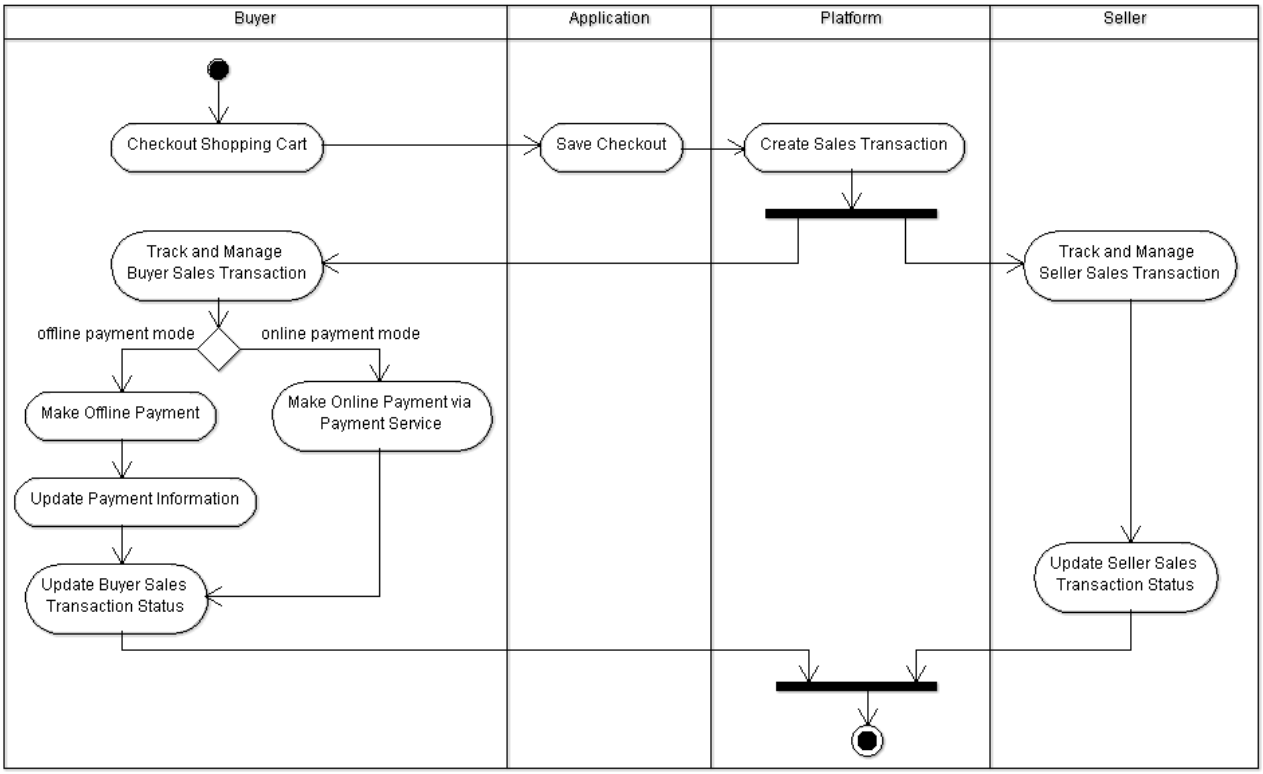


Figure 3.18 – UML activity diagram depicting sales transaction management process schematic of the proposed platform transaction service.

The transaction service defines a total of 20 reference methods for managing a seller's listings, buyer's shopping carts and a user's sell and buy transactions as listed in Table 3.9. Additional methods may be added in the future to support other types of listing.

Transaction Service	
General management of listings	
API Method Name	**Description**
AuthorizeListing	This method allows client to authorize a particular listing belonging to a particular user for sale on a particular application. By default, a listing is authorized for sale on the application in which it is created. This method may be used to authorize the same listing for sale on multiple different applications.
UnauthorizeListing	This method allows client to unauthorize a particular listing belonging to a particular user for sale on a particular application.
DeleteListing	This method allows client to delete a particular listing belonging to a particular user. A listing can only be deleted if there is no pending sales transaction associated with it.
Management of fixed price listings	
API Method Name	**Description**

CreateFixedPriceListing	This method allows client to create a fixed price listing for a particular user. By default, the listing will be authorized for sale on the application that it is created on.
GetFixedPriceListings	This method allows client to retrieve a list of fixed price listings. Records pagination, sorting and filtering are supported. The method allows client to retrieve all fixed price listings or fixed price listings in a particular product category. For the latter, if a non-leaf product category is specified, fixed price listings in all leaf product categories under the particular product category recursively will be retrieved The retrieval of fixed price listings may be constrained to certain scopes. By default, if ALL scope is specified, then all the fixed price listings in the platform will be retrieved. There are three other scopes that may be specified when calling this method: • USER - This will return the fixed price listings belonging to a particular user. • APPLICATION - This will return all the fixed price listings that have been authorized for sale on a particular application. • APPLICATION_USER - This will return all the fixed price listings that have been authorized for sale on a particular application for a particular user.
GetFixedPriceListing	This method allows client to retrieve a particular fixed price listing.
UpdateFixedPriceListing	This method allows client to update an existing fixed price listing for a particular user.
Management of shopping carts	
API Method Name	**Description**
CreateShoppingCart	This method allows client to help buyer creates a new shopping cart for a seller's listings in a particular application. In general, it is possible for a buyer to have multiple shopping carts in a particular application, one for each unique seller. A buyer may also have multiple shopping carts for the same seller albeit on different applications, one for each application. It is not necessary to call this method explicitly in most cases. When calling AddShoppingCartItem, the required shopping cart will be automatically created if it does not exist.
GetShoppingCartsFor Application	This method allows client to retrieve a list of all shopping carts that the buyer has on a particular application.
GetShoppingCartFor Application	This method allows client to retrieve a particular shopping cart for a specific seller's listings that the buyer has on a particular application.
DeleteShoppingCart	This method allows client to delete a particular shopping cart for a specific seller's listings that the buyer has on a particular application.
AddShoppingCartItem	This method allows client to add a listing to a buyer's shopping cart on a particular application. The seller defaults to the user who created the listing. If the buyer currently does not have a shopping cart for this seller's listings in the specific application, a new shopping cart will be automatically created.
UpdateShoppingCartItem	This method allows client to update a particular shopping cart item added by the buyer. Essentially, only the quantity can be updated. If the quantity is updated to zero, the item will be removed from the shopping cart automatically. However, if the buyer has not previously added the item to the shopping cart, an error will occur.
RemoveShoppingCartItem	This method allows client to remove an item from the buyer shopping cart.

CheckoutShoppingCart	This method allows client to checkout a buyer's shopping cart for a particular seller's listings. Upon successful checkout, the seller inventory item will be updated with a quantity transfer from quantity available to quantity reserved. It is important to note that checkout does not include payment. Payment for a completed sales transaction is done separately.
Management of sales transactions	
API Method Name	**Description**
GetSalesTransactions	This method allows client to retrieve a list of sales transactions. Records pagination, sorting and filtering are supported. The method allows client to retrieve all sales transactions associated with a particular user. The retrieval of sales transactions is constrained to certain scopes. There are two scopes that may be specified when calling this method: • BUYER_SALES_TRANSACTIONS - This will return the sales transactions associated with the user as a buyer. • SELLER_SALES_TRANSACTIONS - This will return the sales transactions associated with the user as a seller.
GetSalesTransaction	This method allows client to retrieve a particular sales transaction for a specific user. The sales transaction must be associated with the user either as buyer or seller.
UpdateBuyerSales TransactionStatus	This method allows client to update the sales transaction status of the buyer for a particular sales transaction. Basically buyer can only update the status to RECEIVED or CANCELLED. Payment related statuses can only be updated via the MakePayment method or the PayPal API methods in the payment service. Valid buyer sales transaction statuses are: • PENDING_PAYMENT • PAID • RECEIVED • CANCELLED
MakePayment	This method allows client to enable a buyer to make offline payment for a specific sales transaction. Basically the buyer will be able to enter a payment reference. Upon successful completion, the buyer sales transaction status will be automatically updated to PAID. For PayPal payment, client must use the PayPal API methods in payment service.
UpdateSellerSales TransactionStatus	This method allows client to update the sales transaction status of the seller for a particular sales transaction. Seller may update the status to any of the available statuses including PAYMENT_RECEIVED. However, if the selected payment method is an online one, e.g., PayPal, seller will not be able to set the status to PAYMENT_RECEIVED manually. All online payments must be handled by the payment service. Valid seller sales transaction statuses are: • PENDING • PAYMENT_RECEIVED • PENDING_DELIVERY • DELIVERY_SENT • CANCELLED

Table 3.9 – API method specification for transaction services.

3.3.6 Payment Service

The platform payment service provides the reference implementation mechanism for integrating with third party payment service providers such as PayPal. An important security consideration is to prevent a malicious application from hijacking a buyer's payment request to the legitimate seller and redirecting the payment request to a malicious party.

In order to protect the interest of the seller and buyer, the platform does not allow the buyer to make online payment directly on an application. Rather, the application must request a payment token on behalf of the buyer for a specific sales transaction and then redirect the buyer to the platform secured online payment web page. The platform will then ensure that the buyer is making payment to the legitimate seller of the specific sales transaction before redirecting the buyer to the actual third party payment website. This payment process is depicted in Figure 3.19. Due to this security mechanism, it is possible for a buyer to make payment for a sales transaction from an application that is different from the one that the checkout is performed on.

The transaction service currently defines only 2 reference methods for making online payment with PayPal. These methods are listed in Table 3.10. Additional methods may be added in the future to support other third party online payment services.

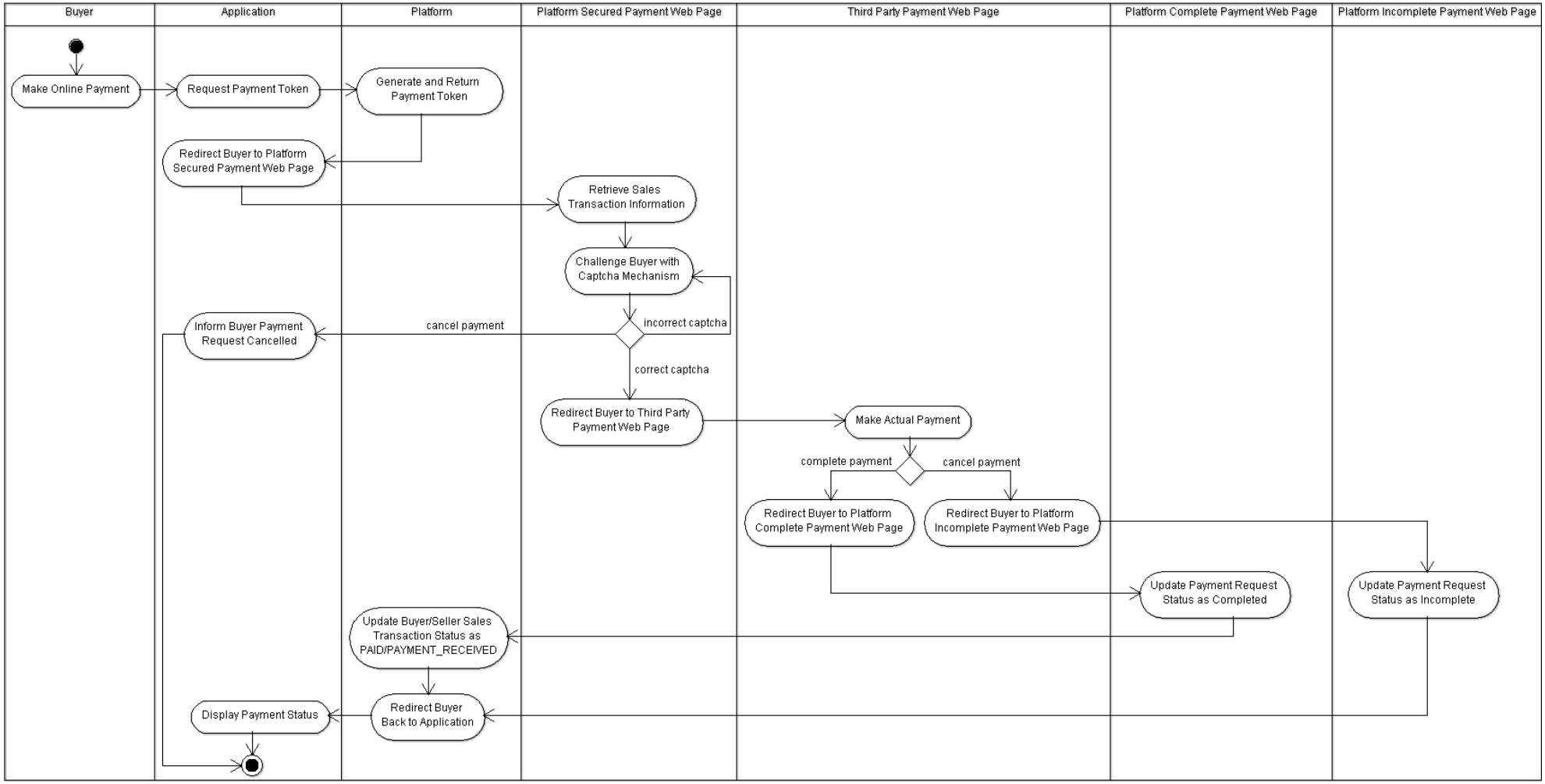


Figure 3.19 – UML activity diagram depicting online payment process schematic of the proposed platform payment service.

Payment Service	
PayPal	
API Method Name	**Description**
CreatePayPalPayment Request	This method allows client to request a PayPal payment request on behalf of a buyer using a particular application. The payment request is for a specific sales transaction that the buyer has previously checkout. The sales transaction may be checkout from any applications. In other words, buyers are not restricted to paying for sales transactions that are only checkout from the current application. This method essentially request for a payment token from the platform for the required sales transaction. After obtaining the payment token, the client must redirect the buyer to the platform secured PayPal payment page. The payment token is valid for one-time use only and will expire after a certain period of time if it is not used.
GetPayPalPaymentRequest ByToken	This method allows client to get the PayPal payment request associated with a particular PayPal payment token to query the transaction status. If buyer proceeds to the platform secured PayPal payment web page but cancel the transaction at this juncture, it is assumed that the request has not yet started. If buyer proceeds further to the actual PayPal Express Checkout web page and cancel the transaction at this juncture, the request is assumed to be incomplete. If buyer successfully completes the transaction, the request is assumed to be completed. If a transaction is held PENDING by PayPal, no further action should be required on the client side. The platform should have a centralized handler to process PayPal's Instant Payment Notification (IPN) and will update the payment status accordingly as and when the IPN comes in. In addition, if a transaction is held PENDING by PayPal, buyer will not be able to make another PayPal payment request until the accept/deny IPN comes in. Otherwise, if a PayPay payment is successfully completed, i.e., the platform will automatically update the sales transaction as follow: • Buyer sales transaction status - PAID • Seller sales transaction status - PAYMENT_RECEIVED

Table 3.10 – API method specification for payment services.

3.3.7 Rating and Review Service

After sales service and support is an important dimension of the functionalities in an electronic commerce website as it determines to a large extent whether a shopper who has just been converted into a customer will continue to become a repeat customer in the future. The rating and review service encompasses two important objectives. First, the platform allows a seller to rate a buyer in a sales transaction and vice versa for the buyer to rate the seller. The rating score and comment essentially form the respective reputation of each party and provide a critical source of information to help other users decide

whether to transact with the same seller/buyer in the future. Second, the platform will eventually allow the buyer to review the purchased product item. The review information comes with a separate rating of the product item. Collectively, the quantity score and qualitative comment constitute the electronic word-of-mouth that helps other potential buyers to decide whether to purchase the same product item.

The rating and review service currently defines a total of 5 reference methods for managing seller and buyer ratings as listed in Table 3.11. Additional methods may be added in the future to support product reviews.

Rating and Review Service	
Management of buyer/seller rating	
API Method Name	**Description**
CreateRating	This method allows client to create either a buyer rating or a seller rating for a particular sales transaction. If the user is the buyer of a sales transaction, only a seller rating for the seller of that sales transaction can be created, and vice versa.
GetRating	This method allows client to retrieve either a buyer rating or a seller rating previously created for a particular sales transaction.
GetRatings	This method allows client to retrieve a list of buyer ratings or seller ratings for a particular user. This list of ratings is typically displayed together with the user's buyer rating summary or seller rating summary, respectively. Records pagination, sorting and filtering are supported.
UpdateRating	This method allows client to update either a buyer rating or a seller rating previously created for a particular sales transaction.
GetRatingSummary	This method allows client to retrieve either a buyer rating summary or a seller rating summary for a particular user. By default, both rating summaries are initialized to 0s. The rating summaries are automatically updated as the user is rated by other users after completing sales transactions as either buyer or seller, respectively. The client can utilize the rating summary data to generate a rating bar chart. Alternatively, the platform should automatically generate and update a set of default bar charts that client can retrieve.

Table 3.11 – API method specification for rating and review services.

3.4 Instantiations

Instantiations operationalize the constructs, models and methods into the actual artifact that is used in the intended environment (March and Smith 1995). As part of this research, the constructs, models and methods defined in the preceding sections were used to create a fully functional prototype of the proposed platform, i.e., Cloud Commerce

(http://www.cloudcommercesg.com). Cloud Commerce exhibits all the characteristics listed in Table 2.1 and it is designed according to the reference architecture shown in Figure 2.2. More importantly, Cloud Commerce possesses all the capabilities that are required to fulfill the cloud computing-based distributed electronic commerce scenario depicted in Figure 2.8. Cloud Commerce epitomizes the best practice recommended by design science scholars to the extent that its design ideas have been implemented in concrete forms rather than exist as mere abstract entities (Arnott and Pervan 2012).

A detailed technical discussion of Cloud Commerce is beyond the scope of this dissertation. However, sufficient information will be presented in the remainder of this section to illustrate how the constructs, models and methods have been integrated into a fully functional prototype. A high-level architecture of Cloud Commerce is depicted in Figure 3.20. As shown in the figure, the entire platform essentially manifests as a core backend engine that is composed of persistence entities representing the constructs and models together with distributed components representing the methods. For each construct defined in the constructs specifications (see Table 3.1 to 3.4) and its corresponding model defined in the models specifications (see Figure 3.5 to 3.12), there exists an entity class to represent it. The core backend engine is exposed to external software applications via a comprehensive set of RESTful web service API methods. For each API method defined in our reference methods specifications (see Table 3.5 to 3.11), there exists an associated method implemented in a distributed component and another corresponding RESTful web service method that exposes this component method to the outside world.

There are currently two platform tools that have been created. The first platform tool is the Official Website that allows all users to perform general tasks associated with account,

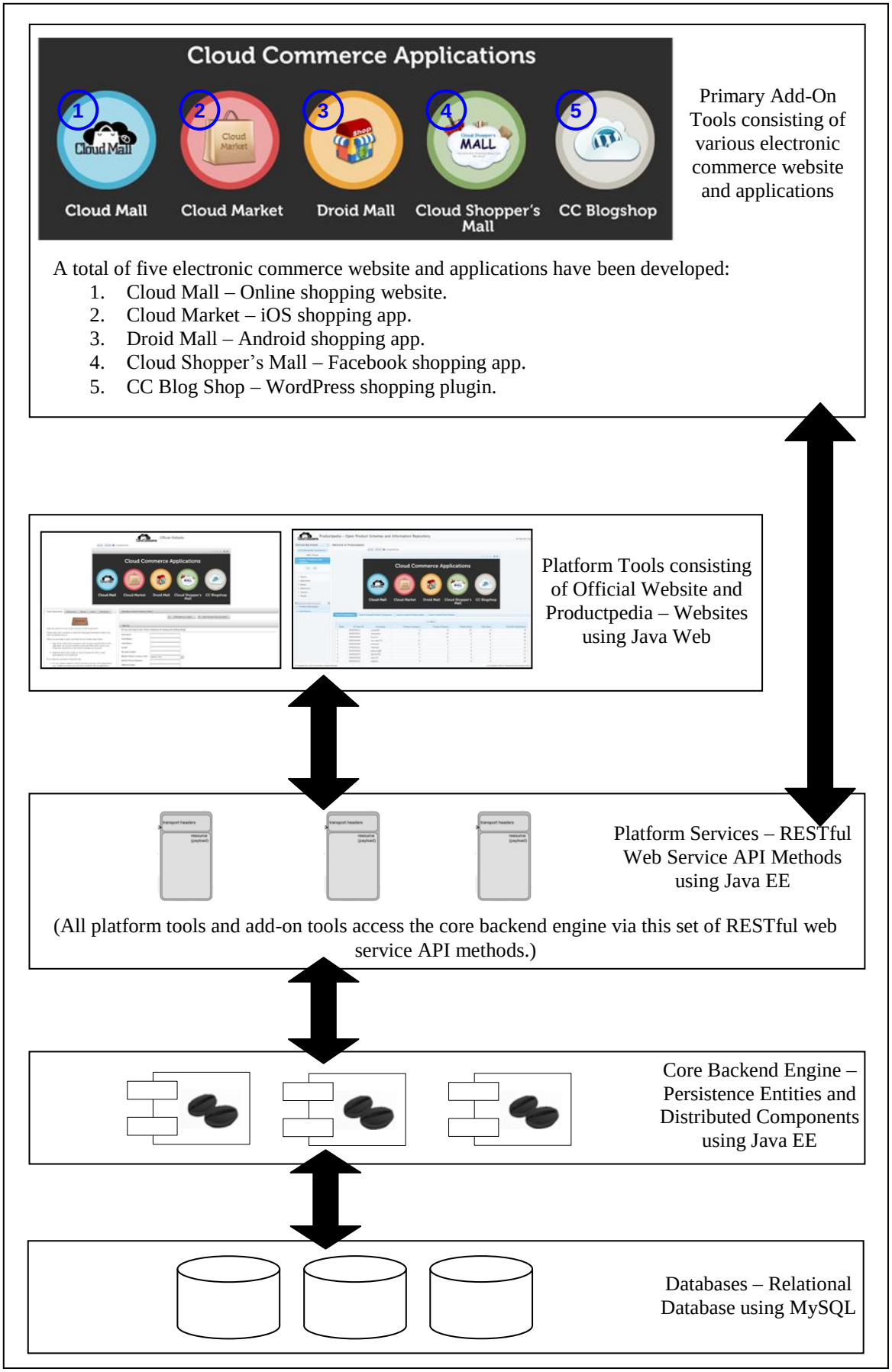


Figure 3.20 – High-level system architecture of Cloud Commerce based on the reference architecture depicted in Figure 2.2.

buyer and seller management. The second platform tool is the web front-end of our open product schemas and information repository, i.e., Productpedia. Primary add-on tools consist of a set of five electronic commerce website and applications carefully conceptualized, designed and developed to full the primary objective of the proposed platform, i.e., a true "website-less" platform that allows the buying and selling of products across multiple websites, channels and media. It should be noted that any community user may develop one's own add-on tool or application using the RESTful web service API methods. No secondary add-on tool has been developed at this juncture as they are of lesser importance in demonstrating the various concepts of the proposed platform. The entire set of software applications would eventually be put to actual use in a large scale field experiment, i.e., actual usage in the intended environment.

3.4.1 Identity Service

In Cloud Commerce's implementation of the identity service, each user is required to register for a Cloud Commerce account. A user may register for a Cloud Commerce account via any application, i.e., add-on tool. The application provides its own front-end user interface to obtain the required information as depicted in the User entity class in the UML class diagram of Figure 3.5. The application then invokes Cloud Commerce API CreateCloudCommerceUser method to perform the actual account creation. CreateCloudCommerceUser is Cloud Commerce implementation of the reference API method CreateUser as listed in Table 3.5.

All Cloud Commerce API methods must be invoked with a valid application key. In Cloud Commerce, each registered application is represented by an application key that manifests as a type 4 pseudo randomly generated UUID. A Cloud Commerce user can request for an application key using the Official Website. The application key represents a

security credential to access the API methods. If an application key is revoked by the user or disabled by an administrator, the application will no longer be able to invoke the API methods. The sample XML request and response of the CreateCloudCommerceUser method are depicted in Listing 3.1.

```
Request:
<?xml version="1.0" standalone="yes"?>
<createCloudCommerceUserRequest>
      <applicationKey>
            abcdefab-1234-5678-abcd-abcdefabcdef
      </applicationKey>
      <cloudCommerceUser>
            <username>testuser</username>
            <firstName>Test</firstName>
            <lastName>User</lastName>
            <email>testuser@gmail.com</email>
            <mobilePhoneCountryCallingCode>
                  65
            </mobilePhoneCountryCallingCode>
            <mobilePhoneNumber>91234567</mobilePhoneNumber>
            <referralEmail>anotheruser@gmail.com</referralEmail>
      </cloudCommerceUser>
</createCloudCommerceUserRequest>

Response:
<?xml version="1.0" standalone="yes"?>
<createCloudCommerceUserResponse>
      <rwsResponseStatus>SUCCESS</rwsResponseStatus>
      <message>SUCCESS</message>
      <errorType>SUCCESS</errorType>
</createCloudCommerceUserResponse>
```

Listing 3.1 – Sample XML request and response for CreateCloudCommerceUser method.

The login process depicted in Figure 3.14 is implemented as Cloud Commerce Unified Login. An application that wants to login a registered Cloud Commerce user must request for a login token by calling the CreateLoginToken method. Thereafter, the application will need to redirect the user to login at Cloud Commerce Unified Login web page by setting the login token as a query string parameter of the redirect Uniform Resource Locator (URL). The sample XML request and response of the CreateLoginToken method are depicted in Listing 3.2. Actual screenshots depicting the login process with Cloud Mall, an online shopping website developed with the Cloud Commerce API, is shown in Figure 3.21. In the case of a mobile smartphone app, the app will need to use a web

browser panel from the mobile operating system's software development kit (SDK) to display the Cloud Commerce Unified Login web page.

```
Request:
<?xml version="1.0" standalone="yes"?>
<createLoginTokenRequest>
      <applicationKey>
            abcdefab-1234-5678-abcd-abcdefabcdef
      </applicationKey>
</createLoginTokenRequest>

Response:
<?xml version="1.0" standalone="yes"?>
<createLoginTokenResponse>
      <rwsResponseStatus>SUCCESS</rwsResponseStatus>
      <message>SUCCESS</message>
      <errorType>SUCCESS</errorType>
      <loginToken>cf60cfbc-fc73-4dff-8473-da74de5bd990</loginToken>
</createLoginTokenResponse>
```

Listing 3.2 – Sample XML request and response for CreateLoginToken method.

3.4.2 Product Information Service

Cloud Commerce product information service implements all 47 reference methods listed in Table 3.6 for managing unit classes, product categories, product schemas and product items in the open product schemas and information repository Productpedia. The generic data record management process schematic depicted in Figure 3.15 is demonstrated with an example of unit class management in Productpedia. This is shown in Figure 3.22. In this example, the unit class Storage Capacity is created with 5 units Byte, Kilobyte, Megabyte, Gigabyte and Terabyte. There are altogether 6 instances of the unit class Storage Capacity. The first instance, i.e., Version 0, is created when the unit class is first created without any unit. Thereafter, the creation of each new unit will lead to the creation of a new instance of the unit class. The last instance, i.e., the sixth instance is Version 5. As shown in Figure 3.15, Cloud Commerce keeps track of all revisions made to each data record instance. At this juncture, the revisions are tracked in an unstructured manner. In the future, it is possible to enhance the platform by tracking the revisions in

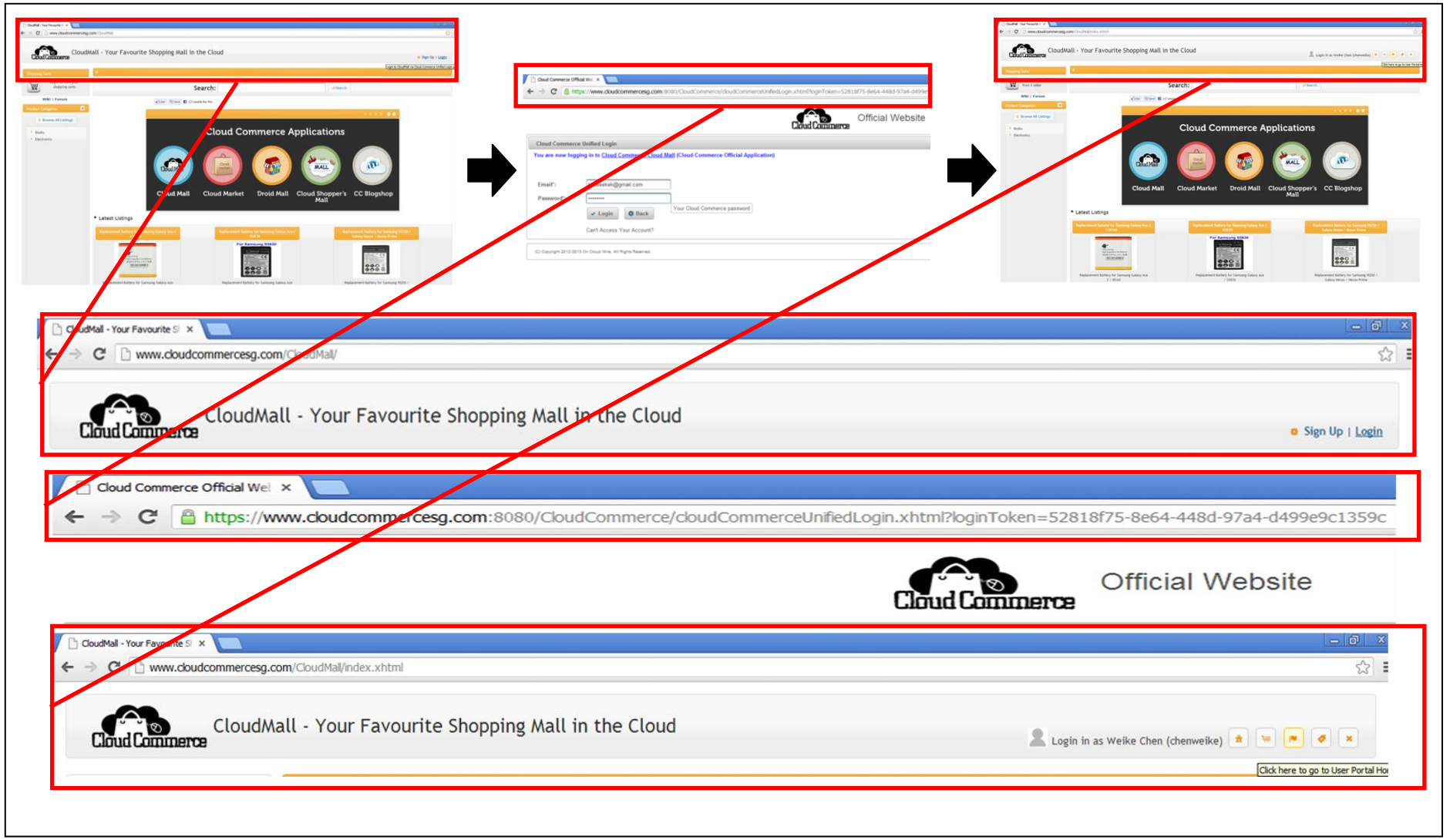
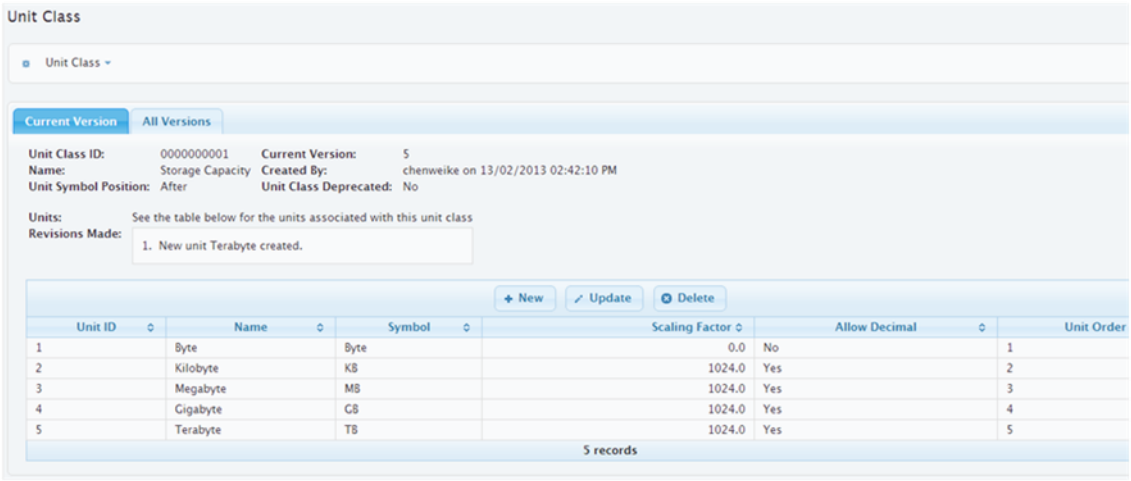
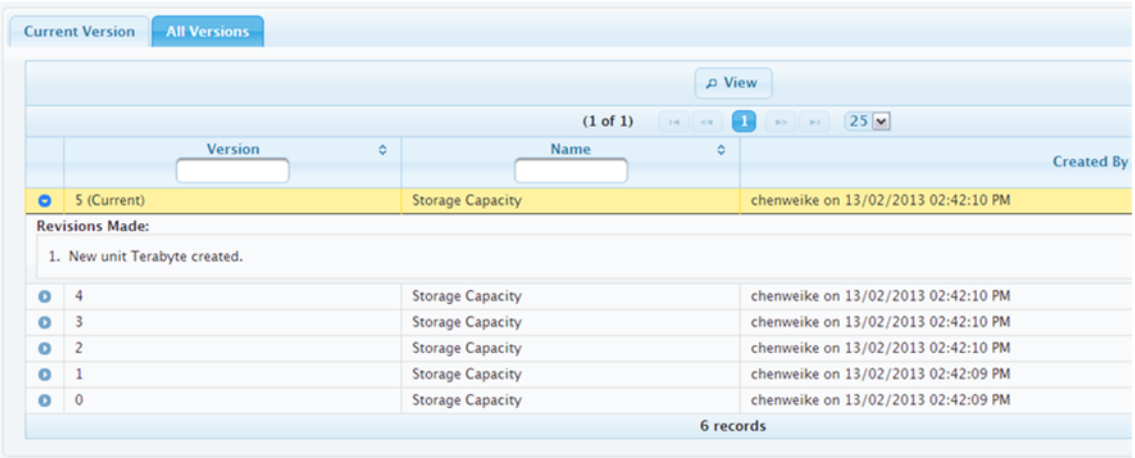


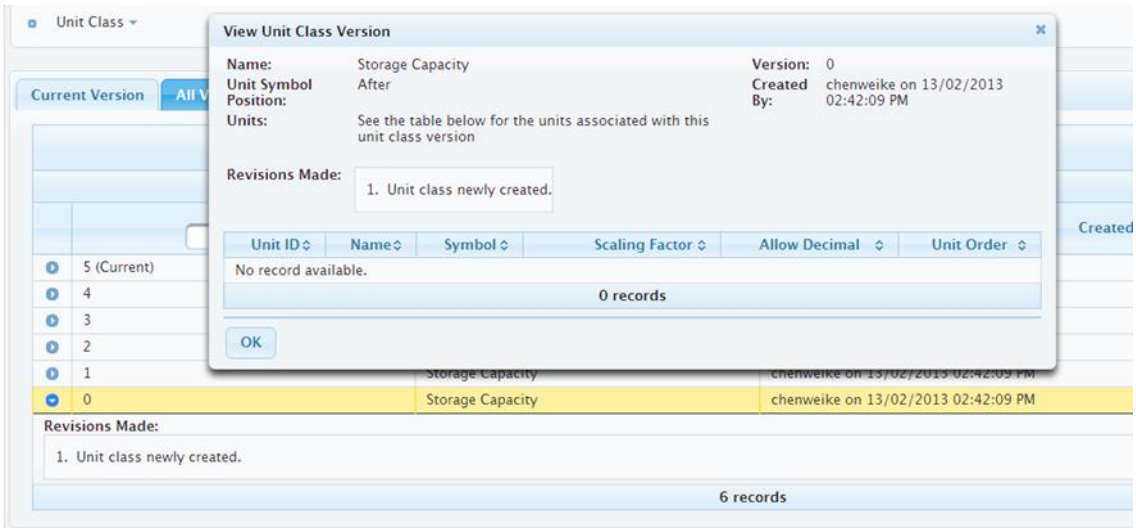
Figure 3.21 – Demonstration of login process as implemented in Cloud Commerce identity service. A user login to Cloud Mall via Cloud Commerce Unified Login web page on the Official Website.



Current instance, i.e., Version 5, of the unit class Storage Capacity.



Revisions made to Version 5 of the unit class Storage Capacity.



Revisions made to Version 0 of the unit class Storage Capacity.

Figure 3.22 – Demonstration of data record management process as implemented in Cloud Commerce product information service. The screenshots show the revisions made to the unit class Storage Capacity.

some structured manner. The XML artifact representing the unit class Storage Capacity is shown in Listing 3.3. This XML artifact is retrieved using the GetUnitClass API method.

```
<unitClass>
      <id>1</id>
      <versionCounter>5</versionCounter>
      <unitCounter>5</unitCounter>
      <deprecated>false</deprecated>
      <deleted>false</deleted>
      <currentUnitClassInstance>
            <id>6</id>
            <name>Storage Capacity</name>
            <version>5</version>
            <unitSymbolPosition>AFTER</unitSymbolPosition>
            <creationTimestamp>2013-02-13 14:42:10.0</creationTimestamp>
            <units>
                  <unit>
                        <id>1</id>
                        <unitId>1</unitId>
                        <name>Byte</name>
                        <symbol>Byte</symbol>
                        <unitOrder>1</unitOrder>
                        <scalingFactor>0.0</scalingFactor>
                        <allowDecimal>false</allowDecimal>
                        <deleted>false</deleted>
                  </unit>
                  <unit>
                        <id>2</id>
                        <unitId>2</unitId>
                        <name>Kilobyte</name>
                        <symbol>KB</symbol>
                        <unitOrder>2</unitOrder>
                        <scalingFactor>1024.0</scalingFactor>
                        <allowDecimal>true</allowDecimal>
                        <deleted>false</deleted>
                  </unit>
                  <unit>
                        <id>3</id>
                        <unitId>3</unitId>
                        <name>Megabyte</name>
                        <symbol>MB</symbol>
                        <unitOrder>3</unitOrder>
                        <scalingFactor>1024.0</scalingFactor>
                        <allowDecimal>true</allowDecimal>
                        <deleted>false</deleted>
                  </unit>
                  <unit>
                        <id>4</id>
                        <unitId>4</unitId>
                        <name>Gigabyte</name>
                        <symbol>GB</symbol>
                        <unitOrder>4</unitOrder>
                        <scalingFactor>1024.0</scalingFactor>
                        <allowDecimal>true</allowDecimal>
                        <deleted>false</deleted>
                  </unit>
                  <unit>
                        <id>5</id>
```

```
                        <unitId>5</unitId>
                        <name>Terabyte</name>
                        <symbol>TB</symbol>
                        <unitOrder>5</unitOrder>
                        <scalingFactor>1024.0</scalingFactor>
                        <allowDecimal>true</allowDecimal>
                        <deleted>false</deleted>
                  </unit>
            </units>
            <unitClassRevisions>
                  <unitClassRevision>
                        <id>6</id>
                        <revision>New unit Terabyte created.</revision>
                  </unitClassRevision>
            </unitClassRevisions>
            <cloudCommerceUser>
                  <id>2</id>
                  <username>chenweike</username>
                  <userProfile>
                        <id>2</id>
                  </userProfile>
            </cloudCommerceUser>
      </currentUnitClassInstance>
</unitClass>
```

Listing 3.3 – XML artifact representing the unit class Storage Capacity.

The XML artifact representing the product category Books > Textbooks > Computing is shown in Listing 3.4. This XML artifact is retrieved using the GetProductCategory API method. Since this is a leaf product category, we can retrieve its product schema using the GetProductSchema API method. The XML artifact representing the product schema of the leaf product category Books > Textbooks > Computing is shown in Listing 3.5. The product schema enables items that belong to this leaf product category to be described using a rich set of product attributes as proposed in the reference models shown in Figure 3.8. A screenshot of the product schema taken from the Productpedia website is shown in Figure 3.23. As shown in this screenshot, there are multiple instances of the same product schema and the revisions made to each instance are tracked by Cloud Commerce.

```
<productCategory>
      <id>42</id>
      <versionCounter>0</versionCounter>
      <isRootProductCategory>false</isRootProductCategory>
      <isLeafProductCategory>true</isLeafProductCategory>
      <deprecated>false</deprecated>
      <deleted>false</deleted>
      <currentProductCategoryInstance>
            <id>97</id>
```

```
            <name>Computing</name>
            <version>0</version>
            <creationTimestamp>2013-02-28 00:55:59.0</creationTimestamp>
            <parentProductCategory>
                  <id>41</id>
                  <versionCounter>7</versionCounter>
                  <isRootProductCategory>false</isRootProductCategory>
                  <isLeafProductCategory>false</isLeafProductCategory>
                  <deprecated>false</deprecated>
                  <deleted>false</deleted>
                  <currentProductCategoryInstance>
                        <id>98</id>
                        <name>Textbooks</name>
                        <version>7</version>
                        <creationTimestamp>
                              2013-02-28 00:55:59.0
                        </creationTimestamp>
                        <parentProductCategory>
                              <id>2</id>
                              <versionCounter>17</versionCounter>
                              <isRootProductCategory>
                                    true
                              </isRootProductCategory>
                              <isLeafProductCategory>
                                    false
                              </isLeafProductCategory>
                              <deprecated>false</deprecated>
                              <deleted>false</deleted>
                              <currentProductCategoryInstance>
                                    <id>95</id>
                                    <name>Books</name>
                                    <version>17</version>
                                    <creationTimestamp>
                                          2013-02-27 16:58:00.0
                                    </creationTimestamp>
                                    <cloudCommerceUser>
                                          <id>2</id>
                                          <username>chenweike</username>
                                          <userProfile>
                                                <id>2</id>
                                          </userProfile>
                                    </cloudCommerceUser>
                              </currentProductCategoryInstance>
                        </parentProductCategory>
                        <cloudCommerceUser>
                              <id>2</id>
                              <username>chenweike</username>
                              <userProfile>
                                    <id>2</id>
                              </userProfile>
                        </cloudCommerceUser>
                  </currentProductCategoryInstance>
            </parentProductCategory>
            <productCategoryRevisions>
                  <productCategoryRevision>
                        <id>101</id>
                        <revision>
                              Product category newly created.
                        </revision>
                  </productCategoryRevision>
            </productCategoryRevisions>
```

```
            <cloudCommerceUser>
                  <id>2</id>
                  <username>chenweike</username>
                  <userProfile>
                        <id>2</id>
                  </userProfile>
            </cloudCommerceUser>
      </currentProductCategoryInstance>
</productCategory>
```

Listing 3.4 – XML artifact representing the leaf product category Books > Textbooks > Computing.

```
<productSchema>
      <id>32</id>
      <versionCounter>12</versionCounter>
      <attributeCounter>10</attributeCounter>
      <productCategory>
            <id>42</id>
            <versionCounter>0</versionCounter>
            <isRootProductCategory>
                  false
            </isRootProductCategory>
            <isLeafProductCategory>
                  true
            </isLeafProductCategory>
            <deprecated>false</deprecated>
            <deleted>false</deleted>
            <currentProductCategoryInstance>
                  <id>97</id>
                  <name>Computing</name>
                  <version>0</version>
                  <creationTimestamp>
                        2013-02-28 00:55:59.0
                  </creationTimestamp>
                  <parentProductCategory>
                        <id>41</id>
                        <versionCounter>7</versionCounter>
                        <isRootProductCategory>
                              false
                        </isRootProductCategory>
                        <isLeafProductCategory>
                              false
                        </isLeafProductCategory>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <currentProductCategoryInstance>
                              <id>98</id>
                              <name>Textbooks</name>
                              <version>7</version>
                              <creationTimestamp>
                                    2013-02-28 00:55:59.0
                              </creationTimestamp>
                              <parentProductCategory>
                                    <id>2</id>
                                    <versionCounter>17</versionCounter>
                                    <isRootProductCategory>
                                          true
                                    </isRootProductCategory>
                                    <isLeafProductCategory>
                                          false
                                    </isLeafProductCategory>
```

```
                                    <deprecated>false</deprecated>
                                    <deleted>false</deleted>
                                    <currentProductCategoryInstance>
                                          <id>95</id>
                                          <name>Books</name>
                                          <version>17</version>
                                          <creationTimestamp>
                                                2013-02-27 16:58:00.0
                                          </creationTimestamp>
                                          <cloudCommerceUser>
                                                <id>2</id>
                                                <username>
                                                      chenweike
                                                </username>
                                                <userProfile>
                                                      <id>2</id>
                                                </userProfile>
                                          </cloudCommerceUser>
                                    </currentProductCategoryInstance>
                              </parentProductCategory>
                              <cloudCommerceUser>
                                    <id>2</id>
                                    <username>
                                          chenweike
                                    </username>
                                    <userProfile>
                                          <id>2</id>
                                    </userProfile>
                              </cloudCommerceUser>
                        </currentProductCategoryInstance>
                  </parentProductCategory>
                  <productCategoryRevisions>
                        <productCategoryRevision>
                              <id>101</id>
                              <revision>
                                    Product category newly created.
                              </revision>
                        </productCategoryRevision>
                  </productCategoryRevisions>
            </currentProductCategoryInstance>
      </productCategory>
      <currentProductSchemaInstance>
            <id>62</id>
            <version>12</version>
            <creationTimestamp>2013-02-28 01:13:35.0</creationTimestamp>
            <productSchemaRevisions>
                  <productSchemaRevision>
                        <id>62</id>
                        <revision>
                              New product attribute Product Dimensions
created.
                        </revision>
                  </productSchemaRevision>
            </productSchemaRevisions>
            <productAttributes>
                  <productAttribute>
                        <id>16</id>
                        <attributeId>1</attributeId>
                        <name>Authors</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
```

```
                        <sortOrder>1</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>19</id>
                        <attributeId>2</attributeId>
                        <name>Cover Type</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>2</valueCounter>
                        <sortOrder>2</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              true
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues>
                              <productAttributeValue>
                                    <id>8</id>
                                    <valueId>1</valueId>
                                    <attributeValue>
                                          Hardcover
                                    </attributeValue>
                                    <sortOrder>1</sortOrder>
                                    <deprecated>false</deprecated>
                                    <deleted>false</deleted>
                              </productAttributeValue>
                              <productAttributeValue>
                                    <id>9</id>
                                    <valueId>2</valueId>
                                    <attributeValue>
                                          Paperback
                                    </attributeValue>
                                    <sortOrder>2</sortOrder>
                                    <deprecated>false</deprecated>
                                    <deleted>false</deleted>
                              </productAttributeValue>
```

A product attribute with predefined values defined.

```
                        </productAttributeValues>
                    </productAttribute>
                    <productAttribute>
                        <id>20</id>
                        <attributeId>3</attributeId>
                        <name>Pages</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>3</sortOrder>
                        <hasPredefinedProductAttributeValues>
                            false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                            NUMERIC
                        </productAttributeType>
                        <productAttributeScale>
                            NOMINAL
                        </productAttributeScale>
                        <productValueType>
                            SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                    </productAttribute>
                    <productAttribute>
                        <id>21</id>
                        <attributeId>4</attributeId>
                        <name>Publisher</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>4</sortOrder>
                        <hasPredefinedProductAttributeValues>
                            false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                            STRING
                        </productAttributeType>
                        <productAttributeScale>
                            NOMINAL
                        </productAttributeScale>
                        <productValueType>
                            SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                    </productAttribute>
                    <productAttribute>
                        <id>22</id>
                        <attributeId>5</attributeId>
                        <name>Edition</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>5</sortOrder>
                        <hasPredefinedProductAttributeValues>
                            false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
```

```
                        STRING
                    </productAttributeType>
                    <productAttributeScale>
                        NOMINAL
                    </productAttributeScale>
                    <productValueType>
                        SINGLE_VALUE
                    </productValueType>
                    <deprecated>false</deprecated>
                    <deleted>false</deleted>
                    <productAttributeAliases/>
                    <productAttributeValues/>
                </productAttribute>
                <productAttribute>
                    <id>23</id>
                    <attributeId>6</attributeId>
                    <name>Year</name>
                    <aliasCounter>0</aliasCounter>
                    <valueCounter>0</valueCounter>
                    <sortOrder>6</sortOrder>
                    <hasPredefinedProductAttributeValues>
                        false
                    </hasPredefinedProductAttributeValues>
                    <productAttributeType>
                        STRING
                    </productAttributeType>
                    <productAttributeScale>
                        NOMINAL
                    </productAttributeScale>
                    <productValueType>
                        SINGLE_VALUE
                    </productValueType>
                    <deprecated>false</deprecated>
                    <deleted>false</deleted>
                    <productAttributeAliases/>
                    <productAttributeValues/>
                </productAttribute>
                <productAttribute>
                    <id>24</id>
                    <attributeId>7</attributeId>
                    <name>Language</name>
                    <aliasCounter>0</aliasCounter>
                    <valueCounter>0</valueCounter>
                    <sortOrder>7</sortOrder>
                    <hasPredefinedProductAttributeValues>
                        false
                    </hasPredefinedProductAttributeValues>
                    <productAttributeType>
                        STRING
                    </productAttributeType>
                    <productAttributeScale>
                        NOMINAL
                    </productAttributeScale>
                    <productValueType>
                        SINGLE_VALUE
                    </productValueType>
                    <deprecated>false</deprecated>
                    <deleted>false</deleted>
                    <productAttributeAliases/>
                    <productAttributeValues/>
                </productAttribute>
```

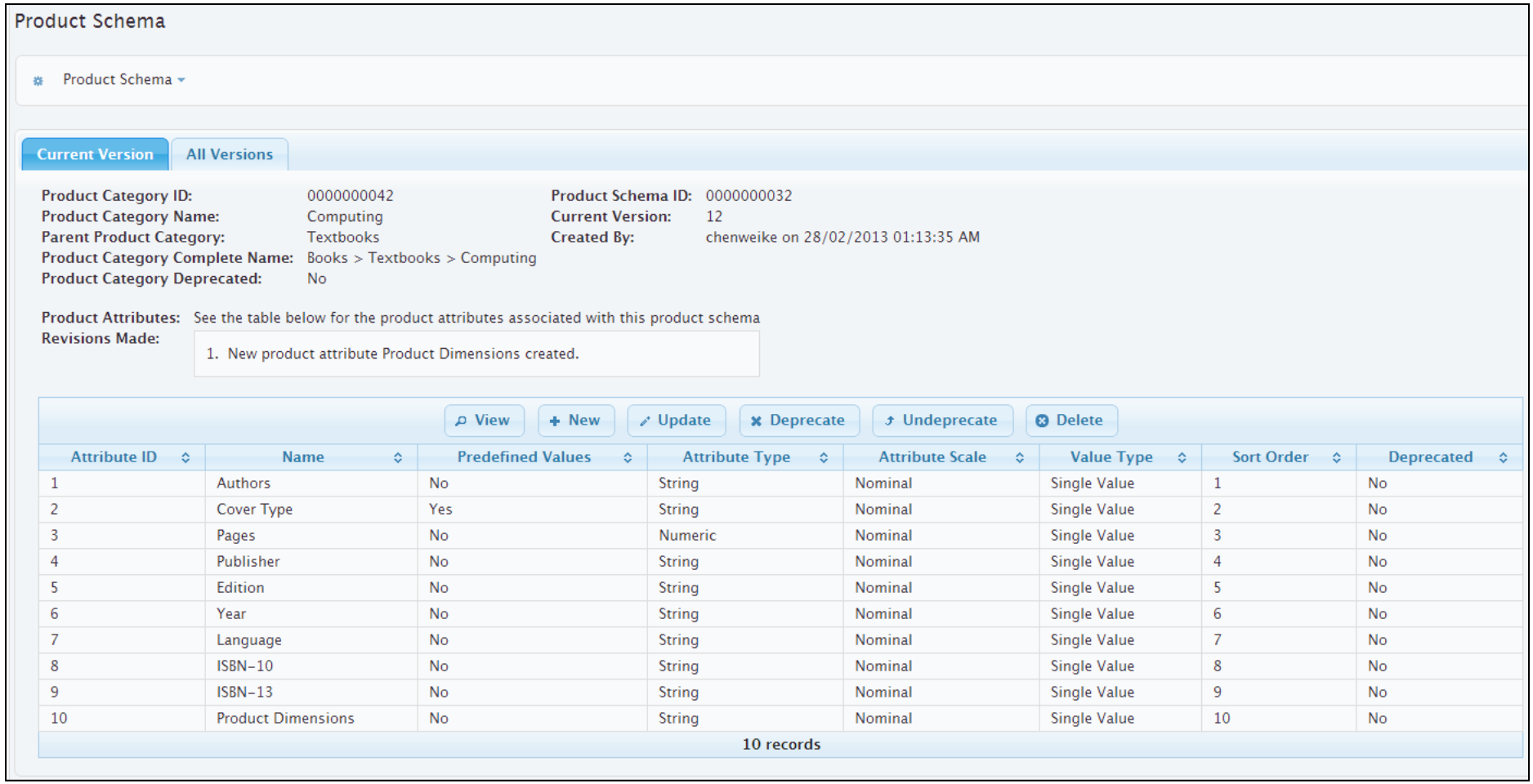
```
                  <productAttribute>
                        <id>25</id>
                        <attributeId>8</attributeId>
                        <name>ISBN-10</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>8</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>26</id>
                        <attributeId>9</attributeId>
                        <name>ISBN-13</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>9</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>27</id>
                        <attributeId>10</attributeId>
                        <name>Product Dimensions</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>10</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
```

```
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
            </productAttributes>
            <cloudCommerceUser>
                  <id>2</id>
                  <username>chenweike</username>
                  <userProfile>
                        <id>2</id>
                  </userProfile>
            </cloudCommerceUser>
      </currentProductSchemaInstance>
</productSchema>
```

Listing 3.5 – XML artifact representing the product schema of the leaf product category Books > Textbooks > Computing.

The XML artifact representing the product item "Pearson Prentice Hall Computer Confluence: Tomorrows Technology and You (Product Item ID: 0000000034)" is shown in Listing 3.6. This XML artifact is retrieved using the GetProductItem API method. The product item belongs to the leaf product category Books > Textbooks > Computing. As shown in the XML artifact, this textbook may be described in rich details using the product attribute defined in the product schema of the leaf product category Books > Textbooks > Computing. The XML artifact for the product item is portable for use in any application to the extent that the corresponding product schema is self-contained within the same XML artifact. An application that understands the Cloud Commerce XML standards will be able to display the rich description of the product item.

The XML artifact also contains the product item images, if any. The URL for each image may be used to retrieve the actual image file from the centralized file repository in the cloud. A screenshot of the product item taken from the Productpedia website is shown in Figure 3.24 and 3.25. As shown in the screenshot, there are multiple instances of the same product item and the revisions made to each instance are tracked by Cloud Commerce.



Product Schema

Product Schema

Current Version | All Versions

Product Category ID: 0000000042
Product Category Name: Computing
Parent Product Category: Textbooks
Product Category Complete Name: Books > Textbooks > Computing
Product Category Deprecated: No

Product Schema ID: 0000000032
Current Version: 12
Created By: chenweike on 28/02/2013 01:13:35 AM

Product Attributes: See the table below for the product attributes associated with this product schema
Revisions Made:

1. New product attribute Product Dimensions created.

View | New | Update | Deprecate | Undeprecate | Delete

Attribute ID	Name	Predefined Values	Attribute Type	Attribute Scale	Value Type	Sort Order	Deprecated
1	Authors	No	String	Nominal	Single Value	1	No
2	Cover Type	Yes	String	Nominal	Single Value	2	No
3	Pages	No	Numeric	Nominal	Single Value	3	No
4	Publisher	No	String	Nominal	Single Value	4	No
5	Edition	No	String	Nominal	Single Value	5	No
6	Year	No	String	Nominal	Single Value	6	No
7	Language	No	String	Nominal	Single Value	7	No
8	ISBN-10	No	String	Nominal	Single Value	8	No
9	ISBN-13	No	String	Nominal	Single Value	9	No
10	Product Dimensions	No	String	Nominal	Single Value	10	No

10 records

Figure 3.23 – Screenshot taken from the Productpeia website showing the product schema of the leaf product category Books > Textbooks > Computing.

```
<productItem>
      <id>34</id>
      <versionCounter>13</versionCounter>
      <imageCounter>1</imageCounter>
      <availableImages>1</availableImages>
      <deprecated>false</deprecated>
      <deleted>false</deleted>
      <productCategory>
            <id>42</id>
            <versionCounter>0</versionCounter>
            <isRootProductCategory>
                  false
            </isRootProductCategory>
            <isLeafProductCategory>
                  true
            </isLeafProductCategory>
            <deprecated>false</deprecated>
            <deleted>false</deleted>
            <currentProductCategoryInstance>
                  <id>97</id>
                  <name>Computing</name>
                  <version>0</version>
                  <creationTimestamp>
                        2013-02-28 00:55:59.0
                  </creationTimestamp>
                  <parentProductCategory>
                        <id>41</id>
                        <versionCounter>7</versionCounter>
                        <isRootProductCategory>false</isRootProductCategory>
                        <isLeafProductCategory>false</isLeafProductCategory>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <currentProductCategoryInstance>
                              <id>98</id>
                              <name>Textbooks</name>
                              <version>7</version>
                              <creationTimestamp>
                                    2013-02-28 00:55:59.0
```

```
                        </creationTimestamp>
                        <parentProductCategory>
                              <id>2</id>
                              <versionCounter>17</versionCounter>
                              <isRootProductCategory>
                                    true
                              </isRootProductCategory>
                              <isLeafProductCategory>
                                    false
                              </isLeafProductCategory>
                              <deprecated>false</deprecated>
                              <deleted>false</deleted>
                              <currentProductCategoryInstance>
                                    <id>95</id>
                                    <name>Books</name>
                                    <version>17</version>
                                    <creationTimestamp>
                                          2013-02-27 16:58:00.0
                                    </creationTimestamp>
                              </currentProductCategoryInstance>
                        </parentProductCategory>
                  </currentProductCategoryInstance>
            </parentProductCategory>
      </currentProductCategoryInstance>
      <productSchema>
            <id>32</id>
            <versionCounter>12</versionCounter>
            <attributeCounter>10</attributeCounter>
            <productCategory>
                  <id>42</id>
                  <deleted>false</deleted>
                  <productCategoryInstances/>
                  <productItems/>
                  <associatedProductCategories/>
            </productCategory>
            <currentProductSchemaInstance>
                  <id>62</id>
                  <version>12</version>
```

Product schema is embedded as part of the product item

```
                        <creationTimestamp>
                              2013-02-28 01:13:35.0
                        </creationTimestamp>
                        <productSchemaRevisions>
                              <productSchemaRevision>
                                    <id>62</id>
                                    <revision>
                                          New product attribute Product Dimensions created.
                                    </revision>
                              </productSchemaRevision>
                        </productSchemaRevisions>
                        <productAttributes>
                              <productAttribute>
                                    <id>16</id>
                                    <attributeId>1</attributeId>
                                    <name>Authors</name>
                                    <aliasCounter>0</aliasCounter>
                                    <valueCounter>0</valueCounter>
                                    <sortOrder>1</sortOrder>
                                    <hasPredefinedProductAttributeValues>
                                          false
                                    </hasPredefinedProductAttributeValues>
                                    <productAttributeType>
                                          STRING
                                    </productAttributeType>
                                    <productAttributeScale>
                                          NOMINAL
                                    </productAttributeScale>
                                    <productValueType>
                                          SINGLE_VALUE
                                    </productValueType>
                                    <deprecated>false</deprecated>
                                    <deleted>false</deleted>
                                    <productAttributeAliases/>
                                    <productAttributeValues/>
                              </productAttribute>
                              <productAttribute>
                                    <id>19</id>
```

```
<attributeId>2</attributeId>
<name>Cover Type</name>
<aliasCounter>0</aliasCounter>
<valueCounter>2</valueCounter>
<sortOrder>2</sortOrder>
<hasPredefinedProductAttributeValues>
      true
</hasPredefinedProductAttributeValues>
<productAttributeType>
      STRING
</productAttributeType>
<productAttributeScale>
      NOMINAL
</productAttributeScale>
<productValueType>
      SINGLE_VALUE
</productValueType>
<deprecated>false</deprecated>
<deleted>false</deleted>
<productAttributeAliases/>
<productAttributeValues>
      <productAttributeValue>
            <id>8</id>
            <valueId>1</valueId>
            <attributeValue>
                  Hardcover
            </attributeValue>
            <sortOrder>1</sortOrder>
            <deprecated>false</deprecated>
            <deleted>false</deleted>
      </productAttributeValue>
      <productAttributeValue>
            <id>9</id>
            <valueId>2</valueId>
            <attributeValue>
                  Paperback
            </attributeValue>
            <sortOrder>2</sortOrder>
```

```
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                  </productAttributeValue>
            </productAttributeValues>
      </productAttribute>
      <productAttribute>
            <id>20</id>
            <attributeId>3</attributeId>
            <name>Pages</name>
            <aliasCounter>0</aliasCounter>
            <valueCounter>0</valueCounter>
            <sortOrder>3</sortOrder>
            <hasPredefinedProductAttributeValues>
                  false
            </hasPredefinedProductAttributeValues>
            <productAttributeType>
                  NUMERIC
            </productAttributeType>
            <productAttributeScale>
                  NOMINAL
            </productAttributeScale>
            <productValueType>
                  SINGLE_VALUE
            </productValueType>
            <deprecated>false</deprecated>
            <deleted>false</deleted>
            <productAttributeAliases/>
            <productAttributeValues/>
      </productAttribute>
      <productAttribute>
            <id>21</id>
            <attributeId>4</attributeId>
            <name>Publisher</name>
            <aliasCounter>0</aliasCounter>
            <valueCounter>0</valueCounter>
            <sortOrder>4</sortOrder>
            <hasPredefinedProductAttributeValues>
                  false
```

```
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>22</id>
                        <attributeId>5</attributeId>
                        <name>Edition</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>5</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
```

```
                        </productAttribute>
                        <productAttribute>
                              <id>23</id>
                              <attributeId>6</attributeId>
                              <name>Year</name>
                              <aliasCounter>0</aliasCounter>
                              <valueCounter>0</valueCounter>
                              <sortOrder>6</sortOrder>
                              <hasPredefinedProductAttributeValues>
                                    false
                              </hasPredefinedProductAttributeValues>
                              <productAttributeType>
                                    STRING
                              </productAttributeType>
                              <productAttributeScale>
                                    NOMINAL
                              </productAttributeScale>
                              <productValueType>
                                    SINGLE_VALUE
                              </productValueType>
                              <deprecated>false</deprecated>
                              <deleted>false</deleted>
                              <productAttributeAliases/>
                              <productAttributeValues/>
                        </productAttribute>
                        <productAttribute>
                              <id>24</id>
                              <attributeId>7</attributeId>
                              <name>Language</name>
                              <aliasCounter>0</aliasCounter>
                              <valueCounter>0</valueCounter>
                              <sortOrder>7</sortOrder>
                              <hasPredefinedProductAttributeValues>
                                    false
                              </hasPredefinedProductAttributeValues>
                              <productAttributeType>
                                    STRING
                              </productAttributeType>
```

```
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>25</id>
                        <attributeId>8</attributeId>
                        <name>ISBN-10</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>8</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>26</id>
                        <attributeId>9</attributeId>
```

```
                        <name>ISBN-13</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>9</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
                              SINGLE_VALUE
                        </productValueType>
                        <deprecated>false</deprecated>
                        <deleted>false</deleted>
                        <productAttributeAliases/>
                        <productAttributeValues/>
                  </productAttribute>
                  <productAttribute>
                        <id>27</id>
                        <attributeId>10</attributeId>
                        <name>Product Dimensions</name>
                        <aliasCounter>0</aliasCounter>
                        <valueCounter>0</valueCounter>
                        <sortOrder>10</sortOrder>
                        <hasPredefinedProductAttributeValues>
                              false
                        </hasPredefinedProductAttributeValues>
                        <productAttributeType>
                              STRING
                        </productAttributeType>
                        <productAttributeScale>
                              NOMINAL
                        </productAttributeScale>
                        <productValueType>
```

```
                                        SINGLE_VALUE
                                    </productValueType>
                                    <deprecated>false</deprecated>
                                    <deleted>false</deleted>
                                    <productAttributeAliases/>
                                    <productAttributeValues/>
                              </productAttribute>
                        </productAttributes>
                        <cloudCommerceUser>
                              <id>2</id>
                              <username>
                                    chenweike
                              </username>
                              <userProfile>
                                    <id>2</id>
                              </userProfile>
                        </cloudCommerceUser>
                  </currentProductSchemaInstance>
            </productSchema>
      </productCategory>
      <currentProductItemInstance>
            <id>122</id>
            <version>13</version>
            <brand>Pearson Prentice Hall</brand>
            <model>
                  Computer Confluence: Tomorrows Technology and You
            </model>
            <manufacturerPartNumber>
            </manufacturerPartNumber>
            <universalProductCode>
            </universalProductCode>
            <internationalArticleNumber>
            </internationalArticleNumber>
            <description>
                  For introductory courses in computer concepts often including instruction in Microsoft Office. Integrates three information sources-an illustrated textbook, a multimedia CD, and a Companion Website-with a lively writing style to explore the promises and challenges of information technology, its effect on businesses, people, society, and the future.
```

```
            </description>
            <creationTimestamp>
                  2013-02-28 01:14:54.0
            </creationTimestamp>
            <productItemRevisions>
                  <productItemRevision>
                        <id>123</id>
                        <revision>Attribute Authors updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>124</id>
                        <revision>Attribute Cover Type updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>125</id>
                        <revision>Attribute Pages updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>126</id>
                        <revision>Attribute Publisher updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>127</id>
                        <revision>Attribute Edition updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>128</id>
                        <revision>Attribute Year updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>129</id>
                        <revision>Attribute Language updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>130</id>
                        <revision>Attribute ISBN-10 updated</revision>
                  </productItemRevision>
                  <productItemRevision>
```

```
                        <id>131</id>
                        <revision>Attribute ISBN-13 updated</revision>
                  </productItemRevision>
                  <productItemRevision>
                        <id>132</id>
                        <revision>
                              Attribute Product Dimensions updated
                        </revision>
                  </productItemRevision>
            </productItemRevisions>
            <itemAttributes>
                  <itemAttribute>
                        <id>20</id>
                        <attributeId>1</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>6</id>
                                    <itemValue>
                                          George Beekman and Michael J. Quinn
                                    </itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>21</id>
                        <attributeId>2</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>7</id>
                                    <itemValue>2</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
```

Each item attribute is mapped to a product attribute in the product schema using attributeId.

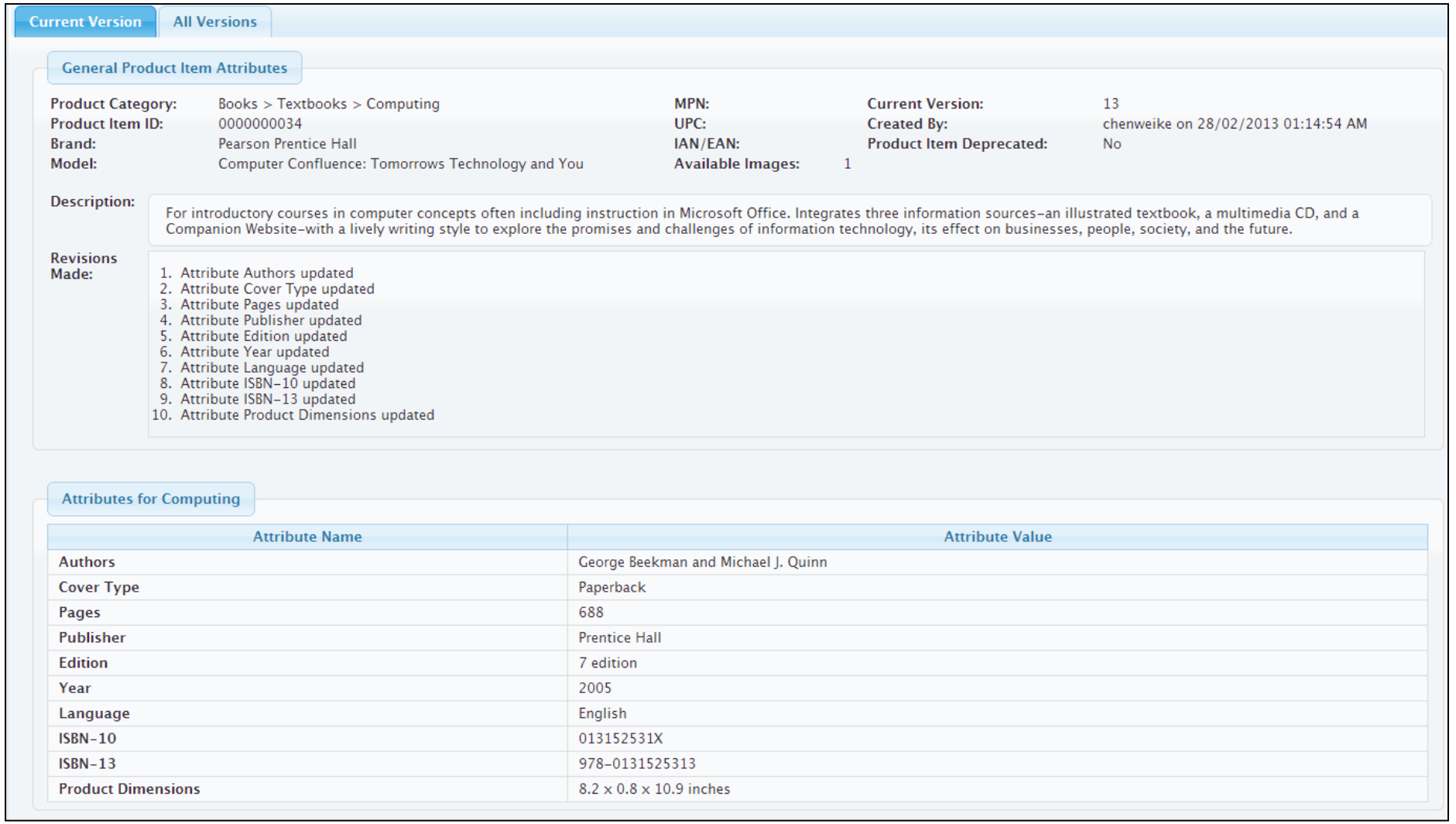
```
                        <id>22</id>
                        <attributeId>3</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>8</id>
                                    <itemValue>688</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>23</id>
                        <attributeId>4</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>9</id>
                                    <itemValue>Prentice Hall</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>24</id>
                        <attributeId>5</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>10</id>
                                    <itemValue>7 edition</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>25</id>
                        <attributeId>6</attributeId>
```

```
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>11</id>
                                    <itemValue>2005</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>26</id>
                        <attributeId>7</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>12</id>
                                    <itemValue>English</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>27</id>
                        <attributeId>8</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
                              <itemValue>
                                    <id>13</id>
                                    <itemValue>013152531X</itemValue>
                                    <deleted>false</deleted>
                              </itemValue>
                        </itemValues>
                  </itemAttribute>
                  <itemAttribute>
                        <id>28</id>
                        <attributeId>9</attributeId>
                        <deleted>false</deleted>
                        <itemValues>
```

```
                        <itemValue>
                              <id>14</id>
                              <itemValue>
                                    978-0131525313
                              </itemValue>
                              <deleted>false</deleted>
                        </itemValue>
                  </itemValues>
            </itemAttribute>
            <itemAttribute>
                  <id>29</id>
                  <attributeId>10</attributeId>
                  <deleted>false</deleted>
                  <itemValues>
                        <itemValue>
                              <id>15</id>
                              <itemValue>
                                    8.2 x 0.8 x 10.9 inches
                              </itemValue>
                              <deleted>false</deleted>
                        </itemValue>
                  </itemValues>
            </itemAttribute>
      </itemAttributes>
      <productItemImages>
            <productItemImage>
                  <id>71</id>
                  <imageId>1</imageId>
                  <caption>
                        Front cover of paperback edition.
                  </caption>
                  <filename>
                        036da70d-cadf-4c14-89ca-40bea3e8146d
                  </filename>
                  <fileExtension>jpg</fileExtension>
                  <sortOrder>1</sortOrder>
                  <deleted>false</deleted>
            </productItemImage>
```

```
            </productItemImages>
            <cloudCommerceUser>
                  <id>2</id>
                  <username>chenweike</username>
                  <userProfile>
                        <id>2</id>
                  </userProfile>
            </cloudCommerceUser>
      </currentProductItemInstance>
</productItem>
```

Listing 3.6 – XML artifact representing the product item "Pearson Prentice Hall Computer Confluence: Tomorrows Technology and You (Product Item ID: 0000000034)" that belongs to the leaf product category Books > Textbooks > Computing.



Current Version | All Versions

General Product Item Attributes

Product Category:	Books > Textbooks > Computing	**MPN:**		**Current Version:**	13
Product Item ID:	0000000034	**UPC:**		**Created By:**	chenweike on 28/02/2013 01:14:54 AM
Brand:	Pearson Prentice Hall	**IAN/EAN:**		**Product Item Deprecated:**	No
Model:	Computer Confluence: Tomorrows Technology and You	**Available Images:**	1		

Description: For introductory courses in computer concepts often including instruction in Microsoft Office. Integrates three information sources–an illustrated textbook, a multimedia CD, and a Companion Website–with a lively writing style to explore the promises and challenges of information technology, its effect on businesses, people, society, and the future.

Revisions Made:

1. Attribute Authors updated
2. Attribute Cover Type updated
3. Attribute Pages updated
4. Attribute Publisher updated
5. Attribute Edition updated
6. Attribute Year updated
7. Attribute Language updated
8. Attribute ISBN-10 updated
9. Attribute ISBN-13 updated
10. Attribute Product Dimensions updated

Attributes for Computing

Attribute Name	Attribute Value
Authors	George Beekman and Michael J. Quinn
Cover Type	Paperback
Pages	688
Publisher	Prentice Hall
Edition	7 edition
Year	2005
Language	English
ISBN-10	013152531X
ISBN-13	978-0131525313
Product Dimensions	8.2 x 0.8 x 10.9 inches

Figure 3.24 – Screenshot taken from the Productpeia website showing the product item "Pearson Prentice Hall Computer Confluence: Tomorrows Technology and You (Product Item ID: 0000000034)" that belongs to the leaf product category Books > Textbooks > Computing.

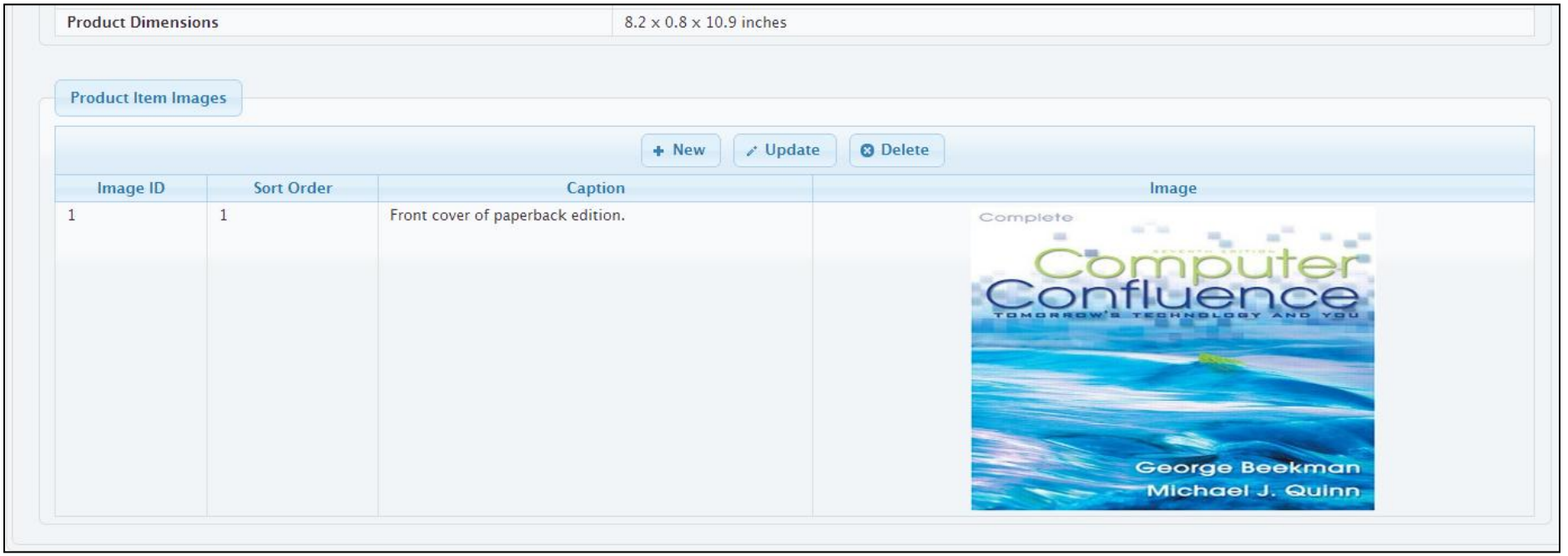


Figure 3.25 – Screenshot taken from the Productpedia website showing the product item image of "Pearson Prentice Hall Computer Confluence: Tomorrows Technology and You (Product Item ID: 0000000034)".

3.4.3 Seller Service

Cloud Commerce seller service implements all 19 reference methods listed in Table 3.7 for managing a user's seller profile, centralized warehouse and inventory items as well as shipping information. An existing product item in Productpedia can be brought into a user's warehouse as an inventory item by specifying a stock keeping unit code and a description (see Figure 3.26). The inventory item is then used to create a sales listing with the transaction service. The XML artifact of an inventory item is self-describing to the extent that it includes the XML artifacts of the product item, which itself encompasses the XML artifact for the product schema, and the associated leaf product category.

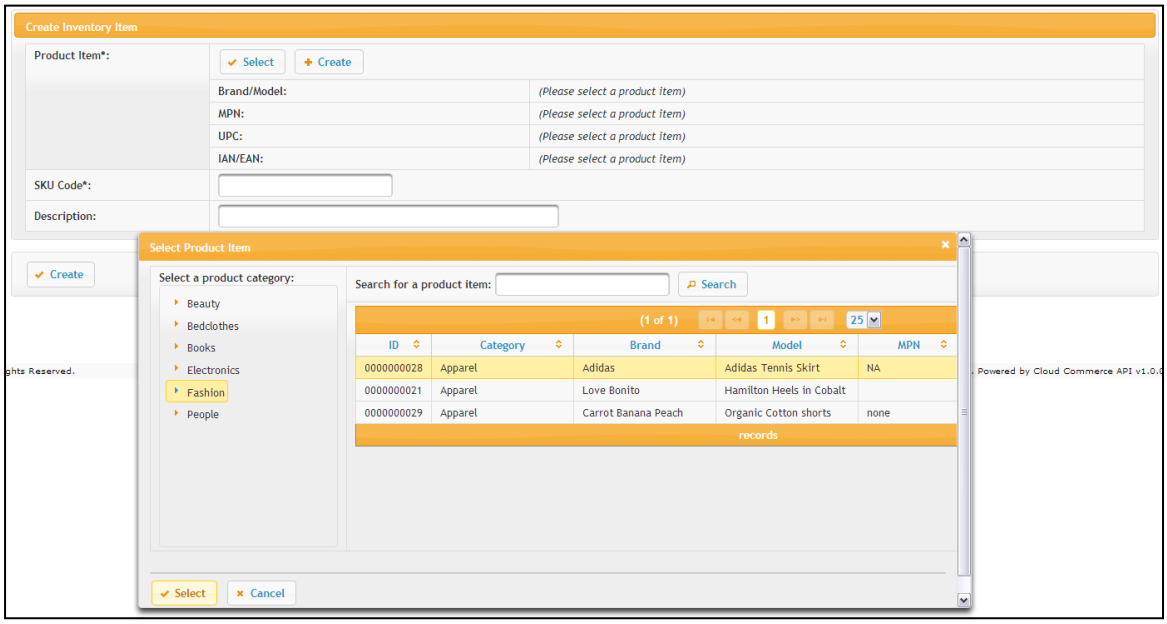


Figure 3.26 – Screenshot taken from the Cloud Mall website showing how a user can bring an existing product item in Productpedia into his/her warehouse as an inventory item.

The seller service also allows a Cloud Commerce user to create shipping profiles for describing the shipping fees of one or more geographical regions. It is assumed that the country of origin is the seller location that the user configured in his/her seller profile. A screenshot of the shipping profiles management tool in Cloud Mall is shown in Figure 3.27.

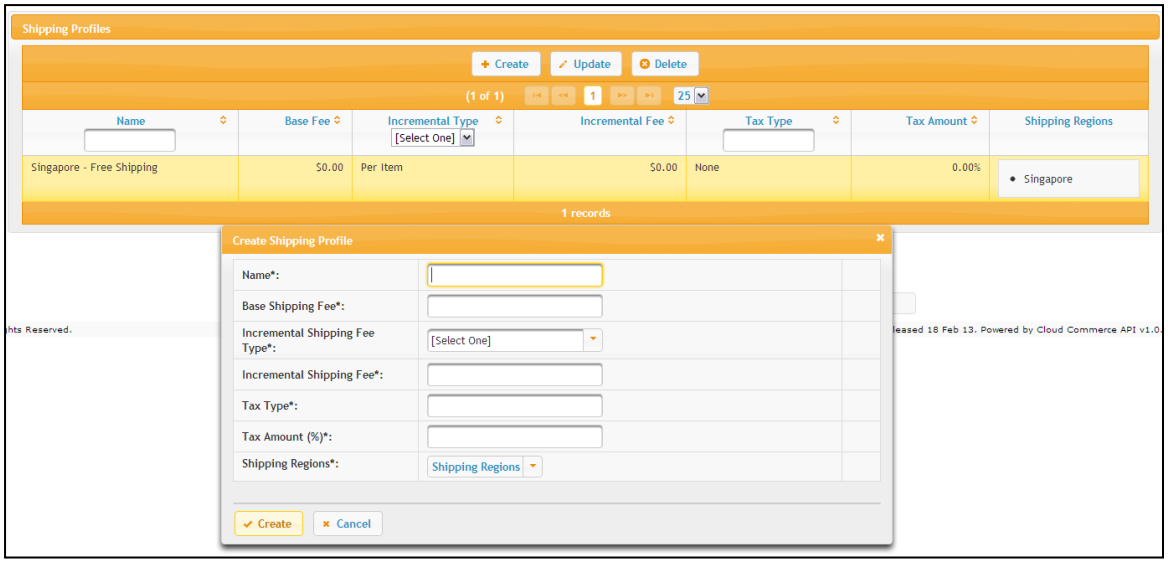


Figure 3.27 – Screenshot taken from the Cloud Mall website showing the shipping profiles management tool.

3.4.4 Buyer Service

Cloud Commerce buyer service implements all 6 reference methods listed in Table 3.8 for managing a user's buyer profile and addresses. A screenshot of the buyer addresses management tool in Cloud Mall is shown in Figure 3.28.

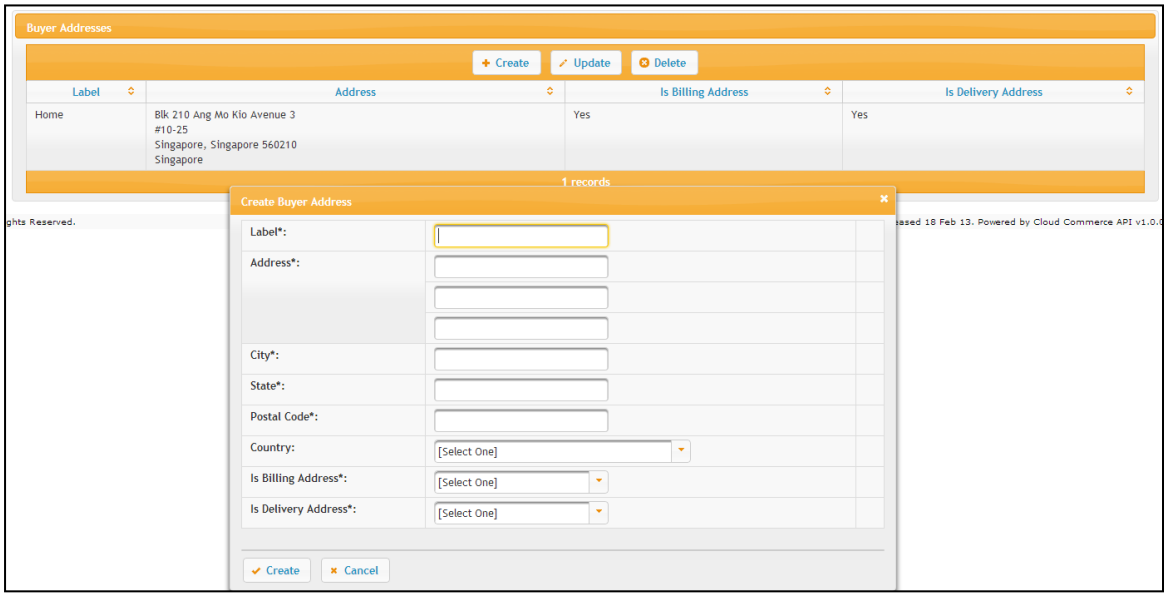


Figure 3.28 – Screenshot taken from the Cloud Mall website showing the buyer addresses management tool.

3.4.5 Transaction Service

Cloud Commerce transaction service implements all 20 reference methods listed in Table 3.9 for managing a seller's listings and sales transactions as well as a buyer's shopping carts and sales transactions. Currently, Cloud Commerce only supports fixed price listings. A seller creates a listing based on an inventory item in his/her centralized warehouse. A screenshot of the fixed price listing creation tool in Cloud Mall is shown in Figure 3.29. By default, a listing is authorized for sales only on the application that it is created. The seller needs to login to other applications to authorize the listing for sales on them. However, the Official Website allows a seller to conveniently authorize a listing for sales on any and all applications. This is depicted in Figure 3.30. After this mass authorization process, a listing will be available for sales on the selected applications thus maximizing the selling opportunity across websites, channels and media. Figure 3.31 shows a listing as viewed from the seller's perspective in Cloud Mall. Figure 3.32 shows the same listing as viewed from the buyer's perspective on four of the five Cloud Commerce electronic commerce website and applications, i.e., Cloud Mall, Cloud Market, Droid Mall and Cloud Shopper's Mall.

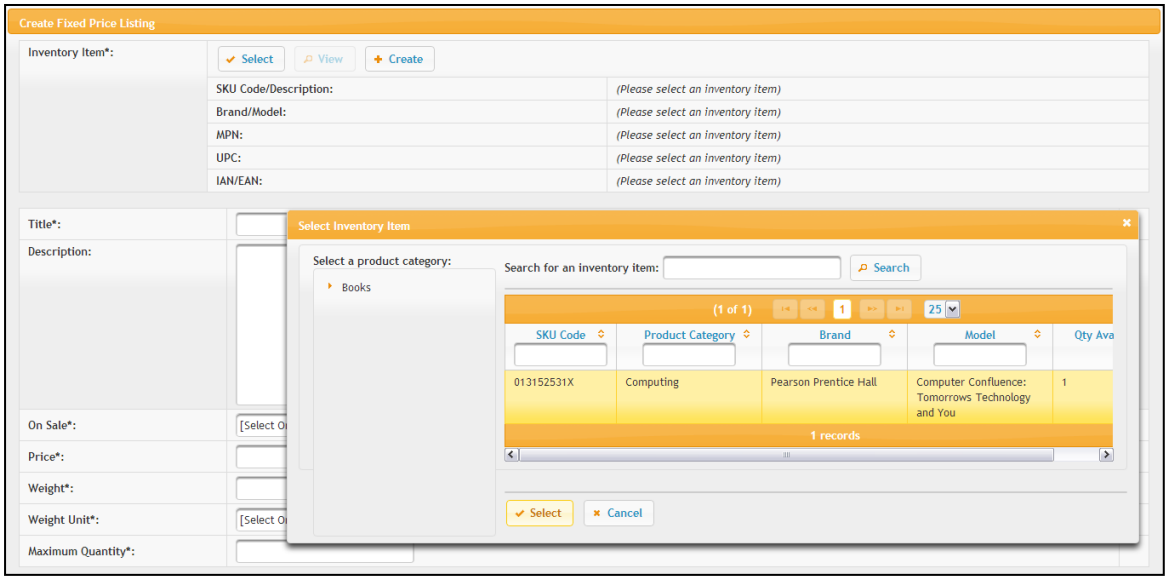


Figure 3.29 – Screenshot taken from the Cloud Mall website showing the fixed price listing creation tool.

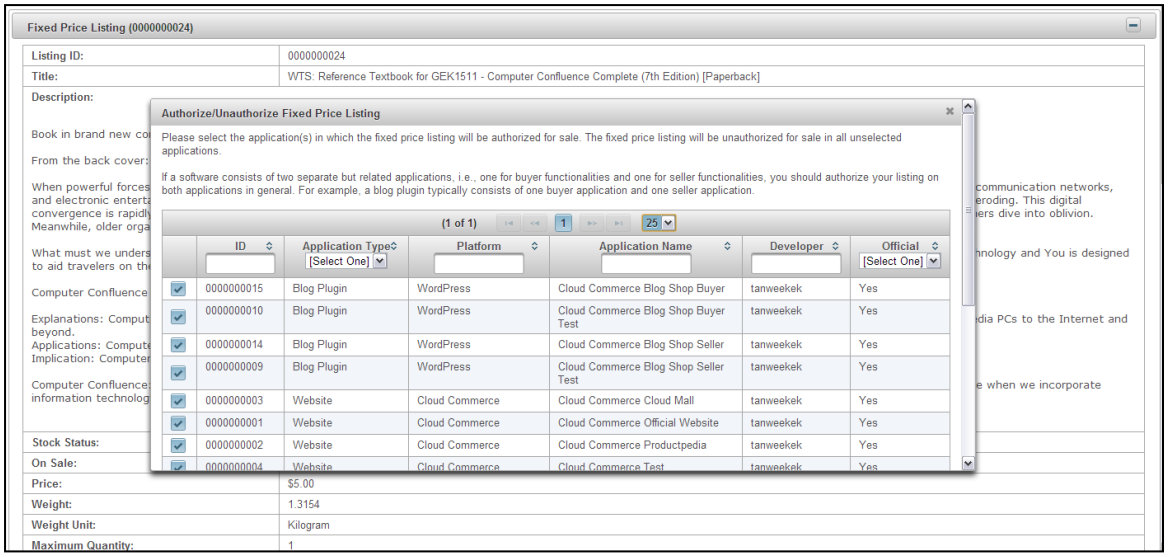


Figure 3.30 – Screenshot taken from the Official Website showing the fixed price listing authorization/unauthorization tool.

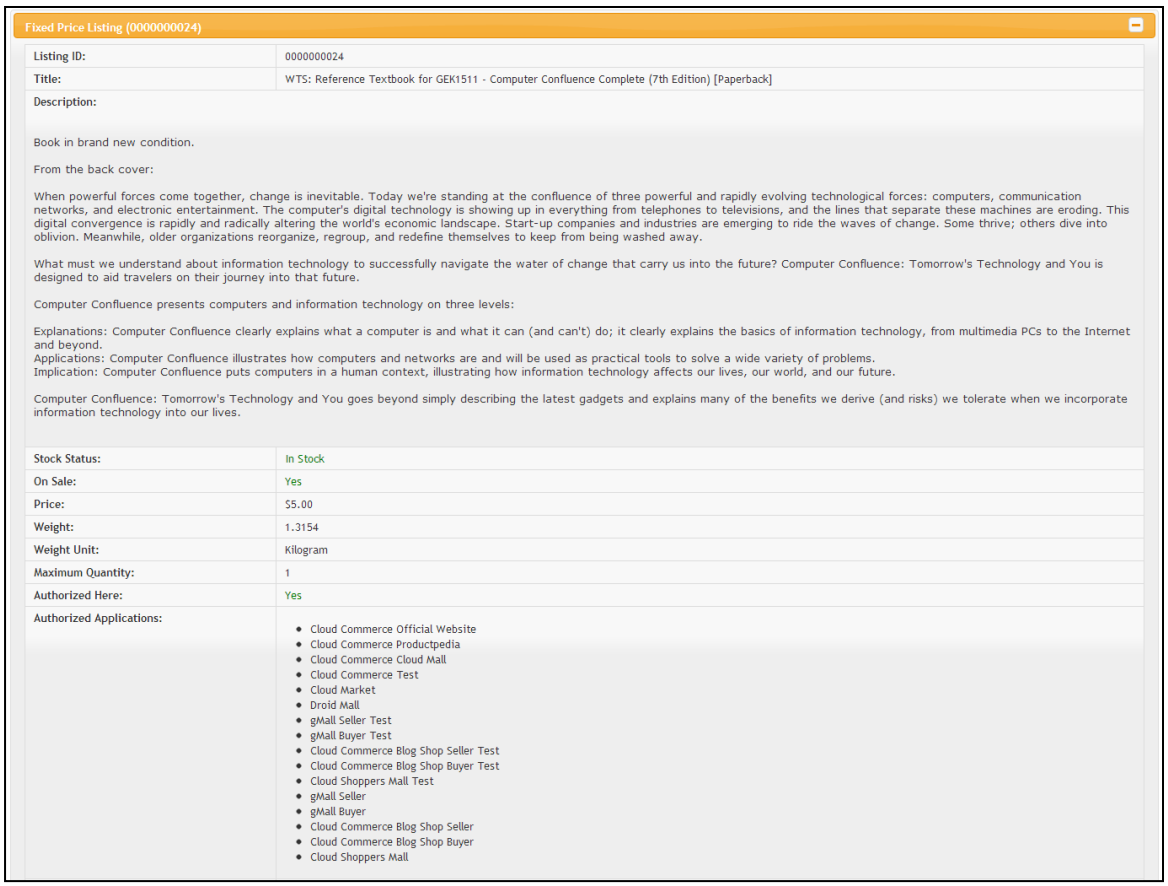
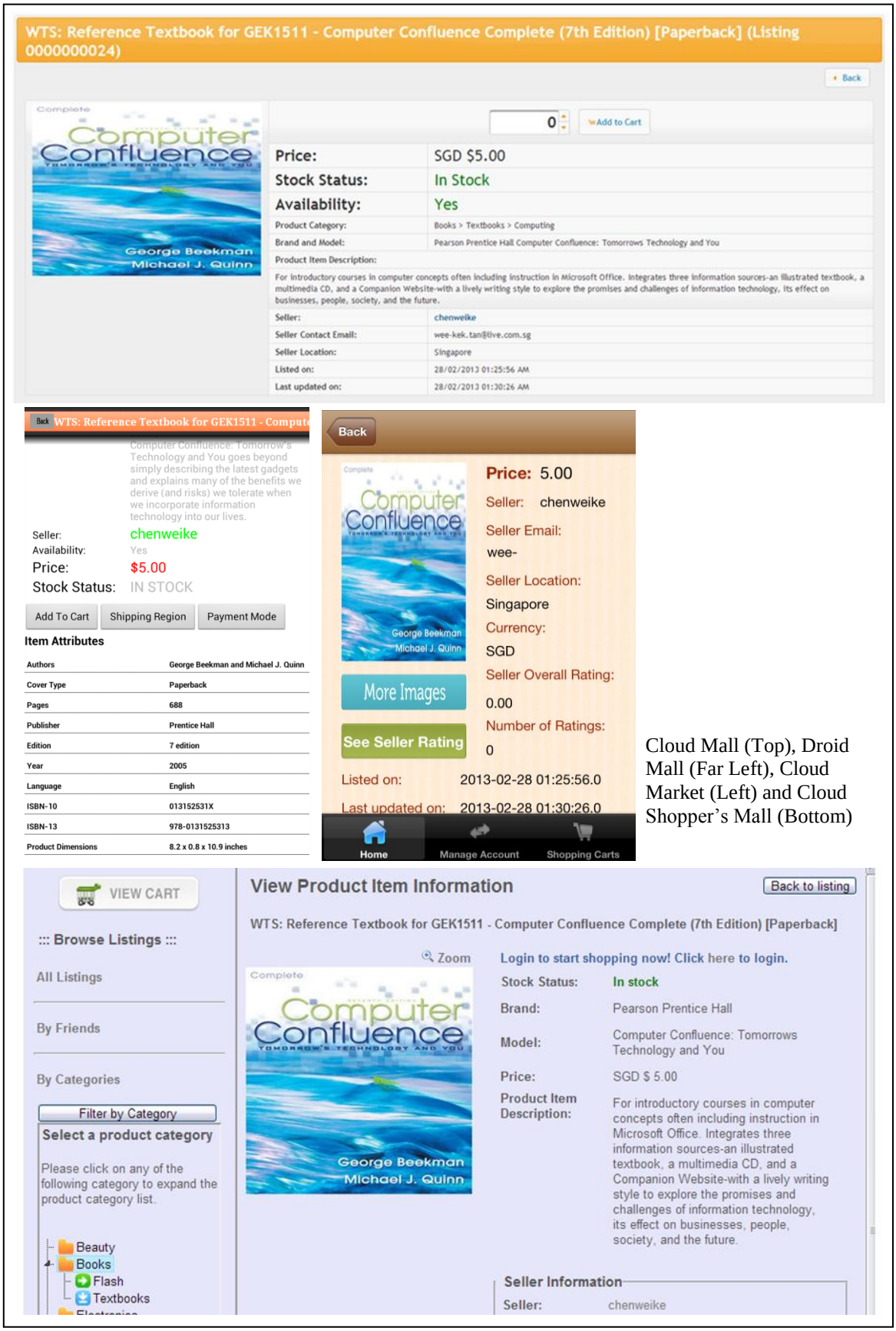


Figure 3.31 – Screenshot taken from the Cloud Mall website showing the fixed price listing "WTS: Reference Textbook for GEK1511 - Computer Confluence Complete (7th Edition) [Paperback] (Listing ID: 0000000024)" as viewed from the seller's perspective.



Cloud Mall (Top), Droid Mall (Far Left), Cloud Market (Left) and Cloud Shopper's Mall (Bottom)

Figure 3.32 – Screenshots showing the fixed price listing "WTS: Reference Textbook for GEK1511 - Computer Confluence Complete (7th Edition) [Paperback] (Listing ID: 0000000024)" as viewed from the buyer's perspective on four of the five Cloud Commerce shopping website and applications.

The XML artifact representing the fixed price listing "WTS: Reference Textbook for GEK1511 - Computer Confluence Complete (7th Edition) [Paperback] (Listing ID: 0000000024)" is shown in Listing 3.7. This XML artifact is retrieved using the GetFixedPriceListing API method. The listing is based on an inventory item with the stock keeping unit code "013152531X", which itself is based on the product item "Pearson Prentice Hall Computer Confluence: Tomorrows Technology and You (Product Item ID: 0000000034)". The product item belongs to the leaf product category Books > Textbooks > Computing. As shown in Listing 3.7, this XML artifact is self-contained with the rich description of the product item together with the product schema.

From the buyer's perspective, the concept of each buyer having multiple shopping carts in one application is illustrated in Figure 3.33. In this screenshot, the user tanweekek has added items from three different sellers to his shopping carts on Cloud Mall. Thus, there will be three shopping carts altogether. In the next screenshot shown in Figure 3.34, the user tanweekek, i.e., the buyer, proceeds to checkout the shopping cart for chenweike's items using PayPal as the payment mode. After the checkout has completed successfully, a sales transaction will be created. From the buyer's perspective, tanweekek can proceed to make an online payment and track the delivery status of his item (see Figure 3.35). From the seller's perspective, chenweike can track the buyer's payment status and update the seller sales transaction status to keep the buyer informed of the delivery status (see Figure 3.36). Either party may cancel the sales transaction at an appropriate juncture. For instance, the buyer may cancel the sales transaction prior to making payment.

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      <title>WTS: Reference Textbook for GEK1511 - Computer Confluence Complete (7th Edition) [Paperback]</title>
      <description>
            Book in brand new condition.

            From the back cover:

            When powerful forces come together, change is inevitable. Today we're standing at the confluence of
three powerful and rapidly evolving technological forces: computers, communication networks, and electronic
entertainment. The computer's digital technology is showing up in everything from telephones to televisions, and the
lines that separate these machines are eroding. This digital convergence is rapidly and radically altering the
world's economic landscape. Start-up companies and industries are emerging to ride the waves of change. Some thrive;
others dive into oblivion. Meanwhile, older organizations reorganize, regroup, and redefine themselves to keep from
being washed away.

            What must we understand about information technology to successfully navigate the water of change that
carry us into the future? Computer Confluence: Tomorrow's Technology and You is designed to aid travelers on their
journey into that future.

            Computer Confluence presents computers and information technology on three levels:

            Explanations: Computer Confluence clearly explains what a computer is and what it can (and can't) do; it
clearly explains the basics of information technology, from multimedia PCs to the Internet and beyond.
            Applications: Computer Confluence illustrates how computers and networks are and will be used as
practical tools to solve a wide variety of problems.
            Implication: Computer Confluence puts computers in a human context, illustrating how information
technology affects our lives, our world, and our future.

            Computer Confluence: Tomorrow's Technology and You goes beyond simply describing the latest gadgets and
explains many of the benefits we derive (and risks) we tolerate when we incorporate information technology into our
lives.
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Inventory item is embedded as part of fixed price listing

Product item is embedded as part of inventory item

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Product schema is embedded as part of product item

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Office. Integrates three information sources-an illustrated textbook, a multimedia CD, and a Companion Website-with
a lively writing style to explore the promises and challenges of information technology, its effect on businesses,
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Shipping information embedded in the listing

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            </userProfile>
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                <paymentModeCheque>false</paymentModeCheque>
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            </sellerRatingSummary>
      </cloudCommerceUser>
      <price>5.0000</price>
      <maximumQuantity>1</maximumQuantity>
</fixedPriceListing>
```

Listing 3.7 – XML artifact representing the fixed price listing "WTS: Reference Textbook for GEK1511 - Computer Confluence Complete (7th Edition) [Paperback] (Listing ID: 0000000024)", which is created based on an inventory item that itself is based on the product item "Pearson Prentice Hall Computer Confluence: Tomorrows Technology and You (Product Item ID: 0000000034)". This product item belongs to the leaf product category Books > Textbooks > Computing.

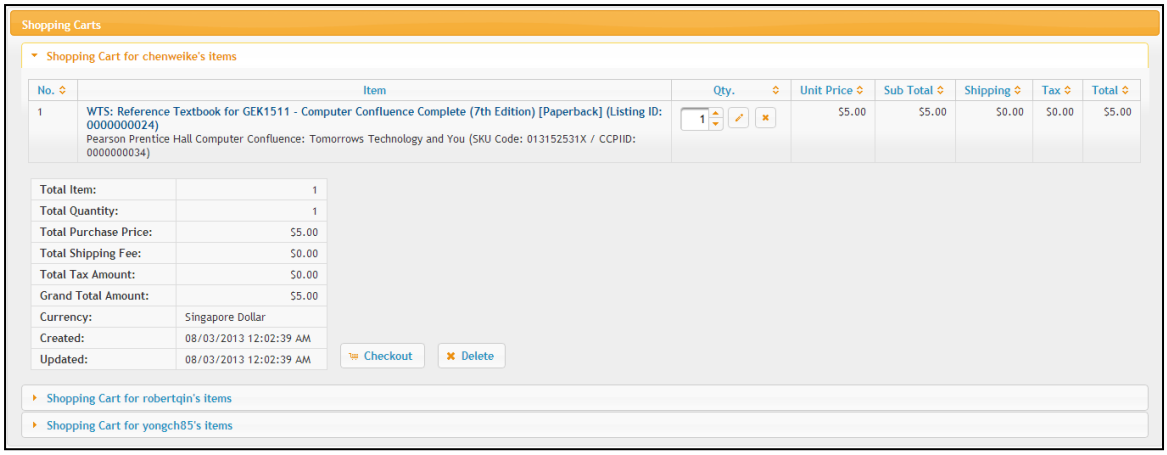


Figure 3.33 – Screenshot taken from the Cloud Mall website showing a buyer with three shopping carts.

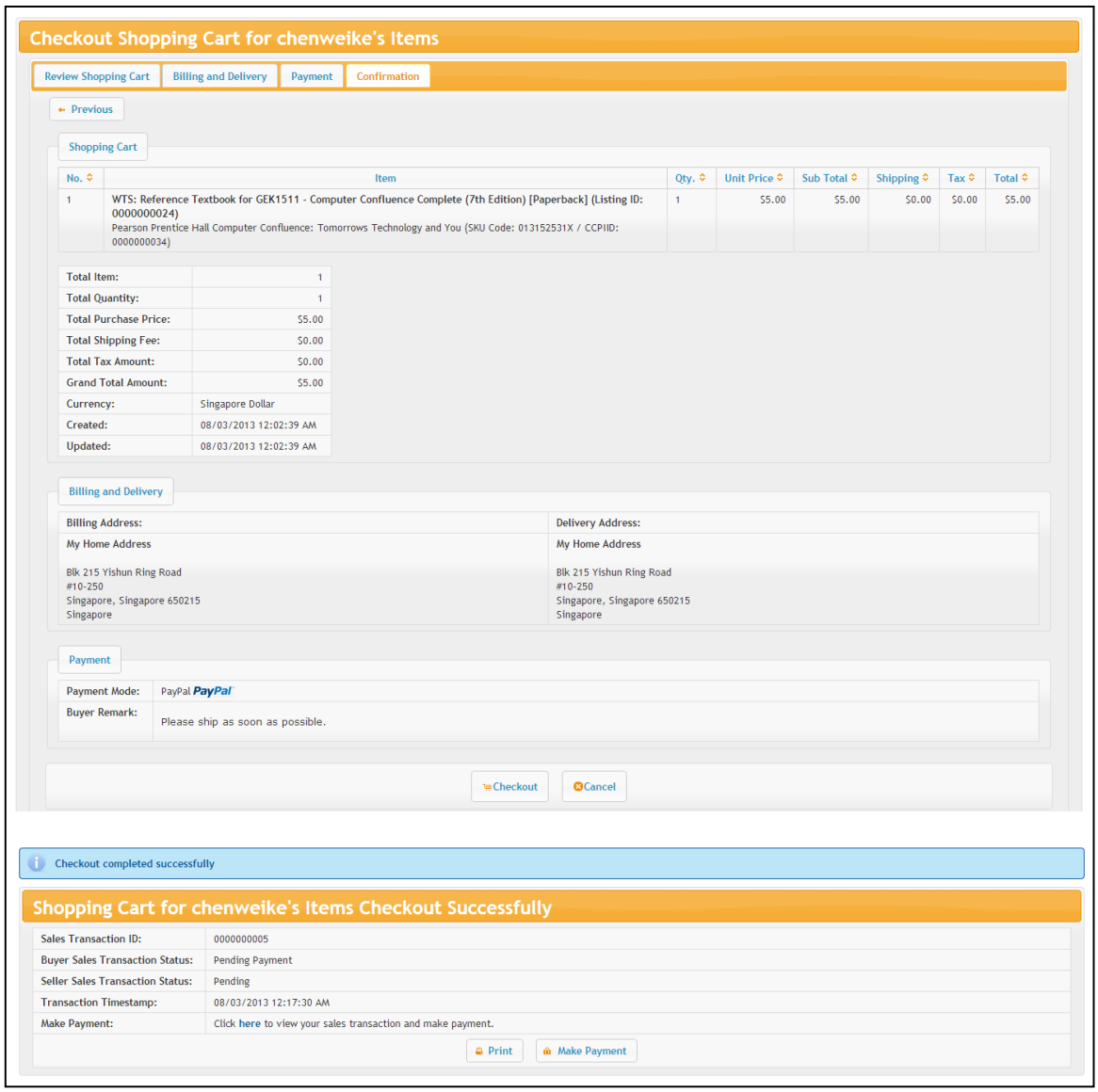


Figure 3.34 – Screenshot taken from the Cloud Mall website showing a buyer performing checkout of a shopping cart.

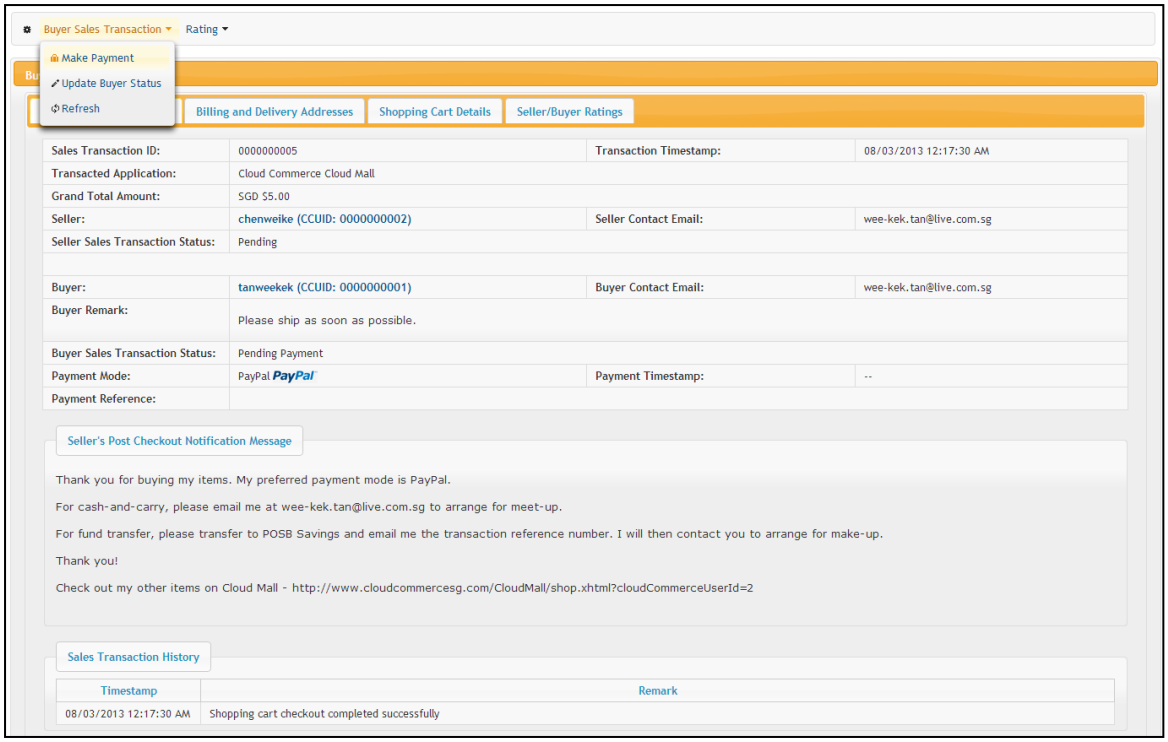


Figure 3.35 – Screenshot taken from the Cloud Mall website showing a buyer sales transaction created after successful checkout of a shopping cart.

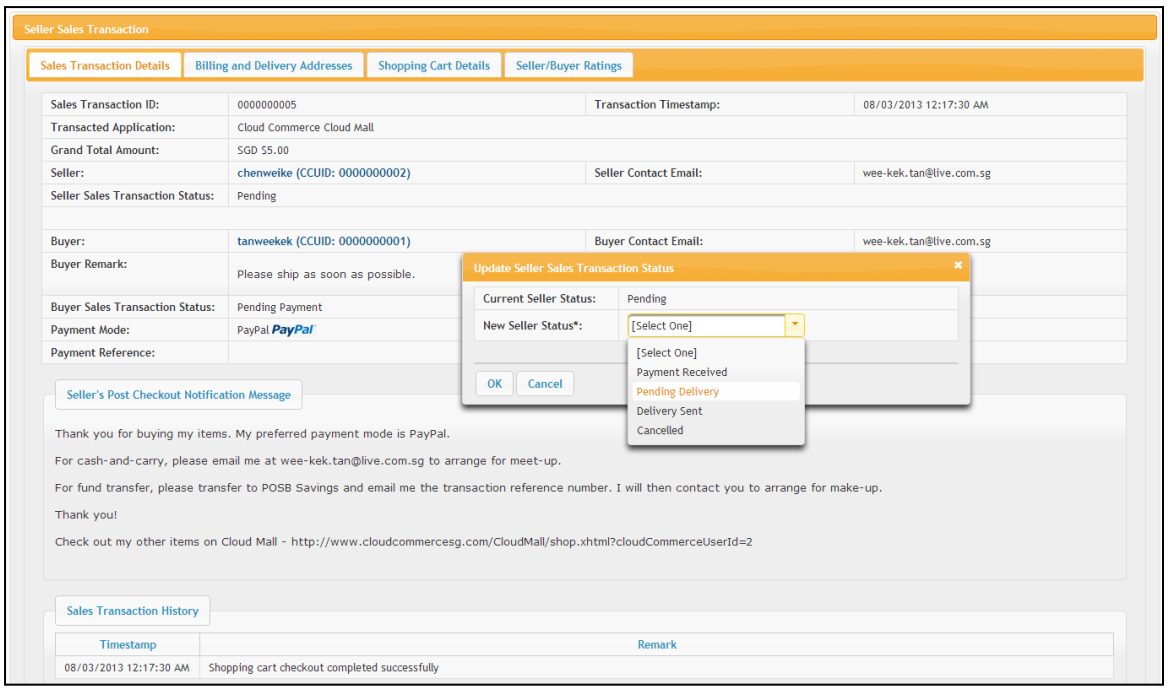


Figure 3.36 – Screenshot taken from the Cloud Mall website showing a seller sales transaction created after successful checkout of a shopping cart by the buyer.

Cloud Commerce also automatically updates the inventory item status on behalf of the seller. Upon a successful checkout of an item, the platform will deduct the amount purchased from quantity available and transfer to quantity reserved (refer to Table 3.2 for

the vocabulary specification of the Inventory Item construct). When the seller eventually updates the seller sales transaction status to shipped, the amount of shipped item is then deducted from quantity reserved. At this juncture, total quantity on hand will also be deducted. Figure 3.37 shows the inventory item status and the associated inventory records for the item checkout in Figure 3.34.

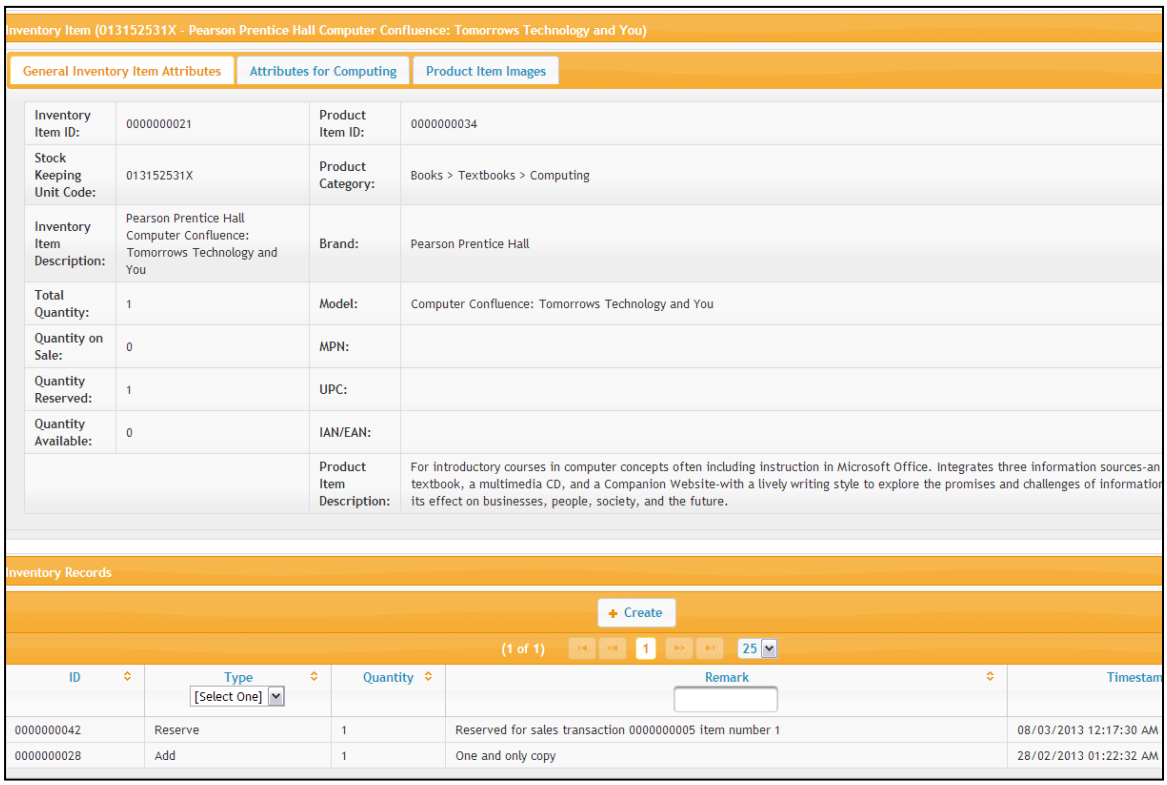
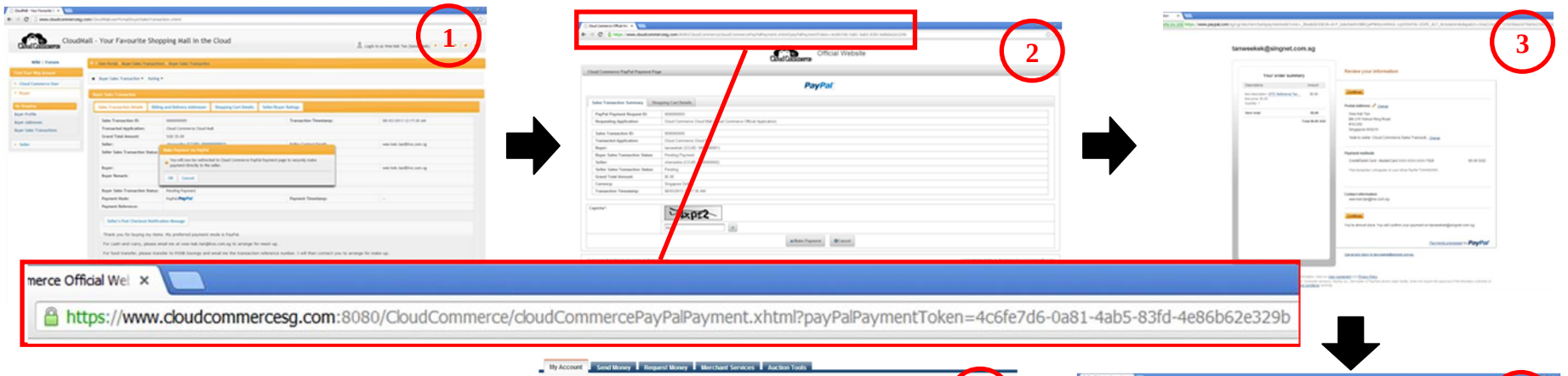


Figure 3.37 – Screenshot taken from the Cloud Mall website showing the automatic updating of a seller's inventory item status and the associated inventory records after a successful checkout.

3.4.6 Payment Service

Cloud Commerce payment service implements the 2 reference methods listed in Table 3.10 for supporting online payment of Cloud Commerce sales transactions using PayPal. Specifically, the online payment process depicted in Figure 3.19 is implemented as Cloud Commerce PayPal Payment. When a buyer requests to make PayPal payment for a particular sales transaction via an application, the application must call the CreatePayPalPaymentRequest method to obtain a PayPal payment token before redirecting the buyer to the Cloud Commerce PayPal Payment web page. During the



In this example, the payment is held pending because the seller's PayPal account is in USD whereas the payment is in SGD.

After the seller has approved the payment, PayPal will send an IPN to Cloud Commerce. The platform then updates the payment status to completed.

6

Sales Transaction History

Timestamp	Remark
08/03/2013 01:34:47 AM	Seller receives payment
08/03/2013 01:34:47 AM	Buyer previously pending PayPal payment has completed - Transaction ID: 8RK10787UN308360H
08/03/2013 01:21:35 AM	Buyer makes PayPal payment but transaction was not completed - Transaction ID: 8RK10787UN308360H, Payment Status: PENDING, Pending Reason: MULTICURRENCY, Reason Code: NONE
08/03/2013 12:17:30 AM	Shopping cart checkout completed successfully

1) A user is redirected from Cloud Mall to Cloud Commerce PayPal Payment web page on Official Website. 2 and 3) The user answers the captcha challenge and is redirected to PayPal Express Checkout web page. 4) Upon completion of payment, the user is redirected back to Cloud Commerce PayPal Payment Complete web page on Official Website, which then redirects the user back to Cloud Mall. 5) The seller login to PayPal to approve the multi-currency payment. 6) Finally, Cloud Commerce PayPal IPN handler updates the payment status.

Figure 3.38 – Demonstration of PayPal payment process as implemented in Cloud Commerce payment service.

redirection, the payment token will be set as a query string parameter of the redirect URL. Actual screenshots depicting the PayPal payment process with Cloud Mall is shown in Figure 3.38.

3.4.7 Rating and Review Service

Cloud Commerce rating and review service implements all 5 reference methods listed in Table 3.11 for supporting rating of buyers and sellers. The screenshot in Figure 3.39 shows how a seller can rate the buyer after payment has been received (refer to Figure 3.38).

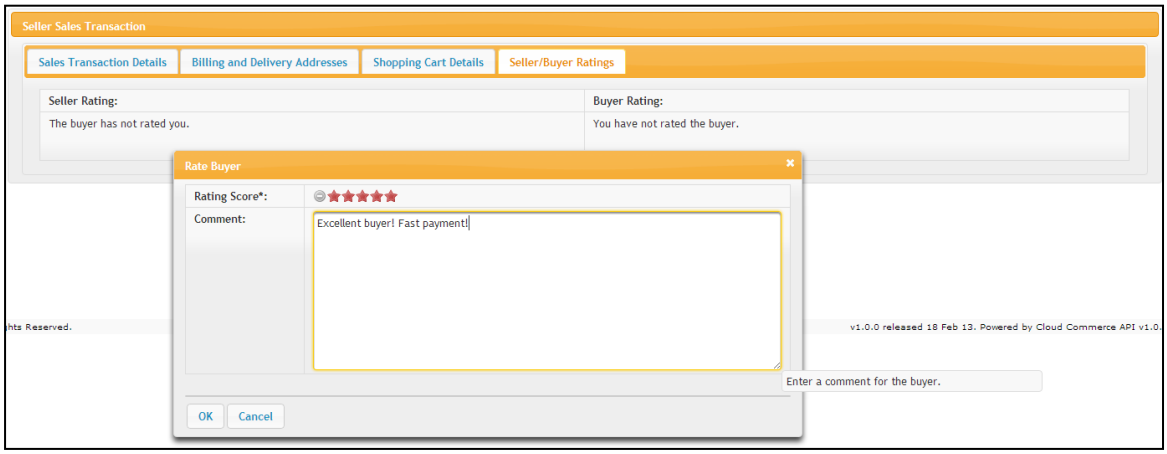


Figure 3.39 – Screenshot taken from the Cloud Mall website showing a seller rating the buyer for a particular sales transaction after payment has been received.

CHAPTER 4: ADOPTION AND USE OF CLOUD COMMERCE IN GENERAL

4.1 Introduction

Cloud Commerce is positioned as a true location transparent cloud-based electronic commerce platform that will provide substantial benefits to users. Sellers will be able to market their product items seamlessly across different websites, channels and media. Buyers will be able to aggregate and compare product information from diverse sources and easily purchase a product item from any merchants operating out of any websites, channels and media. The entire platform provides a set of seven core services, namely identity service, product information service, seller service, buyer service, transaction service, payment service, and rating and review service. Collectively, they bring about several electronic commerce technological innovations such as an open product schema and information repository residing in the cloud, ability to create sale offers that run in the cloud and the ability to fulfill orders right from the cloud. In the future, Cloud Commerce could also enable a true autonomous recommendation agent that has the ability to match a potential buyer's preferences with product items on offer anywhere in the world across different websites, channels and media. Moreover, it will make available a set of RESTful web service-based Open API for developers to create electronic commerce tools that tap onto the powerful features and convenience afforded by Cloud Commerce.

The wide array of technological innovations aside, Cloud Commerce holds the promise of improving the conventional electronic commerce business model. Since its inception, electronic commerce has been characterized by disintermediation whereby buyers purchase directly from manufacturers thus bypassing the traditional brick-and-mortar

retail sale channel (Christensen and Tedlow 2000). Then come a time when organizations begin to introduce various services such as comparison shopping websites, product review websites, product brokering websites and merchant brokering websites in an attempt to add digital value to mainstream electronic commerce (Rayport and Sviokla 1995). This phenomenon leads to reintermediation in electronic commerce with a buyer possibly having to go through a third party comparison shopping website before being redirected to another merchant's website to make the actual purchase, for instance (Reynolds 2000). Regardless of disintermediation or reintermediation, merchants have always been limited to selling via their own individual websites. Even when reintermediation provides an avenue to drive external sale traffic to merchants' websites, this limitation continues to be a hindrance. Although Cloud Commerce preserves the current status quo of reintermediation, it allows merchants to directly sell to customers from any websites, channels or media, thus potentially creating a more efficient electronic market structure.

The advent of information technology has promised to improve the performance and lifestyle of individuals in and out of the workplace. However, researchers have long acknowledged that any new technology, regardless of its degree of innovation and sophistication, can only bring about benefits to individuals if they are even willing to adopt and use them in the first place (Davis 1989). Understanding how and why individuals adopt new technologies has thus always been an important area of information systems research (Venkatesh, Morris, Davis and Davis 2003). In particular, researchers are interested in understanding the antecedent factors underlying an individual's intention to adopt an information technology and actually use it (Compeau and Higgins 1995; Davis 1989). Another important stream of technology adoption research focuses on task-technology fit, i.e., whether the technology functionalities (either hardware or software)

match the task requirements and user abilities (Goodhue 1995; Goodhue and Thompson 1995). In gist, investigating individuals' adoption and use of Cloud Commerce's various technological innovations is a necessary step.

Although prior research studies on technology adoption are aplenty, the unique system characteristics of Cloud Commerce justify distinct theorization. Pavlou and Fygenson's (2006) work on electronic commerce adoption is a case in point. They argued that electronic commerce combines the adoption of technology with marketing elements and thus deserves further theorizing on its adoption compared to mainstream adoption research that focuses on technology itself. In a similar fashion, Cloud Commerce involves several new electronic commerce functionalities that offer a unique proposition, i.e., allowing sellers and buyers to utilize a true multi-channels/media platform to reach out to a potentially much larger customer/supplier base. There are therefore unique elements of both technological innovations and business innovations. Further theorization of Cloud Commerce adoption and its use is certainly in order. Specifically, this study evaluates how various design features of Cloud Commerce foster its adoption and use not just purely based on technological innovations but also business innovations.

Moreover, I have hitherto emphasized that Cloud Commerce benefits not only consumers but also merchants. It thus provides an excellent opportunity to examine effective design characteristics for electronic commerce applications and tools from both the seller and buyer perspective. The extant literature on electronic commerce research has largely focused on consumers, i.e., buyers, and scant attention has been given to the needs of merchants, i.e., sellers (Chua, Straub, Khoo and Kadiyala 2005). For instance, many researchers have studied how electronic commerce tools could be effectively designed to assist consumers in recognizing their needs, searching for product information, and

making actual purchase (e.g., Pavlou and Fygenson 2006; Sismeiro and Bucklin 2004; Tan, Teo and Benbasat 2010).

Other researchers have proposed that consumers would benefit from the use of electronic commerce systems only if they are suitably designed for the type of purchase task at hand and the degree of task complexity (Jahng, Jain and Ramamurthy 2000). There have also been various propositions calling for electronic commerce websites to foster perceptions of information quality, service quality, system quality, playfulness and trust among consumers in order to become successful (e.g., Gefen, Karahanna and Straub 2003; Liu and Arnett 2000; Sun, Ke and Cheng 2007). Even studies on online auction, a more specific form of electronic commerce, has mostly focused on auction tools that help consumers in their price negotiation and item acquisition tasks (Chang 2008).

This study aims to bridge the extant knowledge gap by examining the design features of Cloud Commerce from both the seller and buyer perspectives. The fundamental premise is that an electronic commerce platform can only be successful if there are merchants selling a wide variety of products and services to attract consumers. Of course, the platform must offer sufficient motivations for consumers to visit. The chicken or the egg causality dilemma can possibly be resolved only if we balance the interest of both parties and not the current lopsided focus on consumers.

To this extent, the Technology Acceptance Model (TAM) (Davis 1986; Davis 1989) and Task-Technology Fit (TTF) model (Goodhue 1995; Goodhue and Thompson 1995) are two suitable theoretical lenses. TAM will shed light on whether the various design features of Cloud Commerce are capable of getting sellers and buyers to use Cloud Commerce. TTF will explain whether the various design features of Cloud Commerce are suitable for electronic commerce tasks/activities and if so, does this notion of fit promote

utilization and enhance electronic commerce outcome. Successful validation of Cloud Commerce using TAM and TTF will also provide the necessary evidence to determine the feasibility of Cloud Commerce as required by the evaluate process of design science (Hevner et al. 2004).

4.2 Theoretical Foundation

4.2.1 Technology Acceptance Model (TAM)

4.2.1.1 Origin and Development of Technology Acceptance Model (TAM)

TAM (Davis 1989) has been widely used to study the adoption and use of technology (Benbasat and Barki 2007). TAM itself is based on the Theory of Reasoned Action (TRA) (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975). TRA posits that one's attitude towards a specific behavior and the subjective norms surrounding this behavior would influence one's propensity to exhibit such a behavior, i.e., behavioral intention. A positive behavioral intention would ultimately lead one to behave as such. In a similar fashion, TAM posits that a piece of technology artifact that is perceived to be useful and easy to use will foster one's intention to use it (Davis 1986; Davis 1989; Davis, Bagozzi, Warshaw 1989). The behavioral intention to use the technology artifact will have a positive impact on usage behavior (Figure 4.1). In this regard, behavioral intention mediates between perceptions of usefulness and ease of use, and use behavior. However, unlike TRA, TAM does not consider the influence of an individual's perception of whether people important to him/her think the technology artifact should be used, i.e., subjective norm (Davis et al. 1989). This is attributed to problem with establishing the causality between subjective norm and behavioral intention.

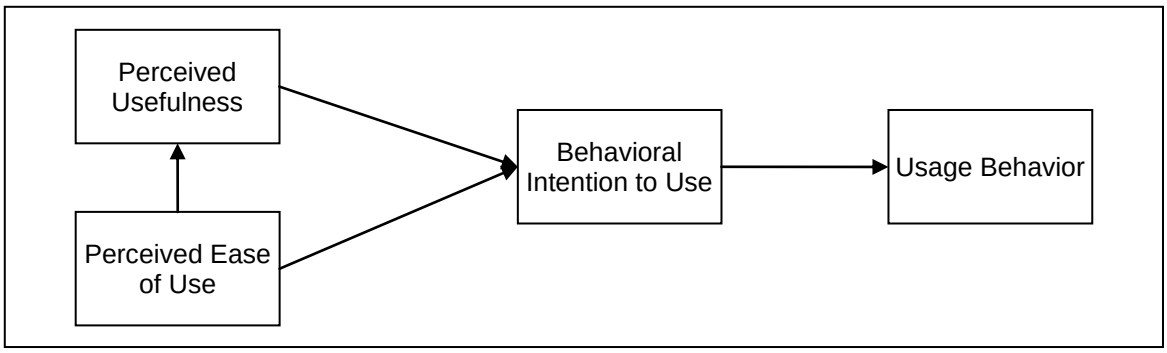


Figure 4.1 – Technology Acceptance Model (TAM) (Davis et al. 1989; Venkatesh et al. 2003).

TAM has been widely used to study the adoption and use of various types of information systems and computer technologies with results indicating a consistent predictive power across different populations and technological artifacts (Lee, Kozar and Larsen 2003; Legris, Ingham and Collerette 2003; Venkatesh et al. 2003). Since its conceptualization, researchers have devoted much efforts beyond just replicating TAM to study different technologies under various contexts. The extant literature on TAM covers a broad spectrum of issues such as the validity and reliability of its measurement instruments, extension of the basic model to scrutinize causal relationships among the TAM constructs as well as identifying antecedent factors of the TAM constructs, development of new variants of TAM models, and addressing known limitations (Lee et al. 2003).

Its immense value as a theoretical lens has also led to numerous extensions of the original TAM model to enhance its predictive power across different contexts. One of the most prominent extensions was put forth by Venkatesh and Davis (2000), aptly abbreviated as TAM2. The basic TAM model is largely silent on the antecedent factors affecting an individual's attitude towards technology, i.e., perceived usefulness and perceived ease of use. TAM2 improves on the basic TAM model by introducing subjective norm, image, job relevance, output quality and result demonstrability as predictors of perceived usefulness. The most noteworthy enhancement is the inclusion of subjective norm. Venkatesh and Davis (2000) reasoned that if an individual's superiors or peers in the

workplace feel that he/she should use a particular system or technology, then actual use of the technology will likely project a positive image of the individual to his/her superiors and peers. Subjective norm and image thus exert a positive influence on one's perception of whether a particular technology is useful. Furthermore, subjective norm will also foster one's intention to use the technology. However, the effect of subjective norm and image is expected to decrease over time as the individual becomes more familiar with the capabilities of the technology and is better able to objectively ascertain the value of continued use independent of social influence. Some researchers have however raised doubts about the efficacy of TAM2. One of the main concerns was that TAM2 uses a new set of belief perceptions, e.g., subjective norm, to predict the original set of belief perceptions, i.e., perceived usefulness and perceived ease of use (Benbasat and Barki 2007).

The Unified Theory of Acceptance and Use of Technology (UTAUT) was an attempt by Venkatesh and his colleague (2003) to skip over perceived usefulness and perceived ease of use to examine the direct effect that a new set of belief perceptions exert on behavioral intention and use behavior. Specifically, the authors conceptualized a set of four constructs anchored on prior acceptance theories such as TRA, TAM and TAM2 – performance expectancy, effort expectancy, social influence and facilitating conditions. Due to the similarity in the epistemological root, UTAUT's antecedent factors for predicting technology acceptance are not very different from prior theories. One major contribution, though, is that the hypothesized direct effects are more specific compared to perceived usefulness and perceived ease of use. Another significant contribution is the incorporation of various individual characteristics such as gender and experience as moderators of the belief perceptions. For instance, men are thought to be more task oriented (Minton and Schneider 1980) and thus the belief that using a particular

technology will improve job performance, i.e., performance expectancy, will have a stronger influence on men's behavior intention to use that technology compared to women (Venkatesh et al. 2003).

4.2.1.2 Problems with Technology Acceptance Model (TAM)

Although these cumulative research efforts have shown TAM and its extensions to be useful theoretical models for understanding use behavior of technological artifacts, TAM has not been without its critics. In particular, Benbasat and Barki (2007) have highlighted several concerns with TAM research. First, TAM has unwittingly diverted researchers' attention away from examining the antecedent of perceived usefulness and perceived ease of use, i.e., technological artifact design and how the resultant system's or software's characteristics affect perceived usefulness and perceived ease of use. Second, although many extensions have been made to the original TAM models over the years, they basically use a new set of belief perceptions to predict the existing set of belief perceptions, i.e., perceived usefulness and perceived ease of use. Scant attention has been paid to discovering design factors that actually make a system or a piece of software useful. Third, TAM narrowly focuses on amount or extent of usage as the dependent variable without adequately considering other salient user behaviors such as users' adaptation, learning and reinvention behaviors around a system or software. Bagozzi (2007) also argued the parsimony of TAM as being overly simplistic and lacking the ability to explain use decision and behavior across different technologies under various situations. Consequently, researchers focusing on TAM might have omitted important antecedent factors underlying individual or organization decision to use or reject a particular technology.

Bagozzi (2007) further highlighted five specific shortcomings of TAM. First, there exist theoretical gaps in the intention-behavior and attitude-intention linkages. Second, there is

a lack of a sound theory or method to identify antecedent factors of perceived usefulness and perceived ease of use. Third, inadequate consideration has been given to how group, social and cultural factors affect technology adoption. Fourth, there is an inadequate consideration of how emotion can possibly affect technology adoption. Fifth, TAM does not consider how self-regulation processes such as imposition of personal moral or self-evaluation standards affect technology adoption. Even the methodologies used in conducting TAM research studies have received occasional criticisms. For instance, researchers such as Legris et al. (2003) have noted that most TAM research studies involved student participants who did not realistically represent actual business environment. These studies also overly relied on self reported measures of system use instead of actual system use, which raises the possibility of inaccuracy or at best biasness.

4.2.1.3 Solutions for a Better Technology Acceptance Model (TAM)

For all its weaknesses, TAM remains a useful theoretical lens to investigate whether users of a particular technological artifact can derive the intended performance gain associated with its use. Indeed, the critics of TAM such as Benbasat and Barki (2007) as well as Bagozzi (2007) have continued to acknowledge its importance, and suggested ways and means to improve TAM research with a greater emphasis on designing effective technology artifact instead of doing away with TAM altogether. This view is shared by other researchers such as Goodhue (2007).

Several solutions have been proposed to improve TAM research along this broad direction of effective technology artifact design. First, researchers should focus on TAM's theoretical foundation, i.e., TRA or the more comprehensive Theory of Planned Behavior (TPB) (Ajzen 1988; Ajzen 1991), to explore more salient beliefs affecting technology design (Benbasat and Barki 2007; Pavlou and Fygenson 2006). Second, system usage should be better conceptualized beyond the fallacies of self-reported

measures and traditional measures that overly emphasized more system use (e.g., frequency, duration and variety of system functionalities) is better (Benbasat and Barki 2007; Lee et al. 2003; Legris et al. 2003; Goodhue 2007). Third, researchers should focus more on concrete guidelines explicating how a piece of technology artifact should be designed and implemented to provide functionalities that foster the desired perceptions (Benbasat and Barki 2007; Goodhue 2007). Fourth, objective measures of usefulness should be devised instead of relying exclusively on subjective self-reported measures (Benbasat and Barki 2007). Fifth, TAM research should take on a longitudinal approach to investigate the effect of attitudinal and belief perceptions on system use at various points in time (Benbasat and Barki 2007). Instead of focusing only on the initial implementation phase of a technology, researchers should also trace the differential impact that these perception factors might have on continued use post-implementation. Sixth, researchers should look beyond designing technology to be useful but instead focus on designing technology that is suitable for the task at hand, i.e., task-technology fit (TTF), which determines usefulness to a very large extent (Dishaw and Strong 1999; Goodhue 2007). Essentially, TAM should take into consideration whether the technology is even a good fit for the specific task rather than just fostering its utilization (Goodhue 2007).

These solutions essentially preserve the status quo of TAM's preeminence. A different school of thought initiated by Bagozzi (2007) has proposed a paradigm shift away from TAM towards one that emphasizes a decision making process to explain how, when, and why individuals make decisions on technology adoption. However, I am of the opinion that TAM is fundamentally sound but that the concerns that have been raised by leading scholars need to be addressed. In particular, the importance of aligning technology characteristics with task characteristics in technology adoption and use research has been

well underscored in the extant literature (Goodhue 1995; Goodhue and Thompson 1995; Tan and Benbasat 1993). In the next section, I will review the notion of TTF and its relevance to technology adoption research.

4.2.2 Task-Technology Fit

The theory of task-technology fit (TTF) originates from the seminal work of Goodhue and Thompson (1995) on technology-to-performance chain that prescribes how technologies affect individuals' performance. The authors suggest that a technology that is perceived as being able to assist the user in performing a specific task, i.e., TTF, is thought to enhance user's motivation in two important ways – 1) utilization of the technology; and 2) perception of task performance (Goodhue and Thompson 1995). The first rationale is based on the stream of technology utilization research such as TRA and TAM (Davis 1989; Davis et al. 1989), which posits that individual beliefs of and attitudes toward technology will positively affect technology utilization. The actual use of technology is thought to enhance task performance. The second rationale is based on the stream of TTF focused research, which hypothesizes that positive task performance will be derived from technology that provides functionalities supporting the task at hand (Benbasat, Dexter and Todd 1986; Dickson, DeSanctis and McBride 1986). Moreover, TTF can better predict perceived task performance compared to utilization alone. Beyond perceptive measure of task performance, researchers have also established the validity of the TTF notion with regard to actual task performance (Zigurs, Buckland, Connolly and Wilson 1999).

TTF itself can trace its epidemiological root to the notion of cognitive fit, which conjectures that a match in the problem representation with the task at hand will allow an individual to use problem solving processes that also emphasize the same type of

information to better solve the problem (Vessey 1991; Vessey and Galletta 1991). The pioneer stream of TTF focused research extends this notion with a specific emphasis on how the correct choice of technology can facilitate the desired problem representation to enhance the problem solving process. For instance, Tan and Benbasat (1993) investigated the impact of using different types of information presentation format, namely bar, symbol and line graphs, on an individual's information extraction task's performance.

The original TTF model synergizes both streams of research to predict that the characteristics of the task and technology will jointly affect an individual's evaluation of TTF, which in turn affects utilization of the technology and task performance (Goodhue and Thompson 1995). The original TTF model is shown in Figure 4.2. Goodhue (1995) also put forth an expanded conceptualization of TTF to include a match between the technology and individual skills and abilities. Goodhue (1995) reasoned that an individual who is more competent, better trained or more familiar with using a particular technology would naturally be better able to utilize the technology to perform the task at hand.

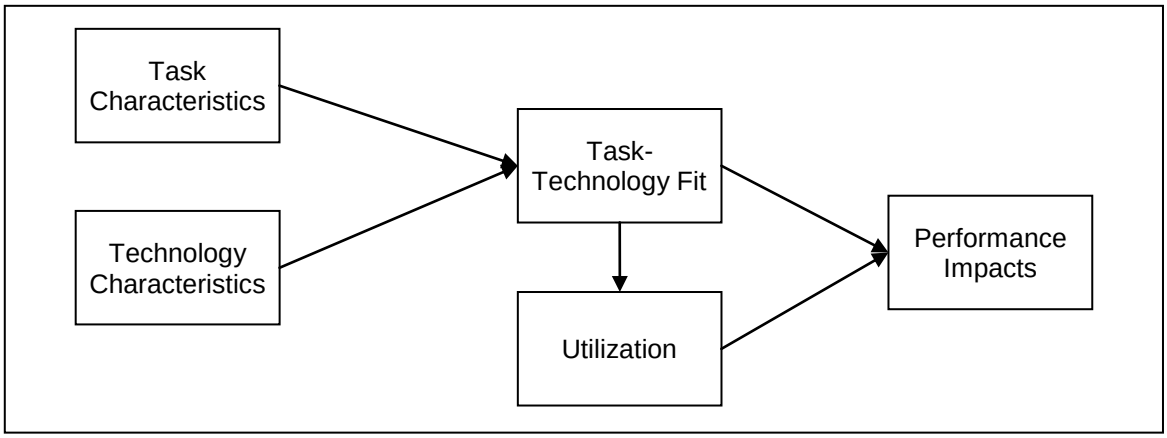


Figure 4.2 – The original Task-Technology Fit Model (TTF) (Goodhue and Thompson 1995).

While TTF is originally conceived to study technology use at an individual level, it has also been widely adopted for studies at the group level. For instance, researchers have examined different dimensions of group decision making task and how different types of

group support system tools should be provided to optimize group performance (Zigurs and Buckland 1998; Zigurs, Buckland and Connolly 1999).

The TTF construct itself may be operationalized in the form of user perception or using the computed approach (Dishaw and Strong 1999). As an example of the first approach, Goodhue (1995) identified a total of sixteen dimensions on how a user may evaluate TTF with respect to organizational information systems used in various industries such as manufacturing and finance. Some of these subjective dimensions include whether the information systems were reliable, provided accurate data and whether the data was presented in a readable and understandable form. The second computed approach is based on the fit as interaction approach suggested by Venkatraman (1989). Specifically, TTF is defined as the interaction of task and technology (Dishaw and Strong 1998). The computed approach is touted as the better approach as it directly corresponds to the definition of TTF, which is the matching of the technology functionalities to task requirements (Dishaw and Strong 1999). To compute TTF, the task and technology characteristics are first measured using separate instruments, which could include either self-reported questionnaire items or objective manipulations of the task/technology use. The interaction product term is then calculated using the normalized scores of the task and technology variables (Dishaw and Strong 1999).

Researchers have long suggested the possibility of integrating TAM with TTF (Dishaw and Strong 1999; Goodhue 2007). In particular, TAM and TTF offer different but overlapping explanations of technology utilization, and integrating both models may offer better predictive power over either model alone.

4.2.3 Combining Technology Acceptance Model and Task-Technology Fit

TTF generally posits that a match between the functionalities provided by a piece of technology artifact and the requirements of the tasks at hand will lead to its higher utilization (Goodhue and Thompson 1995). However, the initial conceptualization of the TTF model has also made provision for other antecedent factors of utilization. Specifically, Goodhue (1995) drew on the technology usage model (Bagozzi 1982) to argue that technology utilization may also be influenced by various attitudinal and belief perception factors such as social norms, affect and habit. Since TAM uses an individual's attitudinal beliefs towards a technology to predict its utilization, there is a possibility that TAM might be integrated with TTF to provide a more holistic explanation of technology utilization (Dishaw and Strong 1999). TAM's predictive power anchors on the presumption that individuals perceiving a technology as useful and easy to use will actually use it (Davis 1986; Davis 1989). However, it is entirely possible that an individual will utilize the technology even if one does not like it as long as the technology promises to enhance one's job performance (Venkatesh and Davis 2000). TTF provides a rationalized explanation for this gap with its prediction that individuals will use the technology as long as it provides tangible benefits such as job performance gain, regardless of their attitude (Goodhue 1995).

This line of reasoning has led researchers to devise several variants of models synergizing TAM and TTF. These models are underscored by two fundamental assumptions (Dishaw and Strong 1999). First, a match between the technology and task requirements, i.e., TTF, will directly affect utilization. Second, TTF may also partially determine the two attitudinal constructs in TAM, i.e., perceived usefulness and perceived ease of use, since users of the technology will rationally associate these beliefs with how well the technology supports the task at hand. In addition, technology tools with excessive

functionalities could also be harder to use. The basic integrated model as shown in Figure 4.3 primarily focuses on the effect of belief perceptions and TTF on utilization but neglected performance impact, a key construct in the original TTF model (Goodhue and Thompson 1995).

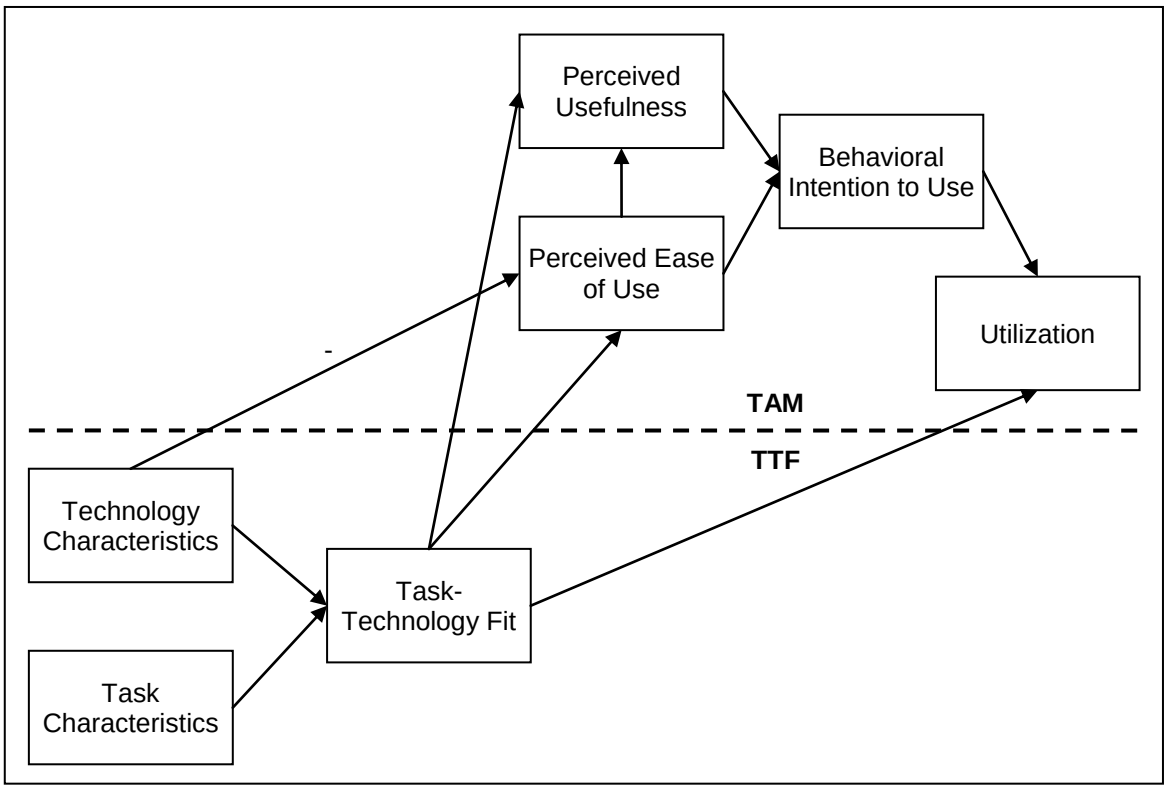


Figure 4.3 – The integrated model of Technology Acceptance Model (TAM) and Task-Technology Fit Model (TTF) (Dickshaw and Strong 1999).

The extant literature on electronic commerce adoption has seen a few studies using the integrated model of TAM and TTF. Some researchers such as Chen, Gillenson and Sherrell (2002) have proposed a technology innovation construct of compatibility, which is similar to TTF. The authors reasoned that compatibility between an online shopping website and consumers' beliefs, values and needs will foster a positive attitude towards the shopping website. Klopping and McKinney (2004) also used an integrated model to examine consumers' adoption of electronic commerce. The authors hypothesized that TTF is positively related to perceived usefulness and perceived ease of use. However, this model differed from Dishaw and Strong's (1999) model in several ways. First, the authors

chose to omit the causal link between TTF and utilization in favor of behavioral intention. Second, the authors did not consider the antecedent factors of TTF, i.e., task and technology characteristics. Sun and his colleagues (Sun et al. 2007) have also proposed extending TAM and TTF to study consumers' adoption of electronic commerce. They made several interesting suggestions such as incorporating trust into the assessment of electronic commerce adoption and advocate a more precise definition of online shopping tasks to improve the predictive power of the model. Other researchers have also attempted to extend the integrated model by introducing additional antecedent factors. For instance, Chang (2008) suggested that TTF could possibly affect perceived playfulness and perceived risk in addition to the two original TAM constructs. Perceived playfulness and perceived risk is expected to influence behavior intention to use online auction website. Along the same fashion as Klopping and McKinney's (2004) model, Chang did not examine utilization.

Lim and Benbasat (2000) synergized TAM and TTF in a vastly different approach to examine information representation formats. The authors' task-representation fit model posits that using the appropriate information representation format, either text-based or multimedia, that matches the analyzability of a task will lower perceived equivocality. This leads to better problem understanding and thus enhances individuals' perception of the information representation format's usefulness. While the task-representation fit model integrates both TAM and TTF, neither utilization nor performance impact is examined explicitly although perceived equivocality is a proxy measure of performance.

Several recurrent problems appear to persist among extant studies using an integrated TAM and TTF model. First, there is an unwitting omission of the key dependent construct of utilization (Chang 2008; Klopping and McKinney 2004). Even the rare exceptions such as the work of Dishaw and Strong (1999) have relied on self-reported measures of

utilization instead of actual objective measures of utilization. Two, none of the studies reviewed has considered the performance impact of TTF and utilization. This is indeed surprising given that performance impact was a key notion underpinning the theoretical bedrock of TTF, i.e., technology-to-performance chain model (Goodhue 1995; Goodhue and Thompson 1995). The first two problems epitomize one of researchers' major concern on extant technology adoption research, i.e., system usage should be better conceptualized beyond the fallacies of self-reported measures and traditional measures that overly emphasized more system use is better (Benbasat and Barki 2007; Lee et al. 2003; Legris et al. 2003; Goodhue 2007).

Third, although there have been a few studies using the integrated model of TAM and TTF to examine electronic commerce adoption (Chang 2008; Klopping and McKinney 2004; Sun et al. 2007), they did not clearly delineate the characteristics of online shopping tasks and the supporting electronic commerce tools. This problem is closely associated with researchers' call to focus more on providing concrete guidelines that explicate how electronic commerce tools should be designed (Benbasat and Barki 2007; Goodhue 2007). Chang's (2008) work, which focuses on online auction intelligent agent, provides a good starting point though. Fourth, none of the extant studies reviewed was of a longitudinal nature, a major problem that has long been highlighted by researchers (Benbasat and Barki 2007). Fifth, none of the extant studies reviewed had attempted to address the needs of merchants, i.e., sellers' adoption and use of electronic commerce tools.

4.2.4 The Role of Technology Acceptance and Task-Technology Fit in the Evaluate Process of Design Science

The design science paradigm mandates a piece of purposefully created technological artifact to be critically evaluated in order to establish its feasibility and usability (March and Smith 1995). Obviously, this evaluate process must be performed rigorously. In this regard, the two well established technology utilization theories of TAM and TTF provide suitable theoretical lenses to evaluate Cloud Commerce. On the one hand, TAM will help to explain whether the various functionalities are beneficial in helping sellers and buyers adopt and use Cloud Commerce. But as researchers have observed, more use of a technology artifact need not necessarily translate into better outcome (Pentland 1989). Thus, on the other hand, the use of TTF will help to determine whether greater utilization of Cloud Commerce does indeed lead to positive electronic commerce outcome. Of course, it is also important to ascertain whether the various functionalities of Cloud Commerce are well suited to, i.e., *fit*, electronic commerce. Such joint use of TAM and TTF has its precedence with very encouraging findings (Dishaw and Strong 1999).

In addition, researchers have hitherto paid scant attention to understanding the adoption of consumer cloud computing services despite their increasing prominence. Interestingly, Claburn (2011) observed that consumers have been using cloud computing services for a long time, even longer than most businesses, but yet remain unaware that they are actually using cloud computing. Extant literature in consumer cloud computing services has thus far been limited to a general survey of their adoption and discussions about the challenges facing their adoption (Kim 2011; Leavitt 2009). Notable exceptions such as the work of Ambrose and Chiravuri (2010) has found that higher levels of perceived usefulness and privacy concern will respectively increase and decrease the use of cloud computing services such as cloud storage and cloud service. But this study covers general

cloud computing and offers little insights on cloud computing-based electronic commerce. Moreover, the study offers little guidelines on how to enhance the usability of cloud computing services.

The present study aims to advance our understanding of the adoption and use of a novel form of cloud computing-based electronic commerce and prescribe specific design guidelines to enhance usability and utilization. It seeks to examine the general use of Cloud Commerce as an electronic commerce platform from the dual perspectives of sellers and buyers. In the next section, I will present my research model integrating TAM and TTF that is designed to achieve this objective.

4.3 Research Model

The research model put forth to evaluate the feasibility of Cloud Commerce will be based on the integrated TAM and TTF model (Figure 4.3) that has been studied in the extant literature. However, this thesis aims to address known deficiencies with prior studies. Chief among the aims of my research model is to explore the specific task and technology characteristics that are pertinent to not just buyers but also sellers using Cloud Commerce as well as how the respective fit of seller/buyer task and technology characteristics affects electronic commerce performance. In this regard, the model depicted in Figure 4.3 will be extended with an additional dependent construct of performance impacts as per the original TTF model shown in Figure 4.3 with utilization and TTF being the antecedent constructs. Also, there will be two variants of the research model, one for seller and another one for buyer. The general TAM constructs of perceived usefulness, perceived ease of use and behavioral intention to use will be similar across the seller and buyer models. The same goes for most of the TTF model constructs such as technology characteristics, utilization and performance impacts. As for TTF itself, this thesis will

adopt the computed approach (Dishaw and Strong 1999) and hence no differentiation is necessary between seller and buyer. However, task characteristics will be conceptualized distinctly different for sellers and buyers.

4.3.1 Seller's Task Characteristics

Tasks are generally defined as the actions carried out by an individual to transform some input into the desired output (Goodhue and Thompson 1995). Seller's tasks in an electronic commerce environment have generally received little attention in the extant literature compared to buyer's tasks. However, Wigand's (1997) work on the conceptualization of electronic commerce provides a good starting ground. The transaction cost notion (Williamson 1981) suggests that online merchants' adoption of electronic commerce represents a clear attempt to economize on the transaction costs involved in selling their products (Wigand 1997). Transaction costs may be further broken down into production costs and coordination costs. Of greater relevance to the electronic commerce context is the coordination costs defined as the costs of information processing required to coordinate the work of people and machines performing primary processes leading to the delivery of completed goods (Malone, Yates and Benjamin 1987). Coordination costs components include search costs of searching for buyers, contracting costs of setting up and executing the sale contract, monitoring costs of ensuring that the sale contracts are fulfilled and adaptation cost incurred in making changes to the sale contract (Wigand 1997). Researchers have demonstrated empirically that electronic commerce is able to reduce transaction costs incurred by merchants thus translating into lower purchase costs for the consumers (Benjamin and Wigand 1995). It may be surmised from the transaction cost perspective that some of the key seller's tasks include searching for buyers to visit the online shopping website, creating sale offers on the shopping

website, maintaining the product catalog that is closely associated with the creation of sale offers and executing the sale offers.

The importance of marketing in an electronic commerce setting has also been emphasized by researchers (Wigand 1997). The three main types of marketing efforts revolve around customer orientation, product orientation and profit orientation. In customer oriented marketing, the merchant attempts to identify the needs of individual customers and sell them the desired products. In product oriented marketing, the merchant manufactures or obtains through a distribution channel products possessing certain merits in which the manufacturer believes will attract mass consumers to purchase them. This approach does not consider whether the targeted consumer segment has a genuine need for the products. In profit oriented marketing, the merchant attempts to identity products that are highly sought after by consumers and provide a high level of profitability. These presumably profitable products are then sold on the merchant's website. While there are numerous marketing tasks that need to be performed by an online merchant, Cloud Commerce is mainly positioned for product oriented and profit oriented marketing. Thus, the more relevant seller's tasks are displaying the products on the shopping website and persuading customers, i.e., visitors to the shopping website, to purchase the products.

Diffusion in our context refers to the social process by which an electronic commerce sale offer propagates to the target customers (Rogers 1995; Wigand 1997). The Internet and the World Wide Web, the fundamental technological infrastructure underlying electronic commerce, provide a cost-effective one-to-many multimedia communication medium for diffusing and marketing products (Wigand 1997). This interactive medium is especially important given the increasing importance that merchants place on customer feedbacks. While the diffusion perspective bears a close resemblance to the marketing perspective, it

nonetheless underscores an important task that must be performed by the seller, i.e., reaching out to customers and gathering feedback from them.

From an information retrieval perspective, the huge amount of product information must be made available to consumers in an effective and efficient manner that can only be achieved by a well designed customer oriented system (Wigand 1997). This is especially so given that product information may be structured or unstructured. However, the trend is clearly towards the provision of more structured product information in order to enable advanced marketing techniques such as the use of recommendation agents (Nwana 1998). A key seller task that can be derived from this line of reasoning is the maintenance of the product catalog and making it readily available to potential buyers. This view is also consistent with the transaction cost perspective of electronic commerce.

Finally, from a strategic networking perspective, trust has been identified as an important mechanism for lowering transaction and coordination costs in electronic commerce (Wigand 1997). Indeed, researchers have noted the importance of trust in helping consumers to overcome their perception of risk and insecurity, which will ultimately increase their propensity of sharing personal information and making purchases (Kong and Hung 2006; McKnight, Choudhury and Kacmar 2002). However, fostering trust is a highly complex process given its multi-dimensionalities (McKnight et al. 2002). Online merchants need to be mindful of consumers' disposition to trust, institution-based trust affords by the electronic commerce environment such as third-party trust seal, trusting beliefs, trusting intentions and trusting behaviors. But what is clear is that a seller has to perform the crucial task of gaining the trust of potential buyers.

4.3.2 Buyer's Task Characteristics

In contrast to seller's tasks, buyer's tasks in an electronic commerce environment have received far more attention from researchers. Purchase tasks usually involve specifying certain product preferences, i.e., the input, searching for those items matching these preferences and buying the final selected item, i.e., the output (Xiao and Benbasat 2007). Task characteristics of interest in TTF studies are typically those that might cause individuals to rely more heavily on certain functionalities provided by a piece of technology artifact (Goodhue and Thompson 1995).

Extant electronic commerce research studies taking a task oriented approach have conceptualized buyer's tasks using several approaches. The most direct and straightforward approach is a two-fold definition encompassing product information search and actual purchase (Chen et al. 2002; Klopping and McKinney 2004). The former involves the search and inquiry of product information on the electronic commerce website while the latter refers to all other activities that need to be performed on the website leading to the purchase of desired items (Chen et al. 2002). Online auction tasks may also be classified into two main categories but of a vastly different nature, namely item acquisition and price negotiation (Chang 2008). The former refers to a pure desire to acquire a particular item whereas the latter involves a deliberate attempt to obtain an item at a lower price compared to other offline and online channels. Other researchers such as Sismeiro and Bucklin (2004) segregates online purchase into three distinct tasks. The first task is to complete the product configuration by choosing desired make and model of the desired product category together with other pertinent product attributes. This corresponds well to product information search. The second task typically involves providing personal information to the shopping website, e.g., date of birth, gender, occupation, income level and billing address. The third task of order completion includes

choosing shipping options, choosing additional services such as insurance, providing payment details such as credit card information and specifying shipping address if it differs from the billing address. The second and third tasks essentially encompass the steps taken in the actual purchase task of the two-fold definition.

Other researchers adopt a more elaborate classification framework based on consumer buying behavior (Bettman 1979; Engel and Blackwell 1982). Such a typical framework (Guttman et al. 1998; Wells, Sarker, Urbaczewski and Sarker 2003) would begin with the product brokering task whereby a buyer searches for product information, shortlists a subset of available items and evaluates them to decide on the final item to purchase. The second task of merchant brokering involves sourcing for merchant-specific information and deciding on whom to buy the item from. Some researchers collapse product brokering and merchant brokering into a single task of information searching (Wells et al. 2003). The third task involves negotiation to determine the terms of the purchase transaction. In mainstream fixed price sale model, there is typically little room for negotiation. However, newer modes of sale such as auction and group buying will involve negotiation. The fourth task is the actual purchase and delivery of the selected items and involves sub-tasks such as customer registration, checkout, online payment, etc. The fifth task of post-purchase product evaluation involves scrutinizing the items purchased against the descriptions provided by the merchant and determines whether they meet the buyer's needs. Although this task may also include after-sale customer service, we are primarily concerned with the functionalities to allow buyers to provide their feedback and share their product use experience. The present study will adopt this five tasks classification framework, which is essentially an expansion of the two-fold definition albeit with much greater details.

4.3.3 Technology Characteristics

Technologies refer to the software tools used by individuals to carry out their tasks (Goodhue and Thompson 1995). In TTF studies, it is possible to examine the impacts of a specific system or the more general impacts of an entire set of systems together with their associated policies and services. This study focuses on a single specific technology artifact, i.e., Cloud Commerce, although there are numerous tools provided by this platform. The tools that are commonly found in an electronic commerce website can be classified into seven categories of user management, content management, merchandising, negotiation, order fulfillment, payment processing, and service and support (Jhingran 2000). The characteristics of these tools are derived based on the general design characteristics of Cloud Commerce (see Table 2.1). The technology characteristics of Cloud Commerce seller's and buyer's tools are listed in Table 4.1 together with the task characteristics.

4.3.4 Utilization

Utilization is defined as the behavior of employing a specific technology to complete some tasks (Goodhue and Thompson 1995). In mainstream information systems research, utilization is often conceptualized as the frequency of use or the diversity of functionalities employed (Davis et al. 1989; Thompson, Higgins and Howell 1991; Thompson, Higgins and Howell 1994). In the ideal case, utilization should be measured as the proportion of time users choose to utilize certain technology tools (Goodhue and Thompson 1995). However, in a field study, it may be difficult to ascertain this proportion especially when usage is mandatory. In such cases, it is acceptable to use perceptive measures to gauge users' choice of utilizing a specific technology tool (Goodhue and Thompson 1995). In fact, most TTF research studies operationalized

Construct		Seller's Model	Buyer's Model
Task Characteristics		• Search for buyers. • Create sale offers. • Maintain product catalog. • Execute sale offers. • Display product catalog on shopping website. • Persuade customers to purchase products. • Gather feedback from customers. • Gaining customers' trust.	• Search for product information. • Search for merchant information. • Purchase negotiation. • Actual purchase. • Post-purchase product evaluation.
Technology Characteristics	User Management	• Single user account.	• Single user account
	Content Management	• Create or reuse rich product schema using multiple devices. • Create or reuse rich product information using multiple devices. • Manage product item inventory using multiple devices.	• Search product items with detailed preferences from multiple sources using multiple devices. • Compare product items side-by-side. • Search merchants from multiple sources using multiple devices.
	Merchandising	• Specify related product categories and items for up-sell and cross-sell across multiple sources.	• Get recommendation on product items and merchants from multiple sources using multiple devices. • Provide autonomous searching of product items from multiple sources.
	Negotiation	• Describe and post fixed price sale offer, auction offer, group buying offer to multiple sources using multiple devices. • Place bid for reverse auction offer from multiple sources.	• Buy fixed price sale offer with bargaining, auction offer, group buying offer from multiple sources using multiple devices. • Perform reverse auction offer (a.k.a. want-to-buy offer).
	Order Fulfillment	• Process sales order from multiple sources using multiple devices.	• Checkout shopping cart using multiple devices. • Provide shipping and billing information.
	Payment Processing	• Verify payment received from multiple sources using multiple devices.	• Make online payment using multiple devices.
	Service and Support	• View own product items' and merchant's rating and feedback from multiple sources.	• Leave rating and feedback for product items and merchant from multiple sources using multiple devices.
Note: A source is defined as a touch point to buy or sell something. A source can be a website, blog (including plugin), social network application, mobile website or mobile application. A device is defined as a computing device to buy or sell something. A device can be a desktop computer, laptop computer, tablet computer or mobile smart phone.			

Table 4.1 – Task and technology characteristics for seller's and buyer's research models.

utilization as perceptive measures that use questionnaire items to ask users for the amount of time spent using a technology tool (Dishaw and Strong 1998; Dishaw and Strong 1999; Klopping and McKinney 2004) or how dependent they were on a specific technology tool (Goodhue 1995).

However, some researchers have suggested that such narrow definitions of system usage should be broadened to examine other ways in which users interact with a system (Benbasat and Barki 2007). For instance, Barki, Titah and Boffo (2007) put forth the notion of Information System Use-Related Activity (ISURA) and propose several types of behavior that are related to system usage. Technology interaction behaviors include any interaction with a technology artifact to accomplish a task. This set of behaviors is similar to the mainstream frequency and diversity of use conceptualization of system usage. Task-technology adaptation behaviors involve those actions taken by individuals to change a technology after using it, i.e., reinvention behavior. Individual adaptation behaviors include any actions taken by individuals to change themselves in order to adapt to a new technology, i.e., learning behavior.

In this study, we will attempt to measure utilization from the dual perspective of frequency of usage and ISURA. First, we will use questionnaire items to gauge how often an individual uses each specific category of Cloud Commerce tools, which are again classified along the seven categories of user management, content management, merchandising, negotiation, order fulfillment, payment processing, and service and support (Jhingran 2000). Second, we will use questionnaire items to gauge an individual's task-technology adaptation and individual adaptation behaviors.

4.3.5 Performance Impacts

Performance impacts refer to the accomplishment of a set of tasks by an individual (Goodhue and Thompson 1997). Higher performance may manifest in the forms of improved efficiency/productivity, improved effectiveness, and/or better task outcome/performance (Goodhue and Thompson 1997). While this general definition holds for sellers and buyers alike, the exact operationalization will be different. For instance, the seller's perspective will focus on the selling tasks while the buyers' perspective will focus on buying tasks. Since the objective of this study is to evaluate the feasibility of Cloud Commerce rather than benchmarking it against other electronic commerce platform or services, it is not feasible to draw a direct comparison. Instead, perceptive measures will be utilized to gauge users' perception of Cloud Commerce. Users will not be asked to compare Cloud Commerce against another online shopping website or tool that they have used before. Using perceptive measures of performance impacts is generally acceptable if equivalent objective measures are neither available nor feasible (Goodhue and Thompson 1997).

4.3.6 Diagrammatic Overview of Research Model

The diagrammatic overview of the combined research model is shown in Figure 4.4. There are essentially two such models, one for seller and another for buyer. The definitions of the constructs will be phrased accordingly. For instance, the task and technology characteristics for seller and buyer will be distinctly different, following the definitions in Table 4.1.

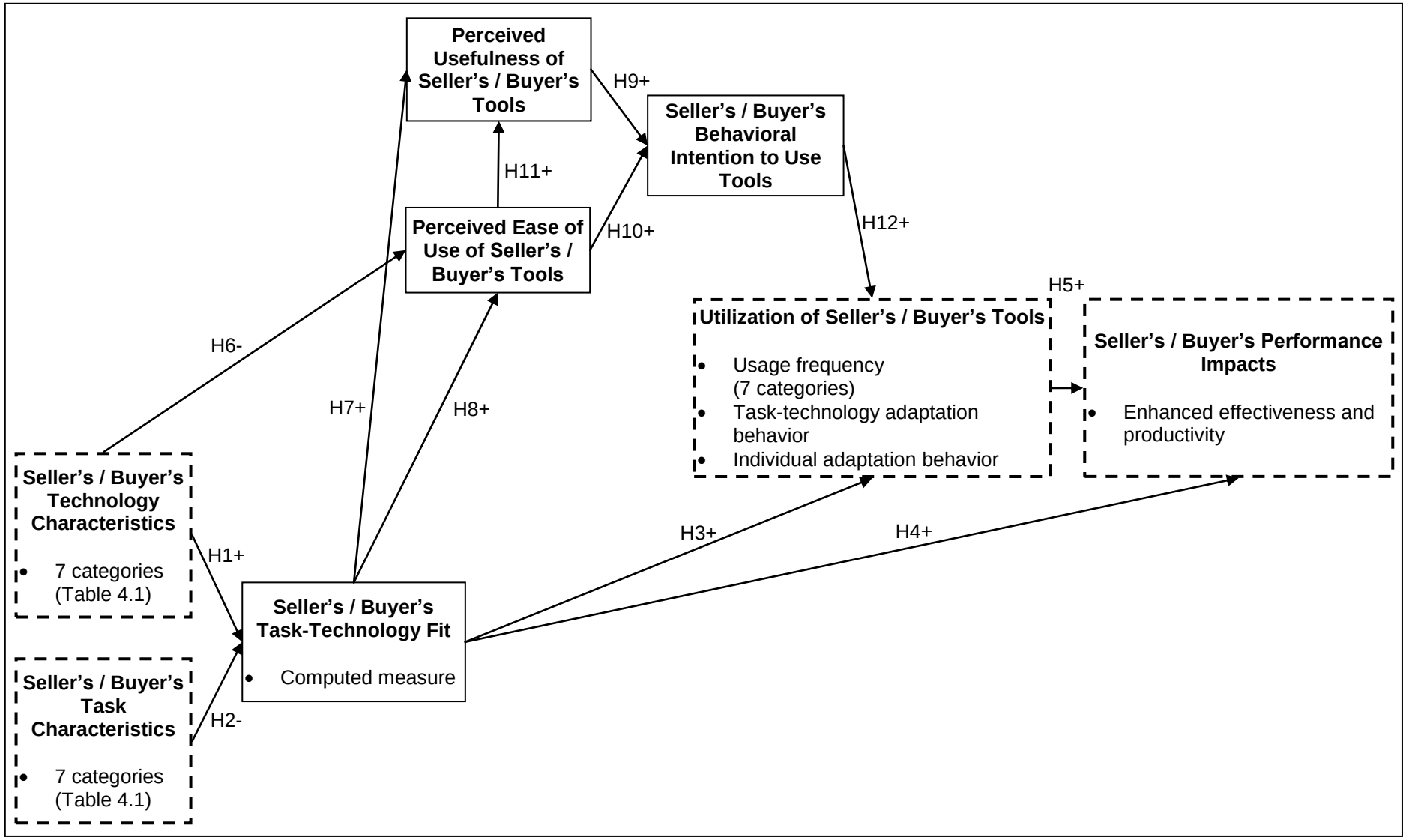


Figure 4.4 – Research model to evaluate the adoption and use of Cloud Commerce in general.

4.4 Hypotheses Development

4.4.1 Task-Technology Fit Effects

The antecedent of TTF is mainly the interaction between technology and task (Goodhue and Thompson 1995). The general thesis underpinning TTF is that certain types of tasks will require certain types of technological tools to provide suitable support leading to task accomplishment. Thus, a wider gap between task requirements and functionalities provided by the technology tool will likely reduce TTF. Moreover, no technology tool exists that meets the requirements of a task perfectly without the users having to commit certain efforts to internalize its use. Thus, all other things being equal, as the technology tool offers more functionalities and the task become less demanding, TTF will increase (Goodhue and Thompson 1995). In other words, technology characteristics are expected to be positively related to TTF while task characteristics are expected to be negatively related to TTF.

In a large scale field survey of over 600 users utilizing 25 different types of organizational information systems, Goodhue and Thompson (1995) found that individuals who use more system functionalities evaluated the systems highly in terms of dimensions such as locatability and reliability, proxy measures of TTF. As expected, the authors also found that individuals who had engaged in more non-routine tasks rated the information systems they used lower on dimensions such as data quality and data compatibility, i.e., a negative relationship between task characteristic and TTF. In another separate large scale survey of 10 large organizations across various industries such as financial services and manufacturing, Goodhue (1995) observed similar causal relationships between technology and task characteristics with TTF.

Dishaw and Strong (1998) conducted a study on programmer analysts working on software maintenance projects aided by various software engineering tools. In this study, the authors examined two different types of software maintenance tasks and their corresponding tools, namely production and coordination tasks. Results from the study show that the greater the extent in which the various software engineering tools provided functionalities to support the respective tasks, the higher the computed magnitude of TTF. In the case of task characteristics, Dishaw and Strong (1998) observed that the greater the extent in which analysts performed the respective software maintenance tasks, the lower the computed magnitude of TTF. In another relevant study, Karimi, Somers and Gupta (2004) studied employee's satisfaction with data obtained from their internal information systems. The results from this study indicated that employees working on more complex tasks characterized by higher degree of non-routineness and interdependence were less satisfied with their data. Satisfaction with data may be considered a proxy measure of TTF to the extent that data that is inaccessible, unreliable, inaccurate and outdated results from the use of information systems that are unable to support the tasks at hand (Goodhue 1995).

In the context of Cloud Commerce, sellers and buyers need to perform numerous tasks (see Table 4.1) in order to achieve their respective goals of earning a profit and getting the required/desired product items. It is likely that the higher the abilities of the various Cloud Commerce tools in supporting these tasks, the higher the degree of TTF. Similarly, the more demanding these tasks become, we may reasonably contrive that the degree of TTF will decrease. Accordingly, the first two hypotheses are put forth below:

H1. Technology characteristics are positively related to task-technology fit.

H2. Task characteristics are negatively related to task-technology fit.

Utilization of any technology artifact is contingent on many factors such as one's beliefs about the consequences of use, affect, social norms, habits and other facilitating conditions (Goodhue and Thompson 1995). The original conceptualization of the technology-to-performance chain model prescribed an indirect causal link between TTF and utilization mediated by expected consequences of utilization. The rationale being that TTF was a key determinant of whether one perceived a technology to be useful. The extant literature provides strong evidences supporting the causality between expected consequences of utilization and actual utilization (Adam, Nelson and Todd 1992; Davis 1989; Davis et al. 1989). Consequently, Goodhue and Thompson (1995) reasoned that since the link between user beliefs and utilization is well established and TTF is expected to positively influence user beliefs, having a direct link from TTF to utilization would result in a more parsimonious model of technology-to-performance chain. While their empirical study found several dimensions of TTF to be positively related to utilization, the proportion of variance in utilization as explained by TTF was only 2%. The authors attribute this finding to the conceptualization of utilization as the degree of dependence on technology instead of the more commonly used definitions of duration and frequency of use. Also, the low variance accounted for could also be attributed to the lack of consideration of attitudinal and social norms beliefs, which might have been dominant in the studied organizations.

Despite the initial setback, subsequent researchers have found that TTF does directly predict utilization even after controlling for technology and task characteristics (Dishaw and Strong 1998; Dishaw and Strong 1999). In the context of World Wide Web, researchers have found that only uncertainty reduction, one of the five dimensions of TTF examined, appeared to positively influence utilization (D'Ambra and Wilson 2004). An important trend may be discerned from those studies in which TTF had failed to predict

utilization compared to those that did. Specifically, studies that operationalized TTF as user perceptions did not find any significant relationship with utilizations (D'Ambra and Wilson 2004; Goodhue and Thompson 1995) whereas those that used the computed interaction approach did find significant relationships (Dishaw and Strong 1998; Dishaw and Strong 1999). This may not be surprising since the computed approach of TTF is thought to possess greater construct validity (Dishaw and Strong 1999; Venkatraman 1989).

From the ISURA perspective, it is possible that providing sellers and buyers with suitable electronic commerce tools will motivate them to think of ways and means to further improve these tools, i.e., task-technology adaption, and better align their own selling/ buying process to match the workflow of Cloud Commerce (Barki et al. 2007). In summary, there is no reason to doubt that a better match between Cloud Commerce's tools and the various electronic commerce tasks would not improve utilization. Moreover, we conceptualized TTF using the computed approach. Thus, it is hypothesized that:

H3. Task-technology fit is positively related to utilization.

Researchers have long noted that providing individuals with technology tools that support the tasks at hand will improve the effectiveness and efficiency of task performance (Goodhue and Thompson 1995). For instance, in the context of graph-based and table-based information presentation tools commonly found in decision support systems, providing the appropriate information presentation tool that fits a particular information task does indeed improve task performance (Jarvenpaa 1989; Vessey 1991; Vessey and Galletta 1991). Individual technology usage aside, extant studies examining use of group support systems have found that when appropriate tools are provided to small groups of co-workers, their collective decision making, ideas generation, task completion abilities

are improved (Dennis, Wixom and Vandenber 2001; Zigurs et al. 1999). Beyond mainstream information systems, researchers have also found that when individuals perceive websites or web services as being well suited to their information seeking tasks (e.g., finding information on hobbies and interests), they will correspondingly express positive perceptions of their information seeking performance (e.g., make decision better and faster).

In a similar fashion, if the various tools provided by Cloud Commerce are suitable for the various sellers' and buyers' tasks, we should observe community users reporting better effectiveness and productivity compared to extant electronic commerce tools that they have used previously. Thus, it is hypothesized that:

H4. Task-technology fit is positively related to performance impacts.

Extant research on TAM has largely make an implicit assumption that more use of a technology is better, i.e., leads to better performance outcomes (Goodhue 2007). However, there are known exceptions to this assumption (e.g., Pentland 1989). Thus, an important tenet of the TTF model is that utilizing more of a technology tool will lead to an improvement in task performance only to the extent that the tools provides good support for the task at hand (Goodhue 2007; Goodhue and Thompson 1995). This line of thought has been empirically validated within the context of information seeking on the World Wide Web (D'Ambra and Wilson 2004). Cloud Commerce has been carefully conceptualized and designed to facilitate users' selling and buying across multi-channels/media. The tools provided by Cloud Commerce should be well suited to the needs of sellers and buyers. Accordingly, it is hypothesized that:

H5. Utilization is positively related to performance impacts.

4.4.2 Technology Acceptance Effects

The original intent of integrating TAM and TTF is that they are complementary to each others' strengths and weaknesses. Although TAM provides a parsimonious explanation of technology adoption and use from an attitudinal-behavioral perspective, it fails to account for what makes a technology artifact useful and easy to use (Benbasat and Barki 2007). TTF provides a useful theoretical grounding to make up for this shortfall in TAM. Specifically, TTF emphasizes that a technology artifact should provide functionalities to support the specific task at hand in order for users to derive enhanced task performance (Goodhue 1995; Goodhue and Thompson 1995). TTF further provides a well defined theoretical mechanism for measuring the degree of fit between task and technology. However, even though the original theoretical foundation of TTF, i.e., the technology-to-performance chain model, provides for the incorporation of users' belief perceptions on the use of technology, most application of TTF fails to take this into adequate consideration. For instance, Goodhue and Thompson (1995) had failed to find any causality between TTF and utilization. Thus, an integration of TAM and TTF provides a viable option moving forward (Dishaw and Strong 1999).

Dishaw and Strong (1999), in their conceptualization of the integrated TAM and TTF model, suggested that technology tools with excessive functionality are likely to be harder to use. Cloud Commerce offers sellers and buyers a wide range of tools to accomplish their tasks. While this is a noteworthy aspect of Cloud Commerce, it should be acknowledged that some users might find it hard to employ too many tools at one time. However, Dishaw and Strong (1999) noted that this problem will become less of a concern as users gain more experience. The authors took into consideration the individual characteristic of tool experience and posited that this will be positively related to perceived ease of use. Although this study does not consider individual characteristic, a

longitudinal design will be used for the empirical validation of the research model. Thus, it is still possible to ascertain whether the negative effect exerted by technology characteristics on perceived ease of use will wear off with increasing usage experience. But in general, it is hypothesized that:

H6. Technology characteristics are negatively related to perceived ease of use.

Individuals are likely to develop beliefs about usefulness and ease of use of technology in a rational manner taking into due consideration the characteristics of the technology and the task it is used for (Dishaw and Strong 1999). All other things being equal, a technology that provides good support for the task at hand is likely to be perceived as useful and easy to use. This thesis has been empirically validated within the context of electronic commerce in the extant literature. For instance, a shopping website that provide features to meet the product information requirements of shoppers will be perceived as useful and easy to use (Klopping and McKinney 2004). In a similar fashion, an auction website that provide features to support users' item acquisition and price negotiation tasks will be perceived as useful and easy to use (Chang 2008).

Additional support may also be found from the innovation diffusion perspective (Chen et al. 2002). A technology innovation's compatibility is defined as the degree to which it is aligned with potential users' values, beliefs and needs such that greater compatibility leads to increased adoption of the technology. The compatibility notion is thus similar to TTF and has been found to positively influence perceived usefulness (Chen et al. 2002). Thus, it is hypothesized that:

H7. Task-technology fit is positively related to perceived usefulness.

H8. Task-technology fit is positively related to perceived ease of use.

TAM postulates that individuals' perception of the degree of usefulness and ease of use of a technology artifact positively influence intention to use it, which in turn encourages actual use (Davis 1989; Davis et al. 1989). TAM has been empirically validated in countless number of research studies over the past two decades leading to two of our senior scholars remarking that "*we now know almost to the point of certainty that perceived usefulness is a very influential belief and that perceived ease of use is an antecedent of perceived usefulness and an important determinant of use in its own right*" (Benbasat and Barki 2007, pp.1). Yet it is this degree of certainty that is so crucial towards establishing the feasibility of Cloud Commerce as an electronic commerce platform. In this regard, the final four hypotheses are presented below:

H9. Perceived usefulness is positively related to behavioral intention.

H10. Perceived ease of use is positively related to behavioral intention.

H11. Perceived ease of use is positively related to perceived usefulness.

H12. Behavioral intention is positively related to utilization.

4.5 Proposed Research Methodology

4.5.1 Proposed Research Design

The objective of this research is to understand Cloud Commerce users' intention to adopt and use the platform for selling and buying of products online. This is the first part of the larger design science process to evaluate the feasibility of Cloud Commerce. An emphasis is placed on the generalizability of the results beyond the sample population of participants in order to ensure the long term viability of Cloud Commerce. To this extent, a field experiment would be more appropriate. This study will also adopt a longitudinal

design to examine the effects of TTF on salient beliefs of system usage at different stages of implementation. Specifically, a one-group repeated measures quasi-experimental design (Tan, Tan and Teo 2012) will be used.

A working prototype of the Cloud Commerce platform will be developed and deployed for live use. This will include various sellers' and buyers' tools on different sources and devices (see Table 4.1) as envisioned in Figure 2.8. An invitation will be sent out to solicit for participants, both sellers and buyers. Participants will be encouraged to use as many tools of Cloud Commerce as possible for a period of six weeks to conduct real transactions.

At the beginning of the six weeks period, participants who have registered for a Cloud Commerce account will be shown a brief description of Cloud Commerce together with a Wiki-style tutorial. An online web-based survey will then be administered to gauge their demographic profile as well as their prior experience in online selling and buying. At the end of the third week, a follow-up survey will be administered to gauge participants' initial post-usage responses on TTF variables, beliefs and intention, utilization and performance impacts. There will be two different versions of the survey questionnaire, i.e., one for seller and one for buyer. Each participant will be asked whether they have used Cloud Commerce primarily for selling or buying over the immediate past three weeks. The appropriate version of the survey questionnaire will then be shown to the participant. An online web-based survey is appropriate since we are surveying Internet users on their experience with the use of electronic commerce tools. Presumably, the participants will find this to be the most convenient response method.

At the end of the sixth week, a final follow-up survey will be administered to gauge participants' repeated-usage responses on TTF variables, beliefs and intention, utilization

and performance impacts. In addition to the survey, the prototype will incorporate extensive data logging functionalities to track the actions performed by users and the corresponding usage statistics to facilitate analysis of seller's/buyer's tasks behaviors. The research design is depicted in Figure 4.5.

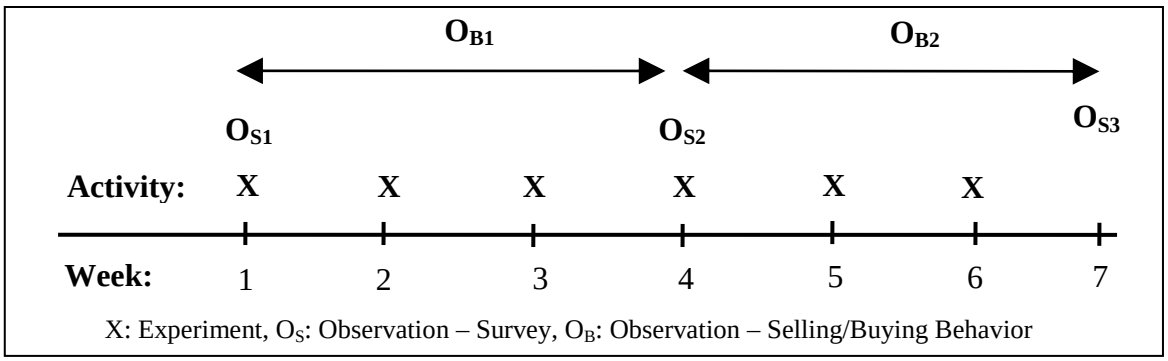


Figure 4.5 – Proposed research design for Cloud Commerce in general.

O_{S1} refers to the online survey that gauges the demographic profile as well as prior online selling and buying experience of the participants. O_{S2} refers to the online survey that gauges participants' initial post-usage responses on TTF variables, beliefs and intention, utilization and performance impacts (i.e., both independent and dependent variables). O_{S3} refers to the online survey that gauges participants' repeated-usage responses on TTF variables, beliefs and intention, utilization and performance impacts (i.e., both independent and dependent variables). The survey data for independent variables collected in Period 1 (i.e., Week 1, 2 and 3) will be run against the survey data for dependent variables collected in the same period (i.e., immediate or near to immediate effect) and similarly for the survey data collected in Period 2.

4.5.2 Proposed Operationalization of Constructs

The theoretical constructs shown in the research model (see Figure 4.4) will be measured with instrument scales adapted either from validated scales taken from the extant literature or self-developed based on established theories. The instrument scales will be

developed based on the recommendations of Moore and Benbasat (1991), which include putting the scales through several rounds of unlabeled and labeled sorting to achieve high inter-rater reliability (Cohen's Kappa) scores greater than 0.80. The measurement items for each instrument scale are listed in Table 4.2. Unless otherwise stated, these are 7-point Likert scale (1 – Strongly Disagree to 7 – Strong Agree). The remaining scales are 7-point Likert-like scales. Since this is a longitudinal study, the first survey will gauge users' intention to buy/sell while the second survey will gauge users' continued intention to buy/sell.

Sellers' and buyers' behaviors, i.e., utilization, will be captured through system data logging, which will track the actual number of transactions that each user makes on Cloud Commerce as well as interactions with individual tools. The first set of behaviors will cover the first three weeks of the experiment and the second set of behaviors will cover the last three weeks of the experiment. TTF will be computed using the interaction approach prescribed in the extant literature (Dishaw and Strong 1998; Dishaw and Strong 1999; Venkatraman 1989).

The data will be analyzed using partial least square structural equation modeling.

Construct	Measurement Items	Key References
Technology Characteristics	**Seller** To what extent do the Cloud Commerce tools available to you supply the following seller's functions? 1. Single user account 2. Create or reuse rich product schema using multiple devices. 3. Create or reuse rich product information using multiple devices. 4. Manage product item inventory using multiple devices. 5. Specify related product categories and items for up-sell and cross-sell across multiple sources. 6. Describe and post fixed price sale offer, auction offer, group buying offer to multiple sources using multiple devices. 7. Place bid for reverse auction offer from multiple sources. 8. Process sales order from multiple sources using multiple devices. 9. Verify payment received from multiple sources using multiple devices. 10. View own product items' and merchant's rating and feedback from multiple sources. **Buyer** To what extent do the Cloud Commerce tools available to you supply the following buyer's functions? 1. Single user account. 2. Search product items with detailed preferences from multiple sources using multiple devices. 3. Compare product items side-by-side. 4. Search merchants from multiple sources using multiple devices. 5. Get recommendation on product items and merchants from multiple sources using multiple devices. 6. Provide autonomous searching of product items from multiple sources. 7. Buy fixed price sale offer with bargaining, auction offer, group buying offer from multiple sources using multiple devices. 8. Perform reverse auction offer (a.k.a. want-to-buy offer). 9. Checkout shopping cart using multiple devices. 10. Provide shipping and billing information. 11. Make online payment using multiple devices. 12. Leave rating and feedback for product items and merchant from multiple sources using multiple devices. (1 – Very Small Extent to 7 – Very Large Extent)	Adapted from Dishaw and Strong (1998), and Dishaw and Strong (1999)

Construct	Measurement Items	Key References
Task Characteristics	**Seller** To what extent did you perform the following seller's tasks? 1. Search for buyers. 2. Create sale offers. 3. Maintain product catalog. 4. Execute sale offers. 5. Display product catalog on shopping website. 6. Persuade customers to purchase products. 7. Gather feedback from customers. 8. Gaining customers' trust. **Buyer** To what extent did you perform the following buyer's tasks? 1. Search for product information. 2. Search for merchant information. 3. Purchase negotiation. 4. Actual purchase. 5. Post-purchase product evaluation. (1 – Very Small Extent to 7 – Very Large Extent)	Adapted from Dishaw and Strong (1998), and Dishaw and Strong (1999)
Utilization – Usage Frequency	To what extent did you use the following seller's/buyer's tools (exact visual stimulus taken from the prototype will be provided)? 1. User Management 2. Content Management 3. Merchandising 4. Negotiation 5. Order Fulfillment 6. Payment Processing 7. Service and Support (1 – Very Small Extent to 7 – Very Large Extent)	Adapted from Dishaw and Strong (1998), and Dishaw and Strong (1999)

Construct	Measurement Items	Key References
Utilization – Task-Technology Adaptation Behavior	**Formative** How much effort (in time and energy) did you spend recommending or suggesting: 1. improvements to Cloud Commerce's functions? 2. improvements to Cloud Commerce's interfaces? 3. modifications to your tasks so that they better fit Cloud Commerce? 4. modifications to Cloud Commerce so that it better fits your task? (1 – A Little to 7 – A Lot) **Reflective** Overall, how much effort (in time and energy) did you spend so that… 1. Cloud Commerce and your buying/selling processes fit each other? 2. Cloud Commerce and your buying/selling processes would be in harmony with each other? (1 – A Little to 7 – A Lot)	Adapted from Barki et al. (2007) Adapted from Barki et al. (2007)
Utilization – Individual Adaptation Behavior	**Formative** 1. I communicated with other community users in order to better understand how Cloud Commerce operates. 2. I researched, on my own initiative, in order to increase my knowledge and my mastery of Cloud Commerce. 3. I explored several information sources, on my own initiative, concerning Cloud Commerce. **Reflective** 1. How much effort (in time and energy) did you spend to learn about Cloud Commerce? (1 – Not At All to 7 – Very Much) 2. I invested much effort (in time and energy) in order to better use Cloud Commerce?	Adapted from Barki et al. (2007) Adapted from Barki et al. (2007)
Performance Impacts	1. Cloud Commerce has a large, positive impact on my effectiveness and productivity in online selling/buying. 2. Cloud Commerce is an important and valuable aid to me in the performance of my online selling/buying. 3. The quality of my online selling/buying has improved because of using Cloud Commerce. 4. I can accomplish online selling/buying more quickly because of my use of Cloud Commerce.	Adapted from D'Ambra and Rice (2001), D'Ambra and Wilson (2004), and Goodhue and Thompson (1995)

Construct	Measurement Items	Key References
Perceived Usefulness	1. Using Cloud Commerce will enable me to accomplish my online selling/buying tasks more quickly. 2. Using Cloud Commerce will enable me to improve my online selling/buying task performance. 3. Using Cloud Commerce will enable me to increase my online selling/buying productivity. 4. Using Cloud Commerce will enable me to enhance my effectiveness on online selling/buying. 5. Using Cloud Commerce will make it easier to sell/buy online.	Adapted from Davis 1989, Davis et al. 1989, and Dishaw and Strong (1999).
Perceived Ease of Use	1. Learning to use Cloud Commerce would be easy for me. 2. I will find it easy to get Cloud Commerce to do what I want it to do. 3. My interaction with Cloud Commerce would be clear and understandable. 4. I will find Cloud Commerce to be flexible to interact with. 5. I will find Cloud Commerce easy to use.	Adapted from Davis 1989, Davis et al. 1989, and Dishaw and Strong (1999).
Behavioral Intention	1. I intend to use Cloud Commerce in the next 3 weeks. 2. I predict I will use Cloud Commerce in the next 3 weeks. 3. I plan to use Cloud Commerce in the next 3 weeks.	Adapted from Davis 1989, Davis et al. 1989, and Dishaw and Strong (1999).
Continued Behavioral Intention	1. I will continue to use Cloud Commerce in the next 3 weeks. 2. I predict I will continue to use Cloud Commerce in the next 3 weeks. 3. I plan to continue using Cloud Commerce in the next 3 weeks.	Adapted from Davis 1989, Davis et al. 1989, and Dishaw and Strong (1999). Reference was also made to the instrument scale used by Agarwal and Prasad (1997) to measure future use intention.

Table 4.2 – Instrument scales for measuring Cloud Commerce selling/buying constructs.

CHAPTER 5: ADOPTION AND USE OF OPEN PRODUCT SCHEMA AND INFORMATION REPOSITORY

5.1 Introduction

In the previous study, I have proposed to examine the adoption and use of Cloud Commerce in general using an integrated model synergizing the Technology Acceptance Model (TAM) (Davis 1986; Davis 1989) and Task-Technology Fit (TTF) model (Goodhue 1995; Goodhue and Thompson 1995). This integrated model has two variants, i.e., one for sellers and another one for buyers. The empirical validation of these two models will establish the feasibility of Cloud Commerce as a next generation electronic commerce platform called for by the design science paradigm (Hevner et al. 2004; March and Smith 1995). However, an important point to underscore is that the success of Cloud Commerce hinges to a very large extent on community users' contributions to its open product schema and information repository, hereon known as **Productpedia**, which is maintained by the product information service. This research is a pioneer attempt to establish such a repository to the best of my knowledge. The maintenance of this repository resembles more of a knowledge contribution and sharing endeavor rather than pure commerce activities. To this extent, it is important to develop a nuanced understanding of community users' behavior and the types of incentive that are effective in encouraging contribution and sharing (Alavi and Leidner 2001).

A quick recap of a potential usage scenario in Cloud Commerce depicted in Figure 2.8 will demonstrate that critical tasks such as creating sale offers or searching for product information rely heavily on the information stored in Productpedia. Obviously, maintaining such a huge repository requires a herculean effort beyond the means of Cloud

Commerce's operator and a select group of champion users. To this extent, it is important to understand the intention of Cloud Commerce's community of users towards contributing to Productpedia and the associated behaviors. Since sellers and buyers may benefit from Productpedia alike and buyers may also be sellers themselves, there is neither any credible reason to believe that buyers will have a lower contribution propensity compared to sellers nor necessity to differentiate between them.

Mainstream theories on technology adoption and usage such as TAM and TTF may not be suitable for investigating contribution intention and behavior of Productpedia. TAM's belief perceptions of usefulness and ease of use, without doubt, will explain whether community users will adopt and use the tools provided by Cloud Commerce to maintain the product schemas and information. But if community users do not believe that contributing their time and resources to maintain Productpedia benefits themselves, or worse still is detrimental to their interest, then even providing the best-in-class tools is unlikely to make a difference. A similar argument is made against TTF. It is at best naive to believe that providing tools that well support the maintenance of product schemas and information will somehow encourage community users to act. Perhaps providing useful, easy to use and appropriate tools will increase community users' propensity to contribute. But that is assuming that they even have the remotest intention to do so in the first place. The research objective of this study is to establish the validity of such an assumption.

If TAM and TTF are both inappropriate, what then is a suitable theoretical lens? Benbasat and Barki (2007) provide a feasible guidance in their call for technology adoption and use research to go beyond TAM and advance in tandem with the nature of technology so that novel theoretical explanations may be found to address evolving innovations. Specifically, Benbasat and Barki suggest researchers to adapt the Theory of Planned Behavior (TPB) (Ajzen 1988; Ajzen 1991) to examine the antecedent beliefs of new technology use

behaviors. This approach has been used by Pavlou and Fygenson (2006) to study the adoption of consumer electronic commerce. TPB itself is a generic attitudinal behavioral model. What Pavlou and Fygenson have done is to extend TPB to look at two specific mainstream consumer behaviors involved in electronic commerce, namely, getting product information and making actual purchase. In the process, the authors propose detailed antecedent factors that are specific to each behavior. This approach provides a more nuanced theoretical understanding beyond usefulness and ease of use.

However, merely investigating TPB's system and design antecedents is inadequate too. Benbasat and Barki (2007) stressed that researchers should first develop a sound theory about the technology artifact such that TPB may be extended in a meaningful way. Indeed, other researchers such as Orlikowski and Iacono (2001) have long underscored the importance of theorizing about technology artifacts and then use the theory for empirical validations of their appropriateness. When theorizing about technology artifact, researchers should take into consideration several premises such as 1) the interests and values of the user's community; 2) the individual components that make up the artifact and their interplay; and 3) ongoing evolvements of the artifact as a result of social or economic process (Orlikowski and Iacono 2001).

In order to address these concerns, I will draw on the extant literature on knowledge sharing. Knowledge sharing refers to the willingness of individuals to share with others in the same community the knowledge they have acquired or created (Gibbert and Krause 2002). Data is commonly defined as raw numbers and facts, information as processed data with a context and knowledge as authenticated information (Vance 1997). Some researchers also consider knowledge to be information that has been processed in the mind of individuals, i.e., personalized information representing facts, procedures,

concepts, interpretations, ideas, observations and judgments (Alavi and Leidner 2001). In this regard, for individuals to develop a shared understanding of data and information, they must share a common knowledge base. The product schemas and information are meaningfully categorized and processed by individuals so that they can be used to create sale offers and are searchable.

In this regard, we may consider the product schemas and information to be valuable knowledge and Productpedia as a knowledge base. This study will use TPB as the general theoretical lens in conjunction with extant research findings on knowledge sharing behaviors to examine Cloud Commerce community users' propensity to contribute to Productpedia. By anchoring on these established theoretical fundamentals, the evaluate process of Cloud Commerce will be more complete and fulfill the rigor that is required of the design science paradigm (Hevner et al. 2004; March and Smith 1995).

5.2 Theoretical Foundation

5.2.1 Theory of Planned Behavior (TPB)

TPB is an extension of the Theory of Reasoned Action (TRA) (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975). Similar to TRA, at the core of TPB is an individual's intention to perform a specific behavior. Intention is thought to capture the motivational factors that influence one's behavior and thus the stronger the intention to engage in a specific behavior, the greater the likelihood that the behavior will be performed. In TRA, intention is determined by two important antecedent factors. The first factor is one's attitude towards the specific behavior, which refers to the degree to which an individual has a favorable or unfavorable evaluation of the specific behavior. The second factor is subjective norm, which refers to one's perceived social pressure to perform or not to

perform the specific behavior. TPB retains these two determinants of intention with the addition of a third determinant known as perceived behavioral control (Ajzen 1991). This theoretical addition is to address the concern regarding the original TRA model's limitation to deal with behavior in which an individual does not have complete control over the cognitive process of deciding his/her commitment to a particular course of action, i.e., incomplete volitional control (Ajzen 1991). Perceived behavioral control itself is defined as the perceived ease or difficulty of performing the behavior taking into account one's past experience and future anticipation of impediments. It is thought to influence actual behavior directly.

Unlike TRA, TPB also attempts to explain human behavior by prescribing the antecedents of attitudes, subjective norms and perceived behavioral control (Ajzen 1998; Ajzen 1991). In particular, TPB postulates that behavior is a function of salient beliefs that are relevant to the specific behavior. The notion of saliency is crucial since individuals can hold many different beliefs about a behavior concurrently but are only able to give due consideration to a small subset of salient ones (Miller 1956). Attitudinal beliefs, normative beliefs and control beliefs are thought to influence attitudes towards the behavior, subjective norms and perceived behavioral control, respectively. Attitudinal beliefs are those that individuals hold about the object of attitude by associating it with certain attributes. In TPB's context of attitude towards behavior, each belief associates the behavior to certain attributes or outcome that one can judge to be positive or negative. Beliefs that are judge to be positive lead to desirable consequences that in turn lead to favorable attitudes. Normative beliefs are concerned with the likelihood that individuals or groups that one deemed to be important would approve or disapprove of one's behavior. Naturally, normative beliefs that garner greater degree of approval are associated with greater social norms. Control beliefs deal with the presence or absence of

requisite resources and opportunities that facilitate the specific behavior. Control beliefs could be affected by past behavioral experience, second-information about the behavior (i.e., further deliberation on the behavior with information obtained from external sources such as news), experiences of acquaintances and perceptions of difficulty of performing the specific behavior. Controls beliefs that confer requisite resources and/or opportunities for a specific behavior will increase one's perception of control over that behavior.

The full TPB model with the inclusion of the various antecedent beliefs is more specifically known as the decomposed TPB model. This is depicted in Figure 5.1. If the antecedent beliefs are excluded, the model will very closely resemble TRA albeit with the inclusion of perceived behavioral control. This basic model is simply referred to as the TPB model and should not be confused with the decomposed variant.

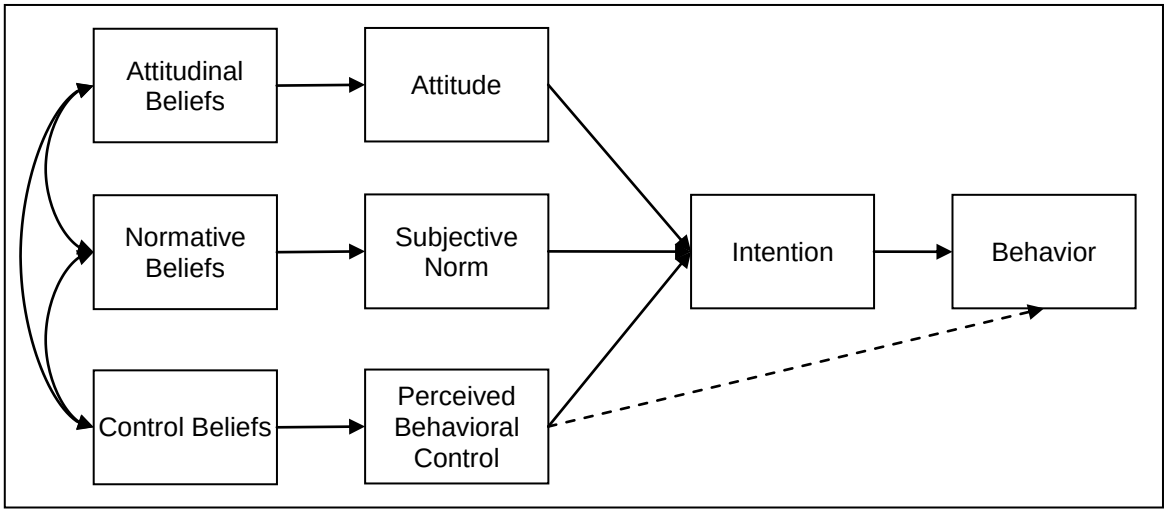


Figure 5.1 – The decomposed model of the Theory of Planned Behavior (TPB) (Ajzen 1991; Pavlou and Fygenson 2006).

TPB has been heralded as one of the most influential theories in explaining behavior and it has been shown to explain a wide range of behaviors (Sheppard, Hartwick and Warshaw 1988). Despite its stellar track record, researchers have highlighted several weaknesses of TPB. For instance, TPB does not take into consideration how emotions such as enjoyment as well as habits could possibly affect one's behavior (Benbasat and

Barki 2007; Trandis 1980). Nonetheless, TPB has been widely used in information systems research. Among the pioneering studies, the work of Taylor and Todd (1995) stands out as an exemplary study. The authors examined personal usage of information technology within the context of a university computer resource centre by comparing three theoretical models of TAM, TPB and decomposed TPB (Figure 5.1). The decomposed TPB model essentially draws upon constructs from the innovations characteristics literature to explore specific belief dimensions underpinning attitude, subjective norm and perceived behavioral control. The authors found that the decomposed TPB model provides the best predictive power of behavioral intention and a better fuller understanding of behavioral intention with its due consideration of the various salient beliefs. Harrison, Mykytyn and Riemenschneider (1997) have also adopted the decomposed TPB approach albeit with a slightly different set of beliefs to investigate small business executives' decision to adopt information technology.

However, another study conducted by Gentry and Calantone (2002) comparing TRA, TPB and TAM in the context of Internet shop-bot actually found TAM to be superior to both TRA and TPB in explaining variance in behavioral intention and in terms of model fit. While this study may at first glance appear to suggest a lack of consensus as to which model is superior to the others, it should be noted that Gentry and Calantone (2002) did not use a decomposed TPB approach. In other words, the decomposed TPB model might have emerged as the superior model had it been tested as in the case of the earlier two studies (Harrison et al. 1997; Taylor and Todd 1995). Further evidence supporting this line of reasoning may be found in the series of two studies on individual professionals' adoption of information technology conducted by Chau and Hu (2001; 2002). The authors used a decomposed TPB model that they described as being an integrated model of TPB and TAM to compare against TPB and TAM. Briefly, Chau and Hu conceptualized the

two TAM constructs of perceived usefulness and perceived ease of use as the salient antecedent beliefs of attitude in their decomposed TPB model. While this approach results in a more parsimonious model, it is really a subset of the decomposed TPB model put forth by Taylor and Todd (1995), and Harrison and his colleagues (1997) since these two earlier variants also included the usefulness and ease of use beliefs. In both studies, Chau and Hu (2001; 2002) found that the decomposed TPB model is superior to TAM, which is better than TPB. An important caveat to note was that while the decomposed TPB model was superior to TAM, the difference was not significant. This led Chau and Hu (2001; 2002) to conclude that TAM was the preferred model. Presumably, had the decomposed TPB model used by Chau and Hu (2001; 2002) include a more comprehensive of beliefs beyond usefulness and ease of use, the conclusion might have favored the decomposed TPB approach.

It is thus reasonable to surmise that the decomposed TPB model is a better theoretical model to the extent that the correct set of beliefs is identified. This line of reasoning is consistent with the findings reported by Pavlou and Fygenson (2006), who had carefully theorized a set of attitudinal and control beliefs to predict electronic commerce adoption with a relatively high predictive power. In addition, Pavlou and Fygenson (2006) formulated perceived behavioral control as a second-order formative construct with controllability and self-efficacy as the first-order dimensions. This followed the prescription made by Ajzen (2002). In this study, the respective antecedent beliefs are identified using the extent literature on knowledge sharing.

5.2.2 Knowledge Sharing

Knowledge is defined as raw numbers and facts that have been processed and verified by individuals within certain context and may be used for solving problems (Alavi and

Leidner 2001; Vance 1997). Knowledge may manifest in two dimensions, namely tacit or explicit (Nonaka 1994). The tacit dimension of knowledge is difficult to transfer to another person either through written or verbal channels. Tacit dimension of knowledge can take the form of cognitive elements such as beliefs and viewpoints as well as technical elements such as know-how and skills for a specific context. An example of tacit dimension of knowledge is how best to approach a particular customer to close a sale for an electronic product. The explicit dimension of knowledge is the inverse of the tacit dimension. Explicit dimension of knowledge can be readily articulated, codified, and stored in certain media to transfer to other people. An example of explicit dimension of knowledge related to the earlier example on tacit knowledge is the owner's manual accompanying the purchase of the electronic product. This manual would have contained knowledge on how to operate the electronic product. The product schemas and information of Productpedia are primarily explicit knowledge.

The broader term of knowledge management is defined as the systematic process of capturing, storing, sharing and using knowledge (Davenport and Prusak 1998). Although knowledge management does not mandate the use of information systems, i.e., knowledge management systems, to support and enhance the knowledge management process, it is considered an important enabler (Alavi and Leidner 2001). Knowledge sharing specifically refers to the willingness of individuals to share with others the knowledge they have acquired or created (Gibbert and Krause 2002). It is sometime used interchangeably with the term knowledge contribution (Kankanhalli, Tan and Wei 2005). A knowledge management system or electronic knowledge repository plays a crucial role in facilitating the knowledge sharing process (Kankanhalli, Tan and Wei 2005). For explicit knowledge, this typically involves functionalities to contribute knowledge, accurately codify knowledge, store the knowledge and efficiently disseminate them to

knowledge seekers. If tacit knowledge is involved, the knowledge management system needs to have some corporate directories for mapping internal expertise and linking knowledge seekers to knowledge contributors. Productpedia may be considered as a type of electronic knowledge repository for managing explicit knowledge.

Individuals' knowledge sharing intention has been the subject of much research in the extant literature. Bock, Zmud, Kim and Lee (2005) extended TRA to conceptualize one such theoretical model. Their general thesis was that knowledge sharing intention may be affected by motivational factors deriving from individuals' personal belief structures as well as institutional structures (e.g., values, norms, and accepted practices in the workplace). The authors conjecture ones' attitude toward knowledge sharing as being influenced by two motivational drivers, namely economic and social-psychological. The economic driver focuses on the extrinsic rewards that the knowledge sharer can expect to receive, e.g., monetary incentives and higher promotion prospect. The socio-psychological drivers encompass the knowledge sharer's desire to maintain ongoing relationships with others on knowledge provision and reception, and the extent to which the knowledge sharer sees his/her knowledge sharing as adding values to the organization. These two socio-psychological drivers are known as anticipated reciprocal relationships and sense of self-worth, respectively. Sense of self-worth is also thought to influence subjective norm. Two other noteworthy adaptations to TRA were made by Bock and his colleagues (2005). First, the authors hypothesized another indirect relationship between social norm and intention mediated by attitude. Second, the authors added organizational climate as a third predictor of intention to share knowledge. Organizational climate may also influence individuals' subjective norm. The authors further propose a set of three sociological drivers that may influence organization climate, namely fairness, innovativeness and affiliation. A climate of trust in which knowledge sharers believe that

their contributions will be recognized engenders fairness. A climate of tolerance for failure and free information flow fosters perception of innovativeness. Finally, a climate characterized by a strong sense of bonding among peers will induce perception of affiliation.

Kankanhalli and her colleagues (2005) took a similar approach in their work on knowledge contributors' use of electronic knowledge repository. The authors proposed a cost and benefit model based on the social exchange theory. The benefit factors conceptualized in their model bear resemblance to the motivational drivers put forth by Bock et al. (2005). The social exchange theory seeks to explain human behavior in social exchanges in which obligations are not clearly specified unlike economic exchanges (Blau 1964). The general maxim is that people do others a favor with a general expectation of some future return yet without a clear expectation of exact future return. Consequently, social exchange typically assumes that the relationships of interest are relatively long term as opposed to one-off relationships (Molm 1997). To this extent, knowledge sharing may be viewed as a form of social exchange (Fulk, Flanagin, Kalman, Monge and Ryan 1996) among numerous knowledge contributors and sharers. Knowledge contributors share knowledge without exact expectation of future return, sharing knowledge on the assumption of long-term relationships of interest (Kankanhalli et al. 2005). On the one hand, costs associated with a loss of knowledge and codification effort will discourage knowledge contributions. These costs could include opportunity costs incurred as a result of not spending the time and effort on coding and inputting the knowledge on other rewarding tasks as well as actual loss of power and unique value in the organization (Molm 1997). On the other hand, extrinsic benefits such as organizational rewards, reputation and reciprocity as well as intrinsic benefits such as knowledge self-efficacy and enjoyment in helping others will encourage knowledge

contributions. At a more generic level, intrinsic motivation has been defined as the pleasure and inherent satisfaction derived from a specific activity (Vallerand 1997). Extrinsic motivation refers to the drive to perform a behavior in order to achieve a specific goal (Deci and Ryan 1987).

The models put forth by Bock et al. (2005) and Kankanhalli et al. (2005) provide useful theoretical lenses to examine knowledge sharing behavior. However, researchers have observed some paradoxical outcomes to knowledge sharing. Specifically, it is plausible that a knowledge sharer may eventually lose his/her unique value relative to what others know (Thibaut and Kelley 1959) and gain almost next to nothing while others free-ride on and benefit from his/her knowledge (Thorn and Connolly 1987). It thus seems irrational for individuals to voluntarily share their knowledge. However, individuals might be driven to forgo the tendency to free-ride due to the influence of social capital (Coleman 1990). Social capital refers to resources in a social structure that may be mobilized to achieve some shared goals (Lin 2001). Such shared goals may include knowledge sharing among individuals. Indeed, Nahapiet and Ghoshal (1998) propose an integrative framework for understanding the creation and sharing of knowledge in organizations based on the social capital notion. The gist of their model suggests that organizations provide a conducive environment that fosters creation of social capital, which in turn encourages knowledge sharing. There are three dimensions of social capital that are helpful in fostering knowledge. First, structural capital refers to the connections or relationships among individuals. Second, cognitive capital refers to individuals' cognitive capability to understand and apply knowledge. Third, relational capital refers to the positive characteristics or goodwill associated with the relationships among individuals. In addition, Nahapiet and Ghoshal (1998) also stress that these individuals must be sufficiently motivated to engage in sharing.

Although Nahapiet and Ghoshal's (1998) model focuses on group level social capital and how it fosters knowledge sharing within an organization, Wasko and Faraj (2005) argue that it is equally applicable to individual knowledge sharing. They reason that in a computer-mediated online discussion forum, individuals engage in mutual interactions that lead to the creation of individual relationships over time. These individual relationships are capable of generating social capital that positively influences knowledge sharing, hence leading to mutual learning and creation of innovations. Wasko and Faraj (2005) build upon Nahapiet and Ghoshal's (1998) model to examine how individual motivations (reputation and enjoyment derived from helping others), structural capital (centrality), cognitive capital (self-rated expertise and domain tenure) and relational capital (commitment and reciprocity) influence knowledge contribution.

In summary, positive predictors of individuals' intention to share knowledge may be broadly classified into two main categories: 1) individuals' extrinsic and intrinsic motivations, some of which are underpinned by the social exchange theory; and 2) three dimensions of social capital. Costs associated with social exchange behavior are likely to reduce one's propensity for sharing knowledge. In addition, researchers tend to take either of two approaches when studying knowledge sharing. The first approach focuses on knowledge sharing intention using theoretical lens such as TRA (Bock et al. 2005). The second approach directly examines knowledge sharing behavior using a set of antecedent factors (Kankanhalli et al. 2005; Wasko and Faraj 2005). The second approach appears to be more prevalent among recent research. For instance, Ma and Agarwal (2007) have studied the impact of using online community tools supporting identity communication on knowledge contribution behavior. Choi, Lee and Yoo (2010) also examined how transactive memory system and the use of information technology to support knowledge management affect knowledge sharing and knowledge application. This study is

particularly interesting as it also drills into the details of how knowledge sharing and knowledge application affect the work performance of teams.

This study adopts a hybrid approach to examine knowledge sharing behavior among Cloud Commerce community users using Productpedia. Drawing on the decomposed model of TPB, we examine both knowledge sharing intention and actual behavior for a more holistic understanding.

5.3 Research Model

The decomposed TPB model (Ajzen 1991) has been used by Pavlou and Fygenson (2006) to investigate consumers' adoption of electronic commerce. Specifically, Pavlou and Fygenson (2006) studied consumers' behavior on two primary electronic commerce buyer's tasks of getting product information and purchasing from an online merchant (Chen et al. 2002; Klopping and McKinney 2004). The authors proposed two distinct decomposed TPB models, one for each buyer's task. The antecedent beliefs of attitudes, subjective norms and perceived behavioral control were carefully conceptualized and chosen for their saliency to ordinary consumers. Some of these beliefs, in particular those for attitude, were common to both models albeit named and operationalized to the specific nature of each task. For instance, the TAM beliefs of perceived usefulness and perceived ease of use were used to predict attitude in both models. Accordingly, the authors conceptualized two sets of the TAM beliefs aptly naming them as perceived usefulness of getting information and perceived ease of use of getting information for the first model. The second model used perceived usefulness of product purchasing and perceived ease of use of product purchasing to predict attitude toward purchasing.

Perceived behavioral control was also conceptualized as constituting two dimensions of self-efficacy and controllability. Most of the antecedent beliefs of controllability were

quite different between the models of the two tasks. Whereas the model of getting information uses download delay, time resources and website navigability, the model of purchasing uses beliefs such as monetary resources and product diagnosticity. Pavlou and Fygenson (2006) combined the two models ingeniously to investigate how intention to purchase will spur consumers' intention to get product information from a particular online merchant. Intention to get product information leads to actual behavior to get information. This behavior is expected to positively influence purchasing a product from the same online merchant since obtaining sufficient product information will lower the uncertainty associated with the purchase.

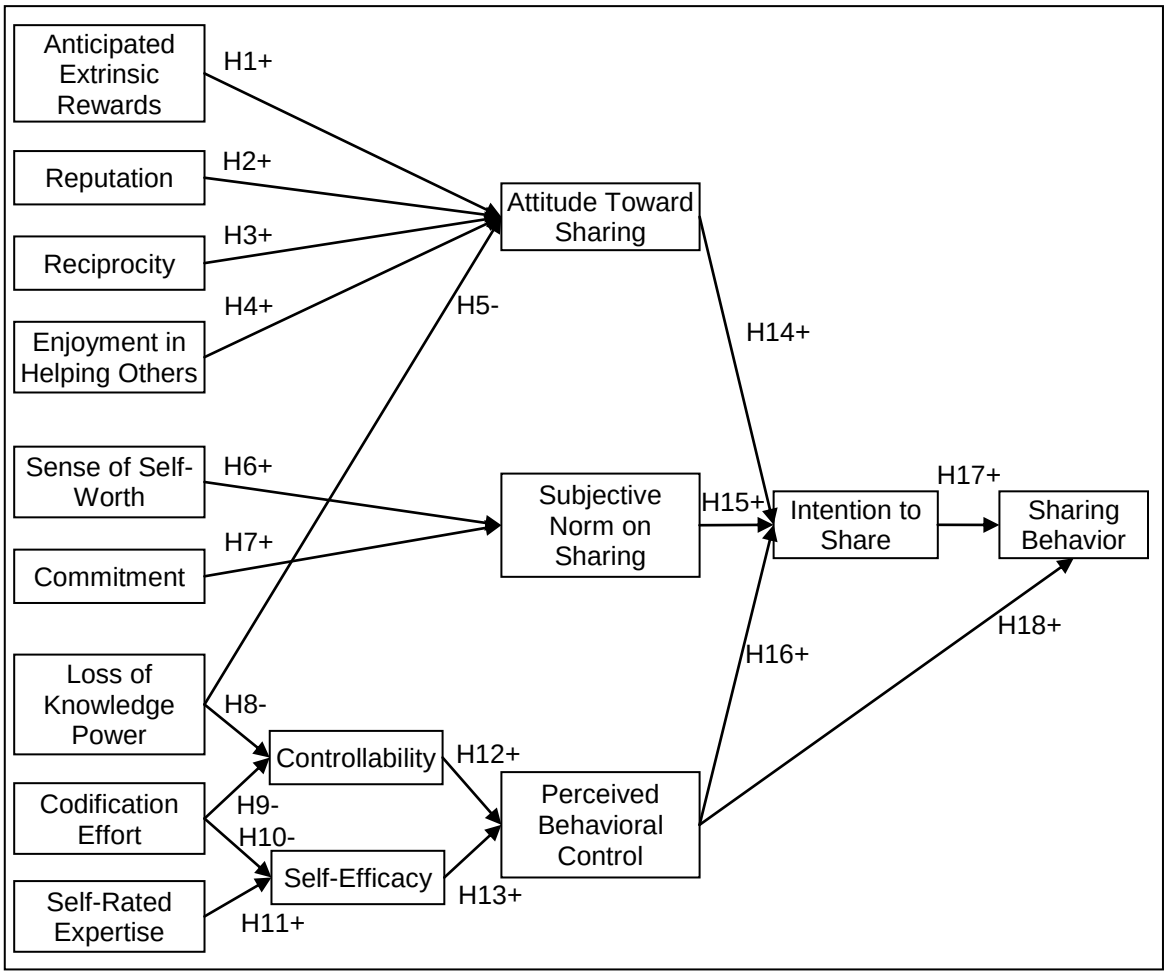


Figure 5.2 – Research model to examine knowledge sharing behavior in Productpedia.

The research model used in this study is depicted in Figure 5.2. It is adapted from the prescriptions made by Pavlou and Fygenson (2006). Specifically, a decomponsed TPB

model with perceived behavioral control as a second-order formative construct is used to examine Cloud Commerce community users' knowledge sharing behavior.

5.4 Hypotheses Development

5.4.1 Behavioral Beliefs and Attitude

TPB posits that individuals' develop beliefs that associate a specific behavior with certain outcomes, or to some other attributes such as the cost incurred in performing the behavior (Ajzen 1991). Individuals value these outcomes and attributes as either positive or negative within the specific behavioral context. In general, people are thought to favor behaviors that we believe have largely desirable consequences and thus form a favorable attitude towards such behaviors. The reverse argument holds for behaviors that we believe have largely undesirable consequences, i.e., leading to the formation of negative behavioral attitude.

Given a set of options, an individual is typically assumed to choose the alternative that maximizes utility (Smelser and Swedberg 1994). In this regard, individuals will opt to share their knowledge if they perceive that the expected benefits outweigh the expected costs (Kelley and Thibaut 1978). In an organizational context, specific forms of reward such as increased salary, better job security and career advancement are known to stimulate employees' knowledge sharing efforts (Ba, Stallaert and Whinston 2001). For instance, in Siemens' ShareNet project, explicit rewards provided by the company were effective in motivating employees to share their knowledge (Ewing and Keenan 2001). In a similar fashion, Samsung's Life Insurance's Knowledge Mileage Program led to a significant increase in employees' knowledge contribution through the use of reward redemption points (Hyoung and Moon 2002).

Researchers have generally found a positive linkage between extrinsic rewards and knowledge sharing (Kankanhalli et al. 2005). Although some researchers have found that anticipated rewards may sometime hinder knowledge sharing, this might be due to the specific design of the study such as the reward mechanisms involved (Bock et al. 2005). In general, extrinsic rewards help individuals to achieve certain goals after having performed some tasks (Deci and Ryan 1987). In the context of Productpedia, community users who contribute to the creation of product schemas and information benefit directly from these resources since they can be used to post sale offers or specify their product preferences. Indeed, knowledge sharing in this sense could mean a tight integration with the electronic commerce tasks performed by buyers and sellers alike. The more community users share their product knowledge, the easier it becomes when performing their tasks. For sellers, this could mean the ability to sell more of their products with lesser efforts while buyers can more accurately search for their desired items to purchase. Thus, it is hypothesized that:

H1. Anticipated extrinsic rewards are positively related to attitude toward sharing.

The social exchange theory posits that individuals participate in social interactions based on an expectation that it will lead in some way to social rewards such as approval, status and respect from others in the social grouping (Blau 1964). Thus, a benefit that an individual can derive from participating in social endeavors is a perception of enhancement to one's reputation (Wasko and Faraj 2005). Indeed, researchers have noted that reputation building is an important motivation underlying active participation in electronic network of practice (Donath 1999). Knowledge sharing behaviors such as answering frequently and intelligently in an online open source software support community have been attributed positively to knowledge sharers' perception of enhanced status within the community (Lakhani and von Hippel 2003). In gist, researchers have

found that reputation is an important predictor of knowledge contribution behavior (Wasko and Faraj 2005). Extending this line of reasoning of the present context, it is not difficult to see that community users contributing to Productpedia can plausibly enhance their reputation as expert sellers and/or buyers/consumers in the eyes of other users. This could constitute a strong motivational belief for sharing product knowledge. Accordingly, it is hypothesized that:

H2. Reputation is positively related to attitude toward sharing.

The social capital theory suggests that trust is a critical relational capital that facilitates collective action (Coleman 1990). In general, trust develops when a history of favorable past interactions leads to expectations about positive future interactions (Wasko and Faraj 2005). Reciprocity is an important dimension underpinning social trust and refers to an individual's expectation that his/her collective efforts will be reciprocated by others in the same social grouping (Putnam 1995). A basic norm of reciprocity develops from a sense of indebtedness such that individuals usually reciprocate the benefits they receive from others thus ensuring ongoing supportive exchanges (Schumaker and Brownell 1984). In the context of knowledge sharing, reciprocity refers to the expectation of knowledge contributors that their current contribution will lead to their future request for knowledge being met (Kankanhalli et al. 2005). Indeed, people who share knowledge in online communities believe in reciprocity and fairness (Wasko and Faraj 2000).

The social exchange theory also suggests that reciprocity is an important benefit underlying individuals' intention to engage in social exchange (Blau 1964). It has been shown that reciprocity acts as a benefit for knowledge sharers because they expect future helps from others in lieu of the current knowledge that they have shared (Connolly and Thorn 1990). In the case of Productpedia, an individual who have shared a particular

product schema may reasonably expects other to help in maintaining the concurrency of the schema by adding new attributes and editing incorrect ones. A seller who has shared information on a particular product may expect others to share information on similar items that he/she is selling to minimize redundant work. Buyers may also contribute to Productpedia in anticipation that a better product schema can help them search for information more efficiently and accurately. They too may share similar norms of reciprocity. Thus, it is hypothesized that:

H3. Reciprocity is positively related to attitude toward sharing.

According to Bandura (1986), self-evaluation based on competence and social acceptance is an important source of intrinsic motivation driving one's participation in an activity for the sake of the activity itself, rather than for some extrinsic reward. The notion of altruism suggests that people derive intrinsic enjoyment from helping others without expecting anything in return (Smith 1981). Putting these two lines of reasoning together, it is highly plausible that individuals contribute knowledge to an online community because they perceive helping others with challenging problems is interesting, and because it feels good to help other people (Kollock 1999). Extant studies on knowledge sharing have shown that this is indeed the case with knowledge sharers finding knowledge sharing to be challenging, fun and enjoyable (Wasko and Faraj 2000). In sum, knowledge sharers may derive intrinsic benefits, i.e., pleasure and inherent satisfaction, from their meaningful work (Ba et al. 2001; Wasko and Faraj 2005). In the context of Productpedia, we contrive that buyers and sellers would enjoy contributing to the humongous task of maintaining the open product schema and information repository. This is especially so given that online shopping has become a part of our daily life and any contributions towards making online shopping better should be well appreciated by Cloud Commerce community users. Thus, it is hypothesized that:

H4. Enjoyment in helping others is positively related to attitude toward sharing.

Prior research has shown that individuals who share part of their unique knowledge could plausibly end up losing their claim to the benefits arising from such knowledge (Gray 2001). It follows that knowledge sharers may lose their value to the very community that they have contributed to and risk losing their influence (Kankanhalli et al. 2005). Extant literature on knowledge management in organizations has shown that loss of influence due to knowledge contribution is a major barrier impeding knowledge sharing (Davenport and Prusak 1998). Potential knowledge contributors may be reluctant to share their knowledge if they feel that hoarding their knowledge rather than sharing it can derive more benefits to themselves (Davenport and Prusak 1998). By this line of reasoning, it is entirely plausible that Cloud Community sellers adopt an adverse attitude toward sharing their product knowledge for fear that this might help others sell similar products thus resulting in direct competition that negatively affect profitability. Although at first glance it may seem that buyers are less affected by this negative belief, it cannot be totally ruled out that some buyers may become sellers themselves in the future. Accordingly, it is posited that:

H5. Loss of knowledge power is negatively related to attitude toward sharing.

5.4.2 Normative Beliefs and Subjective Norms

Normative beliefs are concerned with the probability that people or social groupings deemed to be important to you approve or disapprove your behavior, i.e., subjective norms (Ajzen 1991). Approval beliefs naturally lead to positive perception of subjective norms and vice versa for disapproval beliefs.

The notion of sense of self-worth refers to individuals' degree of liking themselves, based primarily on their competence, power or efficacy regarding conduct (Gecas 1971). In an

organizational knowledge sharing context, sense of self-worth refers to the extent to which employees see themselves as providing value to their organizations through their knowledge sharing endeavors (Bock et al. 2005). By and large, sense of self-worth influences individuals' behaviors in directions congruent with the prevailing norms of their social groupings or organizations (Huber 2001). When this happens, the reference group's norms will become the guiding principles by which individuals evaluate themselves (Gecas 1982). Researchers have found that individuals characterized by a high sense of self-worth through their knowledge sharing are more likely to become aware of the knowledge sharing expectations of people who are deemed important to them (Bock et al 2005). Consequently, they are also more likely to comply with these expectations. Along this line of reasoning, it is hypothesized that:

H6. Sense of self-worth is positively related to subjective norm on sharing.

Relational capital is the affective nature of the relationships within a social grouping (Nahapiet and Ghoshal 1998). Relational capital exists when individuals develop a strong sense of 1) identity with their social grouping (Lewicki and Bunker 1999); 2) trust of others in the social grouping (Putnam 1995); and 3) willingness to participate in common causes (Coleman 1990). Commitment is an important dimension of relational capital. Commitment represents an obligation to perform a future task for one's social grouping and arises from one's frequent interaction with members in the social grouping (Coleman 1990). In the knowledge sharing context, prior research has shown that knowledge sharers willingly contribute their knowledge to their respective communities out of a moral obligation to return to their communities what they have previously taken (Constant, Sproull and Kiesler 1996; Wasko and Faraj 2000). Wasko and Faraj (2005) hypothesized that higher commitment will encourage greater knowledge sharing behavior but did not find support for this conjecture.

In the context of Productpedia, buyers and sellers benefit alike from the product knowledge contributed by each other. The benefits associated with the product knowledge and the potential downsides if no one is willing to contribute to the repository are apparent to and have a tangible impact on community users. Suppose no one makes a commitment to build the repository, then nobody will be able to buy or sell anything. Thus, commitment could be a more salient belief in our study compared to the work of Wasko and Faraj (2005). Accordingly, it is hypothesized that:

H7. Commitment is positively related to subjective norm on sharing.

5.4.3 Control Beliefs and Perceived Behavioral Control

Control beliefs are those affecting the presence or absence of requisite resources and opportunities to perform certain behavior (Ajzen 1991). Individuals base their control beliefs on past behavioral experience or information obtained from others. All other things being equal, the more resources and opportunities individuals believe they possess, and the fewer impediments they expect, the greater the degree of perceived control over a specific behavior. Researchers believe that perceived behavioral control is made up of two distinct dimensions, namely controllability and self-efficacy (Ajzen 2002). Controllability is defined as the judgment an individual makes on whether resources and opportunities are available to perform a specific behavior (Ajzen 2002; Pavlou and Fygenson 2006). Self-efficacy is defined as the judgment an individual make on whether he/she possesses the capabilities to perform a specific behavior (Bandura 1986; Pavlou and Fygenson 2006).

Due to its multidimensionality, Ajzen (2002) suggests that perceived behavioral control may be adequately described using a two-level hierarchical model. Following this prescription, Pavlou and Fygenson (2006) conceptualized perceived behavioral control as

a second-order formative construct formed by the first order dimension of controllability and self-efficacy. Pavlou and Fygenson (2006) further suggested that perceived behavioral control should be predicted through its two underlying dimensions. This study follows this approach and identifies the respective control beliefs for controllability and self-efficacy.

As Cloud Commerce community users share their product schema and information, it is likely that over time their unique knowledge will be depleted. This will naturally hamper their ability to continue sharing knowledge even if they are willing to do so. This problem is more severe when it comes to product schema contribution but could be less of a concern for product information contribution. While buyers will always have ongoing needs and desires for new products and naturally acquire new knowledge, and sellers may expand their product range and consequently acquire new knowledge, there will come a time when their ability to contribute will reach an inflection point and start to decline.

H8. Loss of knowledge power is negatively related to controllability.

Contributing knowledge to an electronic repository such as Productpedia involves explication and codification of knowledge. This process can involve costs to the knowledge contributors as an expense of time and effort (Ba et al. 2001; Markus 2001). Researchers have found that the time and effort that are spent on knowledge contribution constitute an opportunity cost and could discourage knowledge contribution if it becomes high. From a technology adoption perspective, time and effort can be an impediment factors in general (Agarwal 2000). Indeed, researchers have observed that perception of easiness using online shopping website to search for product information and make purchase can positively influence controllability and self-efficacy (Pavlou and Fygenson 2006).

Prior electronic commerce research has also shown that online shoppers need to have sufficient leisure time to spend on obtaining relevant product information so that they will make an actual online purchase (Bellman, Lohse and Johnson 1999). Some researchers have found that availability of time resources positively influence online shoppers' perception of controllability (Pavlou and Fygenson 2006). If merely shopping online requires considerable time resources, then to contribute product knowledge to Productpedia would require community users to commit a fair amount of their leisure time. For sellers, this not expected to be a major problem since they must maintain their product catalog regardless though. However, if they are asked to contribute knowledge for product that they do not intend to sell in the near future, time resources could become a non-trivial factor. For buyers, spending their leisure time to share their product knowledge is certainly a hurdle. If codification tools are complex and difficult to use, perception of controllability and self-efficacy could worsen. Thus, it is hypothesized that:

H9. Codification effort is negatively related to controllability.

H10. Codification effort is negatively related to self-efficacy.

Cognitive capital refers to individuals' cognitive capability to understand and apply knowledge (Nahapiet and Ghoshal 1998). Individuals develop their cognitive capital over time as they interact with other people performing similar tasks in a specific domain. This learning process may be accomplished either though hands-on experiences or conversations with other people possessing similar capabilities. An important dimension of cognitive capital is an individual's expertise and the associated experience with applying the expertise (Wasko and Faraj 2005). The basic axiom is such that individuals, regardless of how motivated they are toward knowledge sharing, will not be able to do so unless they possess the requisite knowledge. On the one hand, researchers have observed

that individuals with higher levels of expertise have a greater tendency to provide useful advice on an electronic network (Constant et al. 1996). On the other hand, individuals are less likely to contribute if they feel that their knowledge is inadequate (Wasko and Faraj 2000). In a similar fashion, Cloud Commerce community users who do not possess relevant product knowledge would likely judge themselves as being incapable of contributing to Productpedia. Thus, it is hypothesized that:

H11. Self-rated expertise is positively related to self-efficacy.

Finally, by definition, controllability and self-efficacy should positively influence individuals' perception of control over product knowledge sharing. Thus, it is hypothesized that:

H12. Controllability is positively related to perceived behavioral control.

H13. Self-efficacy is positively related to perceived behavioral control.

5.4.4 Predicting Intention to Share and Sharing Behavior

TPB postulates that the more favorable the attitude and subjective norm with respect to a specific behavior, and the greater the perceived behavioral control, the stronger would be an individual's intention to perform the behavior (Ajzen 1998; Ajzen 1991). Within the specific context of knowledge sharing, researchers have validated that attitude toward knowledge sharing and subjective norm is positively related to intention to share knowledge (Bock et al. 2005). Accordingly, it is hypothesized that:

H14. Attitude toward sharing is positively related to intention to share.

H15. Subjective norm on sharing is positively related to intention to share.

H16. Perceived behavioral control is positively related to intention to share.

Both TRA (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975) and TPB (Ajzen 1998; Ajzen 1991) posit that behavioral intention influences individuals' actual behavior. In fact, as a general rule of thumb, the stronger the intention, the greater the likelihood that a specific behavior will be performed (Ajzen 1991). Within the extant literature on technology adoption, this has also been a well researched area with strong empirical supports, i.e., intention to use a particular technology will lead to its actual use (see Venkatesh et al. 2003 for a comprehensive review). Hence, it is posited that:

H17. Intention to share is positively related to sharing behavior.

However, TPB further qualifies this causal relationship with the condition that individuals must be able to decide at will whether to perform or not perform the specific behavior (Ajzen 1991). More often than not, whether an individual performs a specific action depends to a large extent on the availability of resources (e.g., time, money, skills and cooperation of others) and opportunities (Ajzen 1985). Thus, TPB additionally posits that perceived behavioral also predicts actual behavior directly. In accordance with this line of reasoning, the final hypothesis is presented as follow:

H18. Perceived behavioral control is positively related to sharing behavior.

5.5 Proposed Research Methodology

5.5.1 Proposed Research Design

The objective of this research is to understand the intention of Cloud Commerce's community of users towards contributing product knowledge to Productpedia and the associated behaviors. This is the second part of the larger design science process to evaluate the feasibility of Cloud Commerce. It is thus important that the research findings can be generalized beyond the sample population of participants in order to ensure the

long term viability of Cloud Commerce. In this regard, a field setting is preferred over a laboratory setting since the latter lacks realism and is impractical for the task nature of this study. This study will also attempt to answer researchers' call for a better understanding of the influence of salient beliefs on system use intention and behavior at different stages of technology implementation, and the subsequent influence of this usage on users' beliefs at later periods by adopting a longitudinal design (Benbasat and Barki 2007). Specifically, a one-group repeated measures quasi-experimental design (Tan et al. 2012) will be used in a field setting.

A working prototype of Productpedia will be developed and deployed for live use as one of the key components of the Cloud Commerce platform. An invitation will be sent out to solicit participants, both sellers and buyers. Participants will be encouraged to use Productpedia as part of Cloud Commerce for a period of six weeks. At the beginning of the six weeks period, participants who have registered for a Cloud Commerce account and login specifically to Productpedia will be shown a brief description of Productpedia.

At the end of the first three weeks, an online web-based survey will be administered for community users who have actually contributed to Productpedia at least once to gauge their initial perception of contributing to Productpedia. In addition to the survey, the prototype will incorporate extensive data logging functionalities to track the actions performed by users and the corresponding usage statistics to facilitate analysis of sharing behavior. At the end of the sixth week, another survey will be administered to gauge the perception of repeatedly contributing to Productpedia. Only community users who have completed the initial survey and contributed to Productpedia at least once starting from the fourth week will be administered with this follow-up survey. The research design is depicted in Figure 5.3.

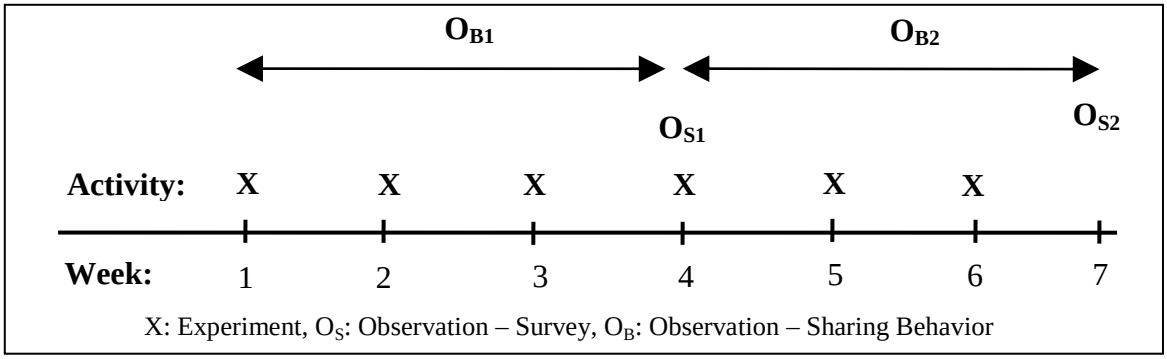


Figure 5.3 – Proposed research design for Productpedia.

O_{S1} refers to the online survey that gauges participants' initial perception of contributing to Productpedia (i.e., both independent and dependent variables). O_{S2} refers to the online survey that gauges the participants' perception of repeatedly contributing to Productpedia (i.e., both independent and dependent variables). The survey data for independent variables collected in Period 1 (i.e., Week 1, 2 and 3) will be run against the survey data for dependent variables collected in the same period (i.e., immediate or near to immediate effect) and similarly for the survey data collected in Period 2.

5.5.2 Proposed Operationalization of Constructs

The theoretical constructs shown in the research model (see Figure 5.2), except for sharing behavior, will be measured with instrument scales adapted either from validated scales taken from the extant literature or self-developed based on established theories. The instrument scales will be developed based on the recommendations of Moore and Benbasat (1991), which include putting the scales through several rounds of unlabeled and labeled sorting to achieve high inter-rater reliability (Cohen's Kappa) scores greater than 0.80. The measurement items for each instrument scale, 7-point Likert scale, are listed in Table 5.1. Since this is a longitudinal study, the first survey will gauge users' intention to share while the second survey will gauge users' continued intention to share.

Sharing behavior will be captured through system data logging, which will track the actual number of contributions that each user makes to Productpedia. The sharing behavior will differentiate between new contributions from modifications/enhancements as well as product schema from product information. A contribution count is defined as the creation of a new instance of a particular data record. If a data record is newly created, it is considered as the first instance. The platform will create a new instance of a particular data record for significant changes made by a user (see sub-section 3.3.2 for more information). For instance, if a user changes the name of a particular product category, a new instance of the product category data record will be created and the user is deemed to have made one contribution to Productpedia. The first set of sharing behavior will cover the first three weeks of the experiment and the second set of sharing behavior will cover the last three weeks of the experiment.

The data will be analyzed using partial least square structural equation modeling.

Construct	Measurement Items	Key References
Anticipated Extrinsic Rewards	1. I will make my selling task easier in return for my product knowledge sharing. 2. I will make my buying task easier in return for my product knowledge sharing.	Adapted from Bock et al. (2005), and Kankanhalli et al. (2005)
Reputation	1. I will earn respect from others by participating in Productpedia. 2. I feel that participation in Productpedia improves my status in the community. 3. Community users who share their product knowledge have more prestige than those who do not. 4. When I share my product knowledge through Productpedia, my peers in the community respect me.	Adapted from Kankanhalli et al. (2005), and Wasko and Faraj (2005)
Reciprocity	1. I know that other Cloud Commerce community users will help me, so it's only fair to help other users. 2. I trust that someone will help me if I lack any product knowledge. 3. When I contribute product knowledge to Productpedia, I expect to get back product knowledge when I need it. 4. When I share my product knowledge through Productpedia, I believe that my queries for product knowledge will be answered in future.	Adapted from Kankanhalli et al. (2005), and Wasko and Faraj (2005)
Enjoyment in Helping Other	1. I enjoy sharing my product knowledge with others through Productpedia. 2. I enjoy helping others by sharing my knowledge through Productpedia. 3. It feels good to help someone else by sharing my product knowledge through Productpedia. 4. Sharing my product knowledge with others through Productpedia gives me pleasure.	Adapted from Kankanhalli et al. (2005), and Wasko and Faraj (2005)
Sense of Self-Worth	1. My product knowledge sharing will help other community users solve their problems. 2. My product knowledge sharing will help other community users achieve their online buying objectives. 3. My product knowledge sharing will help other community users achieve their online selling objectives.	Adapted from Bock et al. (2005)
Commitment	1. I will feel a loss if Productpedia is no longer available. 2. I really care about the fate of Productpedia. 3. I feel a great deal of loyalty to Productpedia.	Adapted from Wasko and Faraj (2005)
Loss of Knowledge Power	1. Sharing my product knowledge through Productpedia makes me lose my unique value in the community. 2. Sharing my product knowledge through Productpedia makes me lose my product knowledge that makes me stand out with respect to others in the community. 3. Sharing my product knowledge through Productpedia makes me lose my product knowledge that no one else has.	Adapted from Kankanhalli et al. (2005)

Construct	Measurement Items	Key References
Codification Effort	1. I do not have the time to enter my product knowledge into Productpedia. 2. It is laborious to enter my product knowledge into Productpedia. 3. The effort is high for me to enter my product knowledge into Productpedia. 4. I am afraid that my contribution to Productpedia will evoke additional clarifications or requests for assistance.	Adapted from Kankanhalli et al. (2005)
Self-Rated Expertise	1. I am knowledgeable with at least one category of consumer products. 2. I am experienced with at least one category of consumer products. 3. With respect to at least one category of consumer products that I am familiar with, if I have to choose this product today, I will need to gather very little information in order to make a wise decision. 4. With respect to at least one category of consumer products that I am familiar with, I feel confident about my ability to tell the difference in quality among different brands of this product.	Self-developed based on the theoretical definitions of self-rated expertise provided by Nahapiet and Ghoshal (1998), and Wasko and Faraj (2005). Reference was also made to the instrument scale used by Smith and Park (1992) to measure prior product knowledge.
Controllability	1. All necessary resources for sharing product knowledge on Productpedia will be accessible to me within the next 30 days. 2. Sharing product knowledge on Productpedia within the next 30 days is completely under my control.	Adapted from Pavlou and Fygenson (2006)
Self-Efficacy	1. If I wanted to, I will be able to share product knowledge on Productpedia within the next 30 days. 2. If I wanted to, I am confident I can share product knowledge on Productpedia within the next 30 days.	Adapted from Pavlou and Fygenson (2006)
Attitude Toward Sharing	1. My product knowledge sharing with other community users is a very good idea. 2. My product knowledge sharing with other community users is an enjoyable experience. 3. My product knowledge sharing with other community users is valuable to me. 4. My product knowledge sharing with other community users is a wise move.	Adapted from Bock et al. (2005), and Pavlou and Fygenson (2006).
Subjective Norm on Sharing	1. Most people who are important to me think it is a good idea to share my product knowledge on Productpedia. 2. Most people who are important to me will share their product knowledge on Productpedia.	Adapted from Bock et al. (2005), and Pavlou and Fygenson (2006).
Perceived Behavioral Control	1. Please rate the difficulty of you sharing product knowledge on Productpedia within the next 30 days.	Adapted from Pavlou and Fygenson (2006).
Intention to Share	1. I intend to share product knowledge on Productpedia within the next 30 days. 2. I plan to share product knowledge on Productpedia within the next 30 days. 3. I will share my product knowledge more frequently in the future. 4. I will always share my product knowledge with community users.	Adapted from Bock et al. (2005), and Pavlou and Fygenson (2006).

Construct	Measurement Items	Key References
Continued Intention to Share	1. I intend to continue sharing product knowledge on Productpedia within the next 30 days. 2. I plan to continue sharing product knowledge on Productpedia within the next 30 days. 3. I will continue sharing my product knowledge more frequently in the future. 4. I will continue sharing my product knowledge with community users.	Adapted from Bock et al. (2005), and Pavlou and Fygenson (2006). Reference was also made to the instrument scale used by Agarwal and Prasad (1997) to measure future use intention.

Table 5.1 – Instrument scales for measuring product knowledge sharing constructs.

CHAPTER 6: CONCLUSION

6.1 Practical Contributions

This thesis is a pioneer attempt to develop an in-depth understanding of consumers' adoption and use of cloud computing-based electronic commerce tools and services. Specifically, a novel platform known as Cloud Commerce is conceptualized to address the limitations of mainstream electronic commerce websites and tools. At the core of Cloud Commerce is an open product schemas and information repository, a world's first, known as Productpedia that promises to revolutionize the way we sell and buy on the Internet. Through the proposed use of realistic field experiments to be conducted with Cloud Commerce, we aim to capture consumers' actions in-situ for an accurate gauge of their behavioral responses to this novel platform.

Practically, this thesis conceptualizes and designs a next generation electronic commerce platform that will greatly benefit merchants and consumers alike. The platform epitomizes the essence of collaborative commerce by allowing individuals to come together to joinly maintain a shared product catalogue, develop electronic commerce applications for the community to use and harness the collective wisdom of the shared product reviews across the entire platform. Consistent with the HMPR's design as an artifact guideline, various construct, model, method and instantiation artifacts have been produced meticulously. These artifacts collectively serve three important objectives. First, they provide a set of highly detailed reference blueprints for guiding scholars and practitioners to develop and further enhance an electronic commerce platform that is true location transparent and "website-less". Second, the instantiation artifacts demonstrate the technical viability of implementing such a platform beyond the existence of mere abstract

entities. Third, the design artifacts cover all four levels as prescribed by Hevner and his colleague (2004) and demonstrate how each higher level of artifacts build upon the lower levels of artifacts in an implied linear hierarchical manner (Arnott and Pervan 2012).

It should be noted that this thesis does not merely call for the development of a particular website or tool. What this thesis aims to achieve is to create an entire ecosystem that revolves around Cloud Commerce and Productpedia, i.e., a platform that allows anyone to develop new and innovative electronic commerce websites and tools. An important cornerstone of this vision is Cloud Commerce's RESTful web service-based API aided by XML-based data standards for describing product schemas, product information, and sale offers together with the transaction protocol for order fulfillment. The keyword here is "open", i.e., the entire ecosystem will be opened to future innovations and contributions from scholars, practitioners and ordinary consumers.

6.2 Theoretical Contributions

Theoretically, this thesis has made several noteworthy contributions too. First, this thesis extends an integrated theoretical model of TAM and TTF to examine both sellers' and buyers' perceptions toward using Cloud Commerce. This is a significant departure from the almost exclusive focus on buyers by the extant literature.

Second, this thesis extends TPB using various knowledge sharing theories such as individual motivational theory, social capital theory and social exchange theory to investigate the intention and actual behavior with regard to the contribution of product knowledge to Productpedia. This represents the first attempt to examine knowledge sharing behavior in such great details using TPB as the theoretical lens. Third, this thesis attempts to address senior scholars' call to improve on technology adoption research (Bagozzi 2007; Benbasat and Barki 2007; Goodhue 2007). For instance, the use of

longitudinal approach enables us to trace the change in users' perception beliefs throughout different stages of technology implementation.

Finally, this thesis aims to become an exemplar in information systems design science research by adhering to best practices prescribed by our senior scholars particularly design evaluation (e.g., Hevner et al. 2004).

6.3 Limitations

The current design and instantiation artifacts have several limitations that readers should usefully note. First, it is entirely possible for a Cloud Commerce user to maliciously edit the product information of items sold by other competitors with the intent to sabotage their sales. For instance, the values of selected product attributes could be edited with false and inferior specifications. Even though Cloud Commerce allows users to roll back the current instance of a unique data record to an earlier instance, the sellers' sales, and possibly reputation, may still be negatively affected to a certain extent.

Second, in the current design and instantiation artifacts, if a seller makes a significant change to a listing, e.g., change of price or shipping fee, the platform will automatically remove the listing from all potential buyers' shopping carts. This approach may cause annoyance to buyers as they discover that their respective shopping cart now contains a different set of items without any prior notification.

Third, in the current design and instantiation artifacts, if a buyer has purchase items from multiple sellers via a particular application, then the buyer will have multiple shopping carts for that application, i.e., one shopping cart for the items of each seller. This may cause inconvenience to the buyer as he/she will need to checkout multiple times. Future

research will examine the possibility of consolidating the checkout process such that the buyer can checkout all shopping carts in an application concurrently.

Fourth, the research design for the second empirical study examining the adoption and use of Productpedia potentially suffers from selection bias (i.e., endogeneity) to the extent that participants who do not use Productpedia will not be asked to answer the surveys. In other words, only participants who have made at least one contribution to Productpedia will be asked to answer the survey. This requirement is a necessary evil to ensure that only participants who have attempted to use Productpedia, and thus assumed to understand what Productpedia is and how it functions, respond to the survey. While selection bias is a valid concern, it should be noted that Productpedia differs from mainstream technology adoption research in a significant way. That is, Productpedia is a totally new technology and we cannot reasonably assume that participants understand what it is and how it works without actually using it at least once. In contrast, for a technology adoption research examining a new Internet banking website, for example, we may reasonably assume that participants have some basic knowledge of Internet banking since it is a fairly common technology. The same cannot be said about Productpedia, unfortunately. If participants who have not used Productpedia are allowed to answer the survey, the validity of the data collected will be called into question.

Fifth, the research design for the empirical evaluation of the general adoption and use of Cloud Commerce is conceptualized at the aggregate level. The research design does not consider individual system components. Thus, it is not possible to determine the viability of each individual system component.

6.4 Future Research

Future research will focus on evaluating the viability of Cloud Commerce as mandated by design science. Specifically, Cloud Commerce will be deployed for real usage in a large-scale field experiment in order to gather data for empirical validation of the research models that have been proposed in this thesis. The results of the field experiment will be used to refine the design of Cloud Commerce.

Beyond realizing the evaluate process of design science for the construct, model, method and instantiation artifacts currently created, it is envisioned that continued development of Cloud Commerce will extend into future phases. Some of these tasks include 1) addressing the limitations of the current design and instantiation artifacts; 2) conceptualizing, designing and implementating the product search and recommendation service; and 3) enhancing the transaction service with auction listing and group buying listing. The third task will fully demonstrate the capability of Cloud Commerce in supporting a multi-modal sales and negotiation mechanism and further explicate the importance of a centralized warehouse for managing a seller's inventory items.

The enhanced Cloud Commerce platform that will be developed eventually will also support three streams of electronic commerce research. The first stream of research will focus on autonomous online decision aid. A traditional problem faced by autonomous decision aids is the necessary standards that unambiguously and universally define goods and services, consumer and merchant profiles, value-added services, secure payment mechanisms and even inter-business electronic forms. Cloud Commerce has the potential to provide these common standards.

Second, extant online decision aids employ techniques that may be classified as collaborative filtering, content-based filtering or hybrids of the former two approaches.

These techniques involve advanced statistical models and information retrieval algorithms (e.g., genetic algorithm) to improve the accuracy of recommendations and alleviate the cold start and sparsity problems. Interestingly, despite the increasing popularity of social networks and social commerce, there has been little research examining the use of an individual's immediate online social network for making product recommendations regardless of demographic and consumption behavior similarity. Thus, I hope to make use of Cloud Commerce to conduct research in this domain.

Last but not least, I hope to utilize the vast amount of electronic commerce transaction data and the rating/review information that can be potentially captured with Cloud Commerce to perform sentiment analysis or other forms of data analytics. The overarching research objective is to identify and understand any difference in buyers' and sellers' behaviors across different websites, channels and media. For instance, comparing between shoppers using smart phone shopping apps and shoppers using mainstream shopping websites, is there any difference in the categories of product items purchased or the formation of post-purchase opinion?

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