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ORIGINAL ARTICLE

Applying virtual reality for trust-building e-commerce environments

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Abstract The application of virtual reality in e-commerce has enormous potential for transforming online shopping into a real-world equivalent. However, the growing research interest focuses on virtual reality technology adoption for the development of e-commerce environments without addressing social and behavioral facets of online shopping such as trust. At the same time, trust is a critical success factor for e-commerce and remains an open issue as to how it can be accomplished within an online store. This paper shows that the use of virtual reality for online shopping environments offers an advanced customer experience compared to conventional web stores and enables the formation of customer trust. The paper presents a prototype virtual shopping mall environment, designed on principles derived by an empirically tested model for building trust in e-commerce. The environment is evaluated with an empirical study providing evidence and explaining that a virtual reality shopping environment would be preferred by customers over a conventional web store and would facilitate the assessment of the e-vendor's trustworthiness.

Keywords Virtual reality · Electronic commerce · Trust · Agents

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1 Introduction

The use of virtual reality in e-commerce has an enormous potential for transforming online shopping into a real-world equivalent and has recently received a growing interest as a research topic. Several research efforts have proposed virtual reality environments for online shopping (Lee and Chung 2005; Ye et al. 2005; Shen et al. 2002; Han et al. 2002; Mass and Herzberg 1999). These studies have a primarily technological scope regarding the application of virtual reality for e-commerce. They focus on technical aspects of designing and implementing a virtual reality shopping environment, in terms of proposed architectures, tools and solutions. Such a technical research orientation leaves only a limited understanding of the social context and behavioral impacts of virtual reality e-commerce applications (Walsh and Pawlowski 2002). Besides technological issues, the social context has to be part of these applications (Maamar 2003). The shopping process in real life is a social one and therefore an e-commerce application should integrate elements from the social context, such as trust, one of the most prominent social aspects of shopping, in physical and online settings (Maamar 2003). Virtual reality applications for e-commerce allow for the accommodation of the social context by simulating a real-world experience, especially in the case of virtual shopping mall environments. However, current literature on such applications does not examine the social context associated with online shopping activities (Maamar 2003; Walsh and Pawlowski 2002; Schummer 2001). While several studies include an evaluation of the virtual reality shopping environment they present, in terms of technical performance or efficiency, there is a

lack of evaluations with respect to social factors such as trust. Thus, research on virtual reality applications for e-commerce needs to be extended to include their effect on social and behavioral issues, among which trust is one of major importance.

Trust is a critical success factor for e-commerce, with lack of trust being recognized as one of the greatest barriers inhibiting online commercial transactions. Building customer trust is a major challenge for online vendors and remains an open issue as to how it can be accomplished within an e-commerce environment. Current literature examines trust from the perspective of a variable that will determine a customer's intended interaction with an online store and not of a dynamic, evolutionary process that continues during interaction. As such, research on building trust is limited up to the stage before the first or a follow-up interaction with an online store and is not addressed at the stage while the customer interacts within the e-commerce environment. While several research models have been proposed for building trust in e-commerce (Cheung and Lee 2006; Hampton-Sosa and Koufaris 2005; Gefen and Straub 2004; Koufaris and Hampton-Sosa 2004; Gefen et al. 2003; Corbitt et al. 2003; McKnight et al. 2002; Jarvenpaa et al. 2000; Gefen 2000), they do not explain how trust is built during customer interaction with an online store. They focus on factors that influence trust so as to entice a customer in interacting with an online store. The effect of the interaction on trust has hardly been examined, in terms of web site characteristics, such as perceived site quality and ease-of-use, without explaining how these influence trust as it progresses during interaction. As such, how trust is built throughout the duration of a customer interaction within an e-commerce environment remains elusive.

In an attempt to jointly address these two issues, the objective of this paper is to provide an understanding of the potential of virtual reality e-commerce environments from a social standpoint, in terms of building customer trust and gaining acceptance over traditional web-based counterparts. The paper posits that virtual reality technologies can effectively be applied for online shopping environments, so as to offer a rich and sophisticated customer experience compared to conventional web stores and enable the formation of customer trust. The paper exemplifies this potential of using virtual reality in e-commerce settings by presenting and evaluating a prototype virtual shopping mall environment. The design of the environment has been informed by the principles derived by an empirically tested model for building trust in e-commerce. The model describes the formation of trust as a process which evolves gradually as customer interaction takes place. Based on the principles derived from the model, the functionality of an online shopping application, beyond covering typical transaction needs, should convey the e-vendor's benevolence, competence, integrity and predictability. The environment serves as an example of how the functionality of a conventional online store can be augmented using virtual reality to provide an advanced form of online shopping and project a vendor's trust-building attributes, by offering a shopping experience that is close to the physical one. The prototype environment has been evaluated with an empirical study. Our findings show that a virtual shopping environment would be preferred by customers over a conventional web store for conducting e-commerce activities and would facilitate the assessment of the e-vendor's trustworthiness. The results are interpreted along three major categories, similarity to a real-world shopping context, visualization and interaction, which are further analyzed into a number of characteristics explaining customer perceptions of the virtual environment. In addition, it is illustrated that customer trust is built gradually during interaction within the virtual environment as it progresses through discrete stages enabling the assessment of the online vendor's benevolence, competence, integrity and predictability.

The rest of the paper is organized as follows. In the next section a comprehensive review of the literature of virtual reality in e-commerce and trust in e-commerce is provided. The third section presents the research design of the study, including the trust-building principles followed for the design of the virtual mall prototype, which is described in the following section. The evaluation study of the prototype and the interpretation of the results are presented next. A discussion of the findings follows and the last section provides concluding remarks.

2 Literature review

2.1 Virtual reality in e-commerce

Virtual reality holds a promising potential for e-commerce applications (Maamar 2003; Walsh and Pawlowski 2002). Virtual reality technology allows for the development of electronic shopping environments which can realistically simulate physical ones. In addition, such environments provide enhanced functionality and interactivity and can address limitations of e-commerce transactions related to the lack of face-to-face interaction and direct product contact (Walsh 2002). As such, virtual reality environments can

provide a new type of online shopping experience, which is closer to the real-world counterpart and superior to that offered in existing web stores. The application of virtual reality in e-commerce has recently received growing research attention, as a technically approached topic. The emerging body of literature examines the use of virtual reality for the design and implementation of e-commerce applications, suggesting solutions, architectures and tools. The use of virtual reality technologies has been proposed for the 3D virtual representation of stores (Chittaro and Ranon 2002), products (Chittaro and Coppola 2000) and avatars of customers and sales assistants. As seen by several research endeavors, a current common trend in virtual reality e-commerce applications is the implementation of shopping mall environments (Han et al. 2002; Mass and Herzberg 1999), with most recent studies presenting virtual shopping mall environments that combine virtual reality with agent technology (Lee and Chung 2005; Ye et al. 2005; Shen et al. 2002).

2.2 Trust in e-commerce

Trust in e-commerce has been extensively addressed as a research topic from different viewpoints and to different levels of analysis. A growing number of studies have proposed empirically tested models that describe trust building in e-commerce. Their focus is on the determinant factors of trust, at an initial stage for first visit customers (Hampton-Sosa and Koufaris 2005; Koufaris and Hampton-Sosa 2004; McKnight et al. 2002; Jarvenpaa et al. 2000; Gefen 2000), or at a later, repetitive stage for return customers (Gefen et al. 2003), or both (Kim et al. 2004), while several others (Cheung and Lee 2006; Gefen and Straub 2004; Corbitt et al. 2003; Sultan et al. 2002; Yoon 2002; Lee and Turban 2001), as also noted by Grabner-Kraeuter and Kaluscha (2003), do not specify the phase of trust investigated. These models view trust as a variable explaining the variance in a customer's intended behavior towards an e-vendor, whether a customer will engage in an interaction with an online store or not. They describe the formation of trust in terms of factors that influence it before a customer engages in the first or a repeat interaction with an online store. They examine the trust effect of factors that are shaped before or after interaction with an online store. The effect of customer interaction per se on trust has been addressed to a limited degree. Several models include interaction and web site characteristics as factors that affect trust, such as perceived site quality (Corbitt et al. 2003; McKnight et al. 2002), ease-of-use (Gefen et al. 2003; Koufaris and Hampton-Sosa 2004), usefulness (Koufaris and Hampton-Sosa 2004), navigation (Sultan et al. 2002) and security (Koufaris and Hampton-Sosa 2004; Gefen et al. 2003; Sultan et al. 2002). However, they do not explain how such factors contribute to the building of trust during the customer interaction with an online store. The model guiding the design of the virtual mall addresses this gap, by analyzing interaction into discrete stages and showing how each of them contributes to the trust-building process.

3 Research design

As mentioned earlier, the virtual reality e-commerce environment presented and evaluated in this paper has been developed based on an empirically tested model for building trust in e-commerce. This section gives an overview of the research design which has been followed for the study presented in this paper, as well as for the previous work that provided the theoretical foundation of the study. The research design, depicted in Fig. 1, is analyzed into discrete steps which are described in the following paragraphs. The development of the trust model and its empirical testing (steps 1–4), which provided the findings that guided the development of the virtual prototype environment will be briefly presented [a detailed analysis can be found in (Papadopoulou et al. 2003)]. Starting with the design principles derived from the empirical findings (step 5), the paper will focus on the presentation of the VR shopping mall (step 6) and the empirical study (step 7) conducted for its evaluation with respect to gaining preference over conventional ones (step 8) and building trust (step 9).

As already mentioned, the first step of this research design was the development of a conceptual model describing trust building in e-commerce (step 1). Trust is approached as a multidimensional concept and is analyzed into a set of four trusting beliefs, the beliefs in the benevolence, competence, integrity and predictability of the e-vendor, trusting intention and trusting behavior. These constructs have been synthesized and theoretically interrelated, resulting in an integrated model and a vertical understanding of how customer trust is formed in e-commerce (Fig. 2).

Trust formation is described as an evolving process that takes place before and during customer interaction with an online vendor. The model suggests that prior to interaction, reputation, in conjunction with attitude towards e-commerce affect trusting intention. Attitude towards e-commerce is the result of propensity to trust, perceived security and perceived privacy of the e-commerce context. The rest of the model

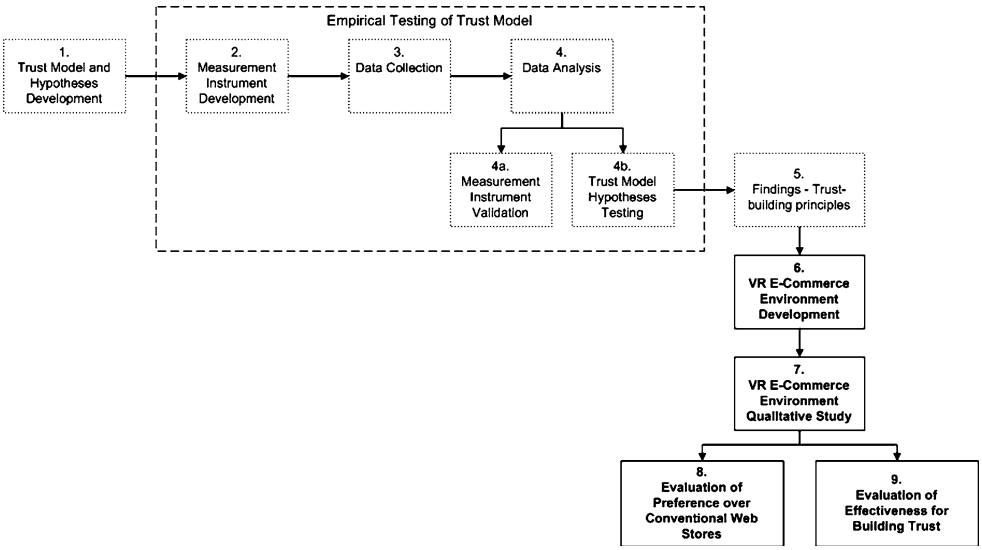

Fig. 1 Research design

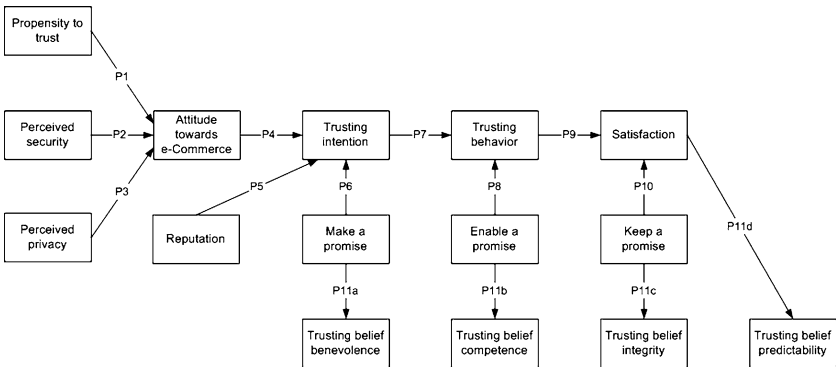

Fig. 2 Research model—trust formation in e-commerce

describes trust formation as it continues during interaction with an online vendor. The model describes how trust is built during a customer's interaction within an e-commerce environment, extending previous works, by making a clear distinction between trust constructs and showing how each trust construct is affected as the interaction progresses.

Trust evolves gradually as the interaction takes place. Interaction is analyzed in three stages reflecting a promise being made, enabled and kept by the online vendor. These three promise fulfillment stages are mapped into the set of services available by an online store. Making a promise is conducted through welcome, recommendations and search facilities. A promise is enabled through product and product-related information view, order placement and purchase/payment facilities. Keeping a promise involves the prompt and correct, physical or electronic, delivery of the order, including order-tracking mechanisms.

Trust—trusting beliefs, intention and behavior—is built during interaction, as the latter progresses through the three stages. Trusting intention is influenced by the promise that is made by the online vendor. Trusting intention in turn and the enabling of the promise made influence trusting behavior. The latter together with the keeping of the promise will determine customer's satisfaction from the overall interaction with the online vendor. Finally, the three promise fulfillment stages and satisfaction from the overall interaction shape the trusting beliefs of the customer. Making a promise forms the trusting belief in the e-vendor's benevolence, enabling the promise forms the trusting belief in the e-vendor's competence, keeping a promise forms the trusting belief in the e-vendor's integrity and satisfaction from the overall interaction forms the trusting belief in the e-vendor's predictability. As such, customer beliefs in the benevolence, competence, integrity and predictability are built gradually, with each interaction stage as well as interaction as a whole building a specific trusting belief.

An empirical study has been performed to test the model and the depicted relationships (steps 2–4). A measurement instrument was developed and pretested to derive the refined final instrument which was used for

the study (step 2). Data were collected by administering an online questionnaire to a sample of 132 university students on a postgraduate information systems course, yielding an effective response rate of approximately 86% (step 3). After establishing the validity of the instrument (step 4a), the hypothesized relationships were tested using multiple regression analysis (step 4b). The results provide empirical support for the relationships depicted in the model. The standardized path coefficients and the variance explained (R^2) for each dependent variable are presented in Fig. 3.

The model and the empirical results led to deriving design principles for trust-building shopping environments, as described in the following paragraphs (step 6). Considering the scope of this paper, it should be mentioned that we only focus on the constructs and the relationships involved in the three stages of promise fulfillment, i.e., the part of the model that describes trust formation during customer experience within the e-commerce environment.

According to the results of the empirical testing of this model, each stage of promise fulfillment has a separate impact on trust, by influencing, directly or indirectly, one of the trusting beliefs and intention about the vendor. Making a promise influences a customer's trusting intention towards the online vendor and a trusting belief in the vendor's benevolence. Enabling a promise affects a customer's trusting belief in the vendor's competence. Keeping a promise shapes a customer's trusting belief in the vendor's integrity. The overall interaction influences a customer's trusting belief in the vendor's predictability.

These findings show that the stages of promise fulfillment reflect vendor attributes which are assessed to form the respective trusting beliefs and intention. Based on the interaction characteristics and satisfaction yielding from it at each stage of promise fulfillment, the customer makes inferences about a vendor's attributes reflected by that stage, i.e., benevolence, competence, integrity and predictability.

Thus, the functions underlying the stages of promise fulfillment, beyond enabling transactions with an online store, are the tools for exhibiting a vendor's attributes and delivering a satisfying interaction so as to build customer trust. Welcome, recommendations and search mechanisms associated with making a promise are the means for showing benevolence. Satisfaction from the interaction with these mechanisms influences a customer's trusting belief in the vendor's benevolence. Facilities for order placement and payment related to enabling a promise are the vehicle for showing competence. Satisfaction from the interaction with these facilities influences a customer's trusting belief in the vendor's competence. Order tracking services, beyond the delivery of an order which can be out of an electronic context, are the channel for showing integrity. Satisfaction from the interaction with these services influences a customer's trusting belief in the vendor's integrity. As a whole, these services offer a way for showing predictability, with satisfaction from the overall interaction affecting a customer trusting belief in the vendor's predictability. The functions of each interaction stage and their effect on building customer trusting beliefs are summarized in Table 1.

As such, we can identify two facets of the functionality associated with promise fulfillment in an electronic setting. The first facet is related to the type of services provided to the customer for his convenience in conducting transactions with a vendor, while the second is related to how these services are provided to clearly show evidence of a vendor's benevolence, competence, integrity and predictability to the customer so as to allow him to make respective attributions of the vendor. While the functionality of an online store enables the conduct of transactions, it is the way that this functionality is provided which enables the assessment of the vendor's trustworthiness.

Therefore, our empirical work highlights that the functionality of an e-commerce environment should be

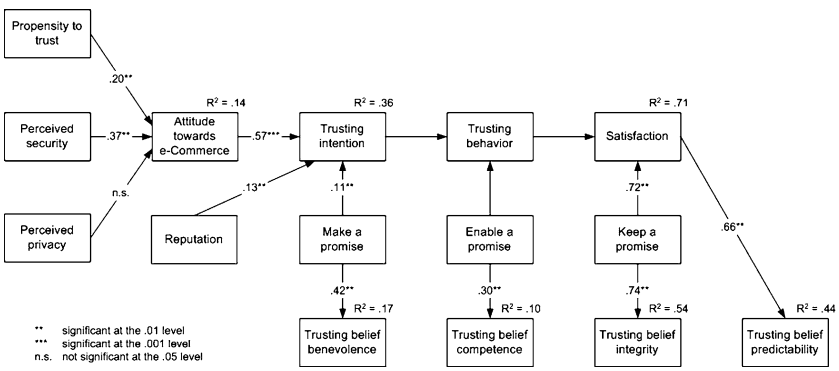

Fig. 3 Empirical results—trust formation in e-commerce

Table 1 Relationship between interaction stages, functions and effect on trusting beliefs in an e-commerce environment

Interaction stage	Functions	Trust-building effect
Making a promise	Welcome Recommendations Search	Benevolence
Enabling a promise	Product view Product-related information Order placement Purchase	Competence
Keeping a promise	Order tracking	Integrity
Overall interaction	All	Predictability

delivered in a way so as to convey a vendor's trust-building attributes, i.e., benevolence, competence, integrity and predictability and generate satisfaction from the interaction in order to shape customer trust. The remainder of this paper discusses how this can be feasible with a virtual reality shopping environment (steps 6–9). We present and evaluate a prototype e-commerce environment which has been designed based on the above principles to convey the list of attributes necessary for the building of trust utilizing virtual reality. The prototype developed is a limited version of an actual virtual mall, in functional and visual terms. Its purpose is not to implement a full and complete e-commerce system or to exactly simulate a real-world shopping environment, but to serve as a vehicle for showing how virtual reality can be used for developing online shopping environments so as to engender customer trust.

4 Virtual reality for trust-building e-commerce environments: virtual shopping mall

Informed by the model, we have developed E-scape, a prototype trust-building e-commerce environment using virtual reality and agent technology. E-scape has been designed and implemented as a 3D virtual world, depicting a shopping mall comprised of virtual stores with 3D products. This virtual environment is populated by anthropomorphized avatars, representing customers and salespersons. A customer is able to visit the virtual environment in the form of an avatar and engage in shopping activities by interacting with a salesperson avatar, which is implemented as an agent. Each customer entering the virtual mall is assigned a salesperson agent, which is his personal shopping assistant throughout the duration of the visit. A salesperson agent belongs exclusively to the customer he has been assigned to. A customer is always in contact with the salesperson while he can freely navigate in the stores, virtually look and feel the 3D products and be aware of the presence of other customers. A customer has constant communication with his salesperson through a text-based chat mechanism. Using a set of natural language type of pre-specified phrases, a customer can engage in a personal dialog with his salesperson, which is not visible to others. Customers can also use the chat mechanism to interact with other avatars, customers or visitors, in the virtual mall.

4.1 Structure

E-scape has been developed using the Active Worlds Internet-based platform of Activeworlds Inc., as a 3D virtual world within the Active Worlds Educational Universe (AWEDU), depicted in Fig. 4.

E-scape can be divided into five components:

1. The virtual world, comprising the 3D representation of the shopping mall space, seven virtual stores, 3D virtual products and avatars of customers and salespeople. The products available at stores are furniture, cars, electric appliances, home appliances, flowers, musical instruments and sports instruments.
2. The agent management module, implemented in C and in combination with Active Worlds SDK which provides the capability of developing agent applications within virtual environments.
3. The data management module for product and customer information and search, order and purchase data.
4. A set of html and asp pages used for the presentation of product recommendations, search results, order information and auxiliary messages.
5. The text-based chat frame used for conversation between a customer and his personal salesperson and among customers.

4.2 Implementation of the trust-building virtual mall

The agent-mediated virtual environment enables customer interaction at three distinct levels depicting the functions of making, enabling and keeping promises and projects the online vendor's benevolence, competence, integrity and predictability. Salesperson agents have a multiple role in the virtual mall, which is reflected in these three levels. At the first level a salesperson agent helps in making a promise, by welcoming the customer at the virtual mall, recommending products, assisting in search for products and guiding the

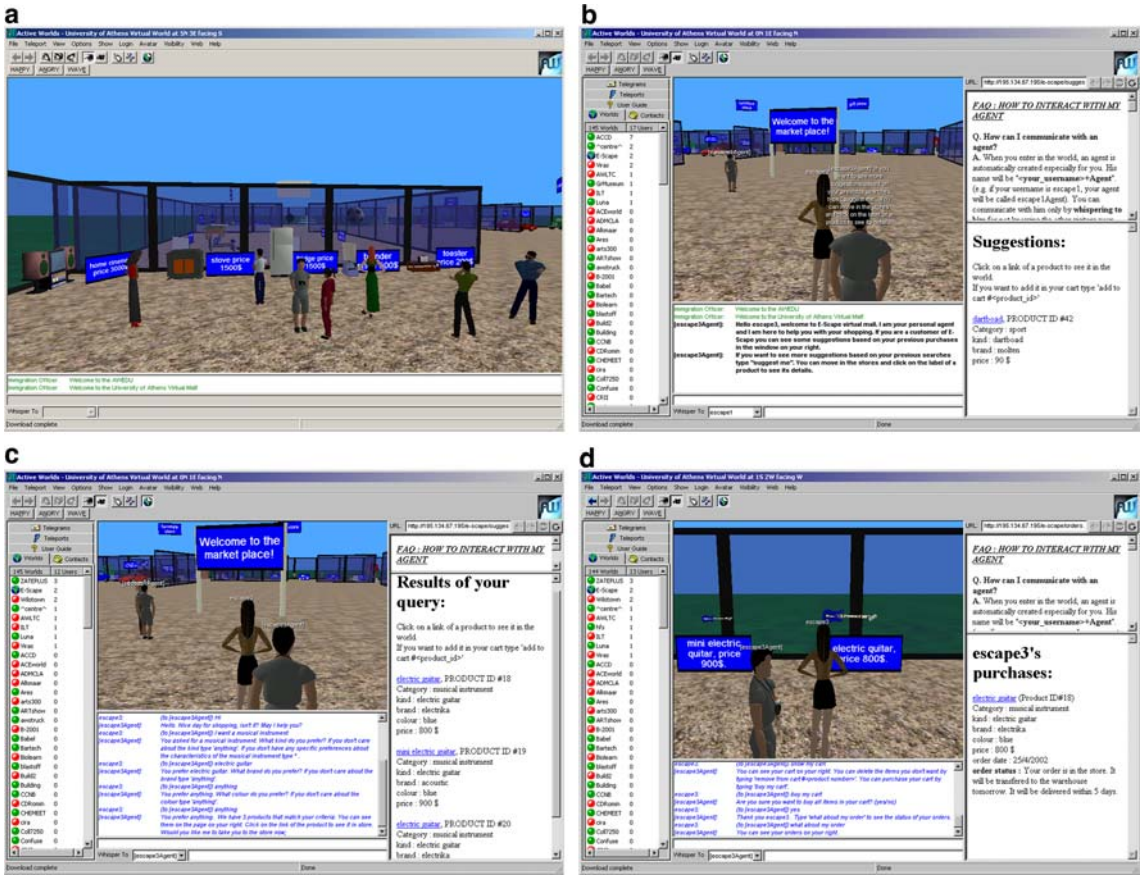

Fig. 4 E-scape virtual mall

customer to the stores. At the second level the agent aids in enabling the promise, by following the customer in a virtual store, being at his disposal and by offering assistance in viewing and ordering products. At the third level the agent contributes to keeping the promise by helping the customer track the status of placed orders. In this section we analyze the implementation of the functions associated with promise fulfillment, explaining how virtual reality and agent technology were applied to provide for the contextual expressiveness needed so as to enable the formation of trust.

4.2.1 Welcome

When a customer visits the virtual mall, a salesperson agent appears which welcomes the customers and kindly offers to help him. The salesperson agent is exclusively dedicated to the customer as a personal shopping assistant. The customer can personally interact with his salesperson agent and converse with him using a predefined set of natural-type of language phrases. Even upon initiation, customer interaction is targeted towards satisfying the customer, showing goodwill and friendliness.

4.2.2 Recommendations

The salesperson collects information from the shopping mall stores and proactively presents selected advertising messages to the customer regarding business offerings, based on the customer profile. There are two types of recommendations, created based on customer's product searches and purchases from previous visits. When the customer enters the virtual mall, the agent recommends products based on the characteristics derived from his previous purchases. The agent can also make suggestions based on previous visits and searches, but only after customer's consent, to further demonstrate the e-vendor's benevolent intentions. Using the chat facility for communicating with the salesperson agent, the customer is able to request information about the advertised offers and can be directed by the agent to the virtual store making a particular offer.

4.2.3 Search

The customer is able to declare his interest in a product to the salesperson agent, regardless of those advertised.

The customer is able to make a request about a product and has the option to show his product-specific preferences to a number of criteria in a dialogue with the agent, seeking to increase his satisfaction. Then the agent performs a search based on the customer's request and according to the specified preferences and characteristics and presents the results of the search. In this way the salesperson makes and communicates the promise to the customer. The search functionality of the agents is designed so as to deliver an objective and unbiased presentation of the findings, in order to render them and the vendors represented in the virtual mall trustworthy, enhancing thus the customer's satisfaction from the promise being made.

4.2.4 Navigation

The customer can visit a specific store at which a product is available by granting permission to the salesperson agent to transfer him to the store, by clicking on a selected product or by moving to the store himself. In this way, the virtual environment aims to strengthen the customer's trusting intention while showing the business benevolence that will be assessed to determine the respective customer trusting belief.

Throughout the duration of the encounter, a customer is free to move in the store and see other products, or visit other stores. The salesperson agent follows the customer closely wherever he goes into the virtual mall being always at the customer's disposal. Aiming to provide a satisfying enabling of the promise, the agent is exclusively dedicated to the customer and persistently ready to help him, showing the vendor's ability to meet customer expectations and impelling the customer to behaviorally express his trusting intention. Enabling the promise in this manner positively influences the customer's trusting belief in the business competence and incites the customer to act in a trusting behavior.

4.2.5 Product and product-related information presentation

When a customer arrives at a virtual store, the agent assumes responsibility as the store's salesperson. The agent welcomes the customer to the store and takes him to the location of the requested product. Products are visually represented within the virtual environment as 3D objects, allowing a customer to view them from all possible angles and fully interact with them. In this way customers are able to preview and experience products before purchase, to ensure satisfaction from the enabling of the promise. Furthermore, the customer is able to see detailed information about a product by clicking on the sign that is next to it, and judge whether or not to depend on the promise.

4.2.6 Order placement, view and purchase

A customer can place an order by asking the agent to add a selected product in his shopping cart. To promote the enactment of a trusting behavior, the customer is allowed to delete a product in case he decides not to buy it, while an order is not actually submitted unless the customer specifically asks the agent to do so. In addition, the customer can also ask the agent to show him the content of his shopping cart before purchase.

4.2.7 Order tracking

Upon submission of an order, the customer can ask the agent to inform him about the status of the order. The customer can see the products he has ordered, the date the order was submitted, the date it will be delivered and the current status of the order. In this way, the customer is able to check if the promise is being kept as expected, evaluating the vendor's integrity. In addition, the customer is allowed to cancel or modify an order, as long as the order has not been shipped yet. By keeping the customer constantly up-to-date about the progress of his order delivery and by granting him control of his order, the virtual environment aims to maximize the customer's satisfaction from the fulfillment of the promise and build his integrity trusting belief. In addition, the satisfaction from the overall interaction that is intended to result from this stage will shape a customer's trusting belief in predictability.

5 Qualitative study

As mentioned previously, our research objectives were (a) to investigate whether a virtual reality e-commerce environment would be preferred over conventional web stores for online shopping activities or not and to understand the factors leading to the positive or negative evaluation of using a virtual shopping environment instead of a traditional web counterpart and (b) to examine the effectiveness of a virtual reality e-commerce environment for building trust and particularly for shaping customer trusting beliefs in the e-vendor's benevolence, competence, integrity and predictability.

For this purpose, a qualitative study was performed to evaluate the effect of the virtual environment on building trust and gaining customer preference over a typical web-based one. The study was carried out at a University setting with students of a postgraduate Information Systems course. A total of 43 subjects aged between 23 and 34 years participated in the study, 74.4% of them were males. All of them had a computing background, were experienced Internet users and had purchased products online at least once. The participants were asked to interact with the prototype environment, acting as customers of the virtual mall. Data were collected through interviews and participant observation. Using a questionnaire as a guide, the interviews were mostly semi-structured and were conducted in a way that allowed for a focus on the issues under investigation, while permitting the interviewees to expand on areas of personal interest that they thought were important. The purpose of the evaluation was to examine and understand the perceptions created based on the type of functionality provided by a virtual reality e-commerce environment. For this reason, the content of the questions was oriented towards the virtual mall facilities and the way they were offered within it. The questions aimed to extract reactions and perceptions regarding the trustworthiness of a virtual mall and to elicit comments about using such an environment for online shopping in comparison with conventional web stores.

Two groups of questions were used for data collection (Table 2). The questions were mapped onto the research objectives. The first set of questions intended to collect data about customer preference of a virtual environment compared to a conventional web store. This comprised a general question regarding customer preference of a virtual shopping environment over a conventional web store and eight questions about customer preference for each specific function offered within the virtual environment compared to the one offered in a conventional web store. The second set of questions aimed at collecting data about the effectiveness of the virtual environment for building trust. It comprised four questions about user perceptions of the e-vendor's benevolence, competence, integrity and predictability respectively.

Data collection and analysis were based on Grounded Theory (Glaser and Strauss 1967). Data were analyzed using open coding (Strauss 1987) as a form of content analysis. Open coding is based on an analytic technique that tends to force the generation of a core category or categories, together with their properties and dimensions. The aim was to establish the core categories using axial coding. This enabled us to generalize the idiographic details revealed by the data interpretation and relate them to general concepts and constructions (Klein and Myers 1999).

The majority of the participants, 35 respondents (81.4%), made a positive evaluation of the environment, stating that they would prefer using a virtual environment for online shopping over a typical web site. Seven respondents (16.2%) were negative towards using a virtual environment for online shopping instead of a typical web store and one respondent (2.3%) was neutral with respect to preferring a virtual to a conventional online shopping environment.

The comments received were analyzed and interpreted. The emerged interpretations revealed a set of categories explaining why and in what instances customers would trust and show a preference for such a virtual environment over a conventional web store for conducting e-commerce activities. These were categorized as *similarity to a real-world shopping context*, *visualization* and *interaction*.

5.1 Similarity to a real-world shopping context

Users' comments evaluating the virtual environment compared to traditional web ones related to the similarity of the virtual mall to a real-world shopping context. The similarity to real-world shopping category uncovered a list of characteristics that were perceived as central to the assessment of the vendor's trustworthiness in all steps of the interaction. This is in agreement with Fogg et al. (2001) who found that a real-world feel is the most important factor affecting web site credibility.

The users' thought of the E-scape as a metaphor of a realistic shopping environment which strongly reminded them of a physical shopping mall. They had the feeling that they performed shopping activities in the same way they do in real world. They could walk and visit stores, view and touch products, see and talk to other customers and be served by a salesperson that they could actually see and have a dialogue with. A user commented:

> ''In general, the virtual mall largely approximates the physical shopping, through the existence and communication with the salesperson agent, and I prefer that compared to traditional e-shopping.''

The similarity of the virtual environment to a real-world shopping context allowed for the accommodation of social elements of shopping. The shopping process in real life is a social one (Maamar 2003). Apart from conducting pure commercial transactions, the users were able to engage in shopping-related

Table 2 Interview guide questions used for data collection and relationship to research objectives

Question	Research objective	Number of questions
Would you prefer online shopping in an environment like the virtual mall or in an environment like the conventional web sites? Explain why	Preference of VR shopping environment over conventional web ones	1 question—general
Would you prefer <function> in an e-commerce environment to be done as in the virtual mall or as in the conventional e-commerce web sites? Explain why	Preference of VR shopping environment over conventional web ones	8 questions—one for each function
Do the welcome, recommendations and search functions, as done in the virtual mall, give you the feeling/impression that such an online store is benevolent and is interested about its customers? How and why is this impression created or not created?	Trust building effectiveness of VR shopping environment	1 question—benevolence
Do the product view, order placement, order view and purchase functions as done in the virtual mall give you the feeling/impression that such an online store is able to meet its obligations? How and why is this impression created or not created?	Trust building effectiveness of VR shopping environment	1 question—competence
Does the order tracking function as done in the virtual mall give you the feeling/impression that such an online store is honest and keeps its promises? How and why is this impression created or not created?	Trust building effectiveness of VR shopping environment	1 question—integrity
Does your overall experience from the interaction as done in the virtual mall give you the feeling/impression that such an online store is predictable, i.e., it is consistent enough for one to know what will happen in a particular situation? How and why is this impression created or not created?	Trust building effectiveness of VR shopping environment	1 question—predictability

activities that are not available in a typical web store, like browsing, window-shopping, moving around stores, seeing other shoppers, going shopping with others. The virtual environment was appreciated to provide a rich shopping experience which besides being useful was also pleasant. In this way the online shopping process was more realistic and attractive as it was augmented with social characteristics of the physical one. According to one user:

> ''What's really interesting is that the virtual mall can be good for socializing. You can see other customers shopping and moving around and you can easily go for virtual shopping with company! It's also easy to see vividly whether there is congestion. For example, you can see that there is a lot of people in a specific store while in another it's just you and it gets crowded at busy hours.''

These features gave the users from the first moment a sense of familiarity, in the sense that they could easily identify and recognize elements of traditional shopping and associate them with their virtual counterparts. The virtual environment and the interaction enabled within it were perceived to be consistent with their mental model of physical shopping and thus they could easily transfer their accumulated knowledge and experience from the bricks-and-mortar world and apply it to the virtual context. This swiftly gained sense of familiarity resulted in perceiving the virtual environment as straightforward, self-explanatory and easy-to-use. The positive influence of familiarity on perceived ease-of-use has also been found in (Gefen et al. 2003). As described by a user:

> ''I'd prefer to do shopping in an environment like a virtual mall. The way it works corresponds a great deal to the way real shops work. A buyer feels he is in a much more familiar environment. Common web sites provide the same products; however, they don't provide this familiarity to the customer; you don't have the feeling that you are in a store and you are shopping. The virtual mall corresponds a lot to the way someone is doing shopping in real life.''

In this way, the users evaluated the shopping experience in the virtual environment as superior to that in conventional e-commerce sites as they thought that it integrated the advantages of both physical and online shopping. A user commented:

> ''I'd definitely prefer the virtual mall which combines the advantages of buying online, buying from anywhere anytime and some of the advantages of shopping in the usual way, dialogue with the salesperson, who facilitates the consumer.''

In addition, the association of the environment with the electronic equivalent of a physical shopping place reduced the cognitive effort that would normally be demanded for assessing the trustworthiness of a traditional web vendor, thus precipitating the formation of trust. This is also supported by other works that have found that familiarity has a positive impact on trust either directly (Gefen 2000) or indirectly through its effect on perceived ease-of-use (Gefen et al. 2003). Despite the fact that the virtual environment was significantly different from a typical web store interface, it raised trust perceptions because of the high degree of understandability and ease-of-use perceived by the users.

5.2 Visualization

The second category that emerged from the analysis of the data related to the high visualization degree in the appearance of the virtual environment. Visualization was offered at all levels of the environment appearance, involving salespersons, customers, products and shops. Users were able to see their virtual self-representation in the form of an avatar, which generated a feeling of physical presence in the environment. In conjunction with the ability to view other customers and salespeople, this made the users reappraise their role from that of a user of a faceless interface to that of an actor in a living, naturalistic environment. They felt that they were active participants in a shopping process carried out in a realistic way, as they could walk and see the virtual shops and products. This also enabled them to have an explicit view and awareness of the environment and facilitated navigation. As one user said:

> ''It's simpler and more natural than a conventional web site. You have a 3D perspective of the space, where you can naturally move, just like in a real store.''

The provision of visualized input at all levels was to allow for an environment integrating features of both physical and conventional web stores. This augmented appearance offered a convenient to use environment, which is an important contributor to customer satisfaction from the web shopping experience (Shim et al. 2002; Bellman et al. 1999). As described by a user:

> ''It's definitely better than existing e-commerce sites because the presentation of products takes place in a 3D almost natural environment and also because the product itself is a 3D representation of the real one and you can also interact with it. So the customer gets a more clear idea of the product and this contributes to a much better shopping experience and also to a much safer product choice.''

Visualization was particularly positively evaluated with respect to the 3D virtual products. Users showed a high preference for a 3D view of products over a 2D one, as they could have a richer experience of the product. This preference was often expressed with a requirement for high-quality images so that virtual products are perfect and precise representations of the real ones. The 3D representation of products satisfies the reported consumer need for better images and adequate visualization of products (Jarvenpaa and Todd 1997). This is illustrated in the following comment:

> ''It's definitely more impressive to have a 3D view of a product and to be able to observe it from different perspectives by rotating it and it gives more information about the product than a 2D one in a current e-commerce web site.''

The 3D visualization of products and stores also satisfies the reported consumer need for easy and convenient product comparisons (Jarvenpaa and Todd 1997), as it enables viewing-related products and information at the same time and place within a store. As mentioned by a user:

> ''The fact that it's possible to see similar products next to it [a product of interest], so easily makes it [the virtual environment] superior to a web site.''

In addition, the visual depiction of stores in the form of a mall structure allowed for viewing different stores and navigating to them for comparing products and prices, covering another consumer requirement for seeing ''head-to-head competition that you can see in a mall'', not met by conventional web stores (Jarvenpaa and Todd 1997). A user commented:

> ''The structure and the familiar layout of stores, which are not collocated in conventional web sites, are an advantage. And it facilitates you to look for a product, either by teleport or by navigating in the mall stores.''

Furthermore, the visualization of salespersons in an anthropomorphic figure created the sense of a face-to-face contact with a real vendor, as the avatar was perceived as the virtual substitute of a human salesperson, thus facilitating the formation of trust (Doney and Cannon 1997). According to a user:

> ''being able to see the agent always next to him [the customer] makes him feel that he can ask anything anytime and get the answers he wants.''

5.3 Interaction

Interaction within the virtual shopping environment and the way this was carried out constitute the final category. Although the functionality offered was largely similar to that provided by traditional web stores, the way this functionality was delivered through interacting within a virtual environment with the expressiveness of a physical commercial context, led the users develop a positive stance towards the environment and also express a strong preference over a conventional web store.

The primary aspect of the interaction that was deemed as important in making a difference with conventional web stores was the interaction with the virtual salesperson. The dialogue with a virtual salesperson resembled a human communication, offering a sense of an interpersonal relationship with the customer. In this way, the shopping process was friendly and natural, close to the physical one, which made it more pleasant and attractive than that of a conventional web store. As described by a user:

> ''It's much better to talk in almost natural language to a salesperson than having an expressionless and cold search engine which may do the job but doesn't make shopping feel like fun but rather a boring experience. With the virtual mall process, it's like the buyer is chatting with the salesperson and that's the usual shopping process, not completing some kind of form.''

As such the users preferred to perform their shopping activities through having a personal dialogue with a virtual salesperson over interacting with a faceless interface of a usual web store using forms, links and buttons. The users thought that their interaction was facilitated and improved by being served by a personal salesperson doing for them all the tasks they wanted to perform, avoiding problems often encountered in web sites such as 'hard to follow ordering directions' (Jarvenpaa and Todd 1997). They could simply turn to the salesperson and ask him to do what they would normally accomplish through a sequence of complicated links. According to a user:

> ''I get the impression that I'll have help at every step I make for searching a product and that I won't get lost among links. This is very important. On the other hand, though, I have to type and lose time instead of clicking on a link. In conclusion, I'd prefer the virtual mall because it makes me feel more sure that I'll have immediate help in finding exactly what I want and I won't need to spend time searching in some web pages.''

On the other hand, there were also negative comments about interacting with the intervention of the virtual salesperson, concerning mostly the functions of order placement and view. They were found to be time consuming as they involved typing instead of clicking. A respondent said:

> ''The [order placement and order view] procedure seems time-consuming to me, for example I have to type 'add to cart #18' or 'show my cart' instead of a single click''

However, the same respondent, regarding purchase, said:

> ''In this case, although the procedure is more time-consuming, I prefer buying products like in the virtual mall. The reason is that it assures me that I won't make a purchase by accident, by clicking or pressing 'enter' by mistake.''

Performing shopping-related activities through engaging in a dialogue with the salesperson was deemed easier and more effective, especially when searching for a product of interest, as the dialogue would proceed gradually, with successive questions refining the search according to the user criteria to find the item that best suits his needs. This allowed for convenience in goal-directed shopping, a task which 44% of consumers consider to be difficult in web stores (Jarvenpaa and Todd 1997). As commented by a user:

> ''Searching is done in a more realistic way, much like when a customer is physically present in a real store. Especially, the gradual locating of a product by setting successive criteria [...] is much similar to being in a real store where while searching for a product we gradually form its selection criteria.''

The same study (Jarvenpaa and Todd 1997) also mentions that consumers often do not understand how to go to a place they want. With the salesperson constantly providing help and guidance in every step of the

shopping process, the users felt safe that they would never get confused or lost during interaction. A user mentioned:

> ''You have someone [the virtual salesperson] at your disposal throughout the shopping duration. So the customer feels secure that he won't get confused or lost while shopping.''

As such, navigation was found to be very easy and intuitive, as the users could navigate into the environment either independently, simply by walking to a place of interest or by requesting their salesperson to teleport them to a specific store, right in front of a selected product.

The users enjoyed and appreciated having a personal, devoted salesperson, always at their disposal, which gives them personal attention and shows courtesy by providing constant guidance, offers individualized service, eagerly responds to all their requests and helps in their intended tasks. These created empathy and assurance and responsiveness which have been found to have a trust-building effect (Gefen 2002). Responsiveness has also been reported to determine consumer evaluations of a site as good or bad (Jarvenpaa and Todd 1997). As such the virtual salesperson enhanced trust, in line with (Urban et al. 2000; Cassell and Bickmore 2000). As shown in the following comment:

> ''The role of the salesperson is central to the virtual mall. It provides a sense of personification of responsibility from the vendor side towards the customer. As such, it increases the level of customer trust, to the extent to which he [the customer] thinks that he has an exclusive salesperson that will serve him, help him or reply to any question and will be responsible for the success or failure of the shopping transaction. On the contrary, in traditional web sites, the whole vendor–customer relationship remains impersonal, which makes such web commercial transactions completely different from physical shopping.''

In conjunction with the fact that the dialogue was in a natural-type language through a chat-like facility, interaction was very simple and easy for users of any expertise level and was particularly attractive for novice and inexperienced users, who often are daunted by web sites (Jarvenpaa and Todd 1997). According to a user:

> ''Welcome in e-scape is definitely much more friendly and creates the feeling that the customer is not alone in an unknown electronic environment eliminating any fear and insecurity that may be caused to him. So it can be ideal especially for new and inexperienced Internet users.''

The salesperson-mediated facilitation of the interaction at all these issues mentioned earlier, with the personal and friendly dialogue with the salesperson projecting a strong similarity to interpersonal communication, increased users perceptions of ease-of-use of the environment, further enabling the formation of trust, in line with Gefen et al. (2003) and Fogg et al. (2001).

5.4 Trust-building effect of interaction stages

Drawing upon the model constructs, we analyzed and interpreted the perceptions of the various stages of the interaction as well as the overall impression, with respect to the satisfaction achieved and the impact on trust. All three stages of promise fulfillment and the entire interaction were found to satisfy the users, with the perceived satisfaction from each of them having a positive trust-building effect, by conveying the e-vendor's benevolence, competence, integrity and predictability.

5.4.1 Benevolence

The stage of 'making a promise', comprising the functions of welcome, recommendations and search, gave the users the sense that the e-vendor was benevolent. Benevolence was conveyed mainly through the virtual salesperson and the way it interacted with the customer for welcome, recommendations and search. The virtual salesperson reminded the users of a real one, who welcomes, recommends products and facilitates their search for a product showing an interest in the customer. The personal dialogue with the virtual salesperson created a sense of friendly, human communication which facilitated the users to assess the vendor's benevolence. As shown in the following comment:

> ''These functions [welcome, recommendations, search] as they are in the virtual mall give the customer the feeling that the store is benevolent, that it cares about its customers and their best service. This feeling comes from the fact that the communication is more friendly and less distant. From the very first moment the customer has the feeling of having a dialogue with a real salesperson who is dedicated only to him.''

Perceived benevolence was especially due to the welcoming of the customer by a human-like figure, the virtual salesperson, greeting the customer visiting the store and initiating a friendly dialogue with him, like in face-to-face communication one would have in a physical store. With the virtual salesperson giving individualized recommendations, asking questions for preferences and providing guidance around the stores, the users felt that they received attention and that they are considered as important and treated as such. As one of them mentioned:

> ''Every customer feels special as he is welcome and served by his personal salesperson, who knows his preferences from past purchases and guides him around the mall.''

The virtual salesperson was trusted as a personal, courteous assistant facilitating the decision-making process. This is consistent with Urban et al. (2000) and Cassell and Bickmore (2000) suggesting that virtual personal shopping advisors can enhance trust. According to a user:

> ''There is an interpersonal relationship between the customer and his personal salesperson, who helps the customer pinpoint exactly what he wants, guiding him in searching for the suitable product. This leads to finding the right products that match the customer needs.''

Benevolence was projected with the continuous presence of the virtual salesperson providing constant help. The salesperson was perceived to show an explicit willingness to aid the customers at any time in the shopping process. Users felt the salesperson was always available for them to provide personal service when needed. This created feelings of empathy, assurance and responsiveness, which have been found to influence trust (Gefen 2002). As a user described:

> ''This impression [benevolence] is created by the presence of the personal salesperson who has an interpersonal relationship with the customer and assumes responsibility for serving him, just like in a real store. Friendliness, will to serve and offering help at any time are enough to create such a feeling.''

In addition, the fact that the salesperson was personal and devoted exclusively to the customer was also perceived as a sign of interest about the customer. It gave customers the feeling that someone spends time to help only them. According to a user:

> ''Having a human-like agent welcoming him [the customer] and following him everywhere makes him feel—like in a real store—that the vendor cares about him and has a salesperson spending time exclusively for him. In a real store when a salesperson spends his time exclusively on one customer it shows interest and good motives. So in the virtual mall one feels he has someone next to him anytime.''

These characteristics were perceived as cues that the vendor actually cares for the customer and is willing to provide a good quality service. In this way they shaped the users belief that the vendor is benevolent and positively influenced their intention to trust the store and proceed with their activities. This is consistent with the findings reported in Gefen (2002) about the influence of service quality on trust, particularly its dimensions of responsiveness, assurance and empathy, which were conveyed through the virtual salesperson. This means that the functions at this interaction stage allowed the users to assess the vendor's motives and intentions, and thereby the degree of its benevolence.

5.4.2 Competence

The perceived satisfaction from the promise enabled was high and gave users the feeling that the e-vendor was competent and could be trusted. The functions at this interaction stage, viewing products and product information, order submission and purchase, allowed the users to assess the vendor's ability to realize its promises, thus building their competence trusting belief.

The users particularly appreciated the 3D visual depiction of the virtual products and the fact that they were able to interact with them and get a real-like look and feel. The users had an easy and convenient way to have a clear and meaningful view of the products by being able to manipulate and interact with them, which instilled trust, similar to the findings of Cheskin Research and Studio Archetype/Sapient Report (1999) and Shim et al. (2002), and also of Gefen (2002) indicating the effect of tangibles dimensions of service quality on trust. A user said:

> ''The customer doesn't just see a photo of a product but he's transferred in a store where he's presented with a 3D product which he can rotate to see a whole view of it, just like he could examine a product in a real store.''

The users also highlighted that it was very easy and convenient to view information about a product. They felt that clicking on a product sign to view detailed information was like looking at the label of a product in a bricks-and-mortar store. This is in line with the

finding of Shim et al. (2002) that simplicity of web design for access to product information is a key factor of customer satisfaction. As mentioned by a user:

> ''It [viewing product information] looks like the actual presentation of a product label, like you turn the label on a real product and see the information.''

Visualization and the intuitive design of the environment resulted in a trust-engendering interaction at this stage. Navigation into the stores, either with or without the virtual salesperson's help, was perceived as easy, convenient and pleasant. The users could view related products easily by going to a store, navigate easily from product to product and view information about them at the same time and place. This is consistent with a number of other studies that have found that perceived ease-of-use influences web site credibility (Fogg et al. 2001) and trust (Gefen et al. 2003) and that trust is also influenced by perceived site quality (McKnight et al. 2002), good interface design (Fung and Lee 1999), presentation and artistic design (Sultan et al. 2002) and navigation (Sultan et al. 2002; Consumer Reports WebWatch 2002; Consumer Reports WebWatch 2005). As one of the users commented:

> ''It facilitates navigation. The customer can talk with a salesperson. It's much more attractive and easy-to-use. Some web sites are badly designed so that you can't find the products you want or there is no price for them. In this one the customer can just ask the agent or go check the product label.''

The feeling that the online vendor is competent to meet its obligations was also created as the interaction with the functions, especially through the virtual salesperson, was perceived to be realistic, following the pattern of a physical shopping experience. According to a user:

> ''These functions and the way they are offered give the feeling that the virtual vendor can meet its obligations; this is created with the realistic way that everything happens, the personal communication with the agent and the explanatory dialogue that it uses.''

In addition, the interaction with the virtual salesperson gave the users a feeling of assurance in terms of being able to get the information they would need, influencing their trusting belief in the e-vendor's competence. As described by a user:

> ''The sense the customer gets, through the salesperson, creates a feeling of assurance that all possible questions about purchase will be answered properly.''

In line with the findings of Gefen (2002), the feeling of assurance and its positive effect on trust was further created as the users had constant and personal guidance from their devoted salesperson at all tasks, eliminating the fear of getting confused about how to proceed at a point of the interaction. They felt that their personal salesperson was there for them and would guide them in every step. This was perceived as a sign of competence in providing help to the customer. A user commented:

> ''With the help of the salesperson you have the feeling that no matter what you need the salesperson will guide you as to what you should do.''

As such, the whole process at this interaction stage, including product and product information view, order submission and purchase, was clear and understandable. This was perceived as a sign of competence as it expressed that the vendor has knowledge of its obligations towards the customer. A user said:

> ''The way of placing and viewing an order is clear and with the necessary information, the purchase procedure is also clear and explicit. This clarity leaves the feeling that the virtual mall has full awareness of what it should offer to the customer.''

5.4.3 Integrity

The perceived satisfaction from a promise kept was only possible to be partially assessed, as in an electronic environment it is largely associated with the function of delivery tracking while it also involves the actual delivery of the product and post-sales services.

While this function was considered very important and useful, it was not deemed adequate for some users to formulate a clear belief in the e-vendor's integrity. Instead, they would defer this judgment for when the ordered products are delivered, to check if they are received correctly and on time as expected and also to see what would be the vendor's post-sales service, for example, in case of a request for a product return. According to a user:

> ''The information given definitely creates this impression [integrity]. Of course this will ultimately be shown when the customer will receive his order on time, when he will be able to return a product in case it's not the right one, feeling sure that he will get his money back.''

However, within the context of an electronic environment, the importance of the delivery-tracking function

and its contribution to the building of trust should not be underestimated. A survey (Jarvenpaa and Todd 1997) reported that 41% of online consumers noted a lack of information on delivery time. As Jarvenpaa and Todd (1997) mentions, the provision of this information determines consumer ascriptions of a web store and, according to Gefen (2002), is part of a web vendor responsiveness which affects trust. This is also consistent with a finding of Sultan et al. (2002) that customer perceptions of order fulfillment, in the absence of actual purchase, influence trust in a web site. The users made a positive evaluation of the vendor's integrity simply by the fact that there was an order-tracking facility available to the customer. The information on delivery also conveyed integrity as it created a feeling of confidence regarding the order fulfillment, similar to the reliability service quality dimension which has been indicated to influence trust (Gefen 2002). A user commented:

> ''This function [order tracking] shows a vendor's integrity. With the customer knowing the status at which his order is, it shows that whatever commitment the virtual mall has made towards the customer will be realized. Customer trust towards the vendor increases with the use of such mechanisms.''

The provision of such a function as well as the information given, especially through the intervention of the salesperson, was perceived as a sign of commitment of the vendor, showing that it keeps its promises. A user said:

> ''The fact that you have information about the status of the delivery process and when the product is to be delivered is a commitment for the virtual mall so the customer feels it's honest and will keep its promises.''

The detailed information per se and the ease of viewing it, just by asking the salesperson, anytime, anywhere, without having to stop their navigation to go to a different page was positively evaluated as an effort of the vendor, signaling integrity. As described by a user:

> ''Yes, it [the virtual mall] gives you the impression of integrity and keeping its promises because it gives the customer the ability to track his order during its fulfillment, any time, any time he wants to, even out of the virtual world.''

In addition, the integrity belief was further enhanced as they felt that with this facility the vendor gave the customer control of the process. Previous research has shown that perceived control in e-commerce has a positive impact on customer attitudes (Cheskin Research and Studio Archetype/Sapient Report 1999). A user mentioned:

> ''The customer is in control of his order fulfillment process. So by providing this option the vendor shows its intent to be honest and fair in its transactions.''

Therefore, this interaction stage allowed the users to assess the extent to which the store has actually delivered on its promise, although partially, and judge the e-vendor's integrity.

5.4.4 Predictability

The perceived satisfaction from the overall interaction could also only partially drive the users opinion about the vendor's predictability.

With respect to the interface, the users felt that they always knew what happens next throughout their interaction. One of them said:

> ''Yes, it's predictable, because after every action I always know what is going to happen next.''

This was due to the constant contact with the salesperson and the resemblance to the physical shopping experience. Real-world feel has been ranked as the most important web site element relating to trust (Fogg et al. 2001). The metaphor of a realistic environment and the metaphor of a salesperson worked as a catalyst in reducing the complexities inherent in the interaction, as in any human–computer interaction. This is supported by other research works showing that humans respond to computers as if they were social entities (Reeves and Nass 1996; Cassell 2000). The users, based on their mental model of shopping in the bricks-and-mortar world, made associations of the various steps of the interaction with those that they are used to and know from the real world. As such, the interaction was natural to them and it was easy for them to figure out what to expect next, what they would expect in real-life shopping. According to a user:

> ''I think that the interaction provided by the virtual mall through the use of the agent helps the user know at which state he is and what to expect next. That's because the user generally knows what to expect from a salesperson in real world and so what [he knows] to expect from the agent.''

The overall interaction allowed the users to assess the store's consistency in delivering the promises it makes, and thus make inferences regarding its predictability. However, the belief in the e-vendor's predictability would ultimately be completely shaped gradually over time, after gaining experience with e-vendor.

6 Discussion

In this section the preference of the virtual shopping environment over a web one as well as its effectiveness in building customer trust are discussed with respect to the number of users positive, neutral and negative responses. Implications for theory and practice are discussed next.

The users' specific evaluations, positive, neutral or negative, of each function of the virtual environment with respect to those of a conventional e-commerce web site are presented in Table 3.

Table 4 presents the users' specific evaluations of the effectiveness of the functions of the virtual environment, in building customer trust. For each interaction stage, it shows the positive, neutral and negative responses of the users as to whether the functions associated with a particular stage shape a respective belief in the benevolence, competence, integrity or predictability of the vendor.

According to the results presented in Table 3, the respondents showed a preference for most of the functions as offered in the virtual environment. The users had a clear preference for the product and product information view (93%), welcome (83.7%) and search (58.1%) functions. They were also positive and had a strong preference for the recommendations (48.8%) and purchase (41.8%) functions. The reasons leading to this preference have already been explained in the analysis above.

Some respondents were neutral in their evaluation of certain functions, especially order tracking (58.1%), order view (46.5%) and recommendations (41.8%). This was because they could not find any difference between the way these are offered in a virtual and a conventional web environment, which would be significant enough for them to develop a preference for the one over the other. Another reason for the respondents being neutral regarding their evaluation and preference of functions was that what was important for them was the specific function to be in place and not the way the function was provided, in a virtual or not environment.

A small number of respondents were negative towards preferring the functions of a virtual environment to a conventional web one. These respondents stated that they preferred to perform these activities, particularly order placement (48.8%), as in a typical web site, through a number of clicks instead of typing sentences as in the virtual environment, because they are familiar with using existing web sites and they need less time for performing these activities in such sites than in a virtual environment.

According to the results presented in Table 4, the users evaluations show that a virtual reality shopping environment builds customer trust. The users' responses regarding the effect of the functions of each interaction stage on trusting beliefs confirmed the findings of the empirical tested model. The functions of welcome, recommendations and search, associated with the first interaction stage, build trust in the vendor's benevolence (86%). The functions of product view, product information view, order placement, order view and purchase, associated with the second interaction stage, build trust in the vendor's competence (76.7%). The function of order tracking, associated with the third interaction stage, builds trust in the vendor's integrity (67.4%). Finally, the overall interaction builds trust in the vendor's predictability (55.8%).

Some users were neutral in their evaluation of certain functions with respect to their impact on trust. These evaluations were mainly about the effect of order tracking on the integrity belief (30.2%) and the effect of the overall interaction on the predictability belief (32.5%). The users said that these functions were not suffice to fully judge the vendor's integrity and predictability and that they would need experience over time to completely form such beliefs.

Table 3 Customer evaluation of virtual e-commerce environment functions compared to conventional web ones

Evaluation	Positive		Neutral		Negative	
Functions	Users	Percentage (%)	Users	Percentage (%)	Users	Percentage (%)
Welcome	36	83.7	1	2.3	6	13.9
Recommendations	21	48.8	18	41.8	4	9.3
Search	25	58.1	8	18.6	10	23.2
Product and product information view	40	93	2	4.6	1	2.3
Order placement	11	25.6	11	25.6	21	48.8
Order view	10	23.2	20	46.5	13	30.2
Purchase	18	41.8	15	34.8	10	23.2
Order tracking	16	37.2	25	58.1	2	4.6

Table 4 Customer evaluation of virtual e-commerce environment functions in building trust

Interaction stage	Functions	Trust-building effect	Positive		Neutral		Negative	
			Users	Percentage (%)	Users	Percentage (%)	Users	Percentage (%)
Make a promise	Welcome Recommendations Search	Benevolence	37	86	4	9.3	2	4.6
Enable a promise	Product and product information view Order placement Order view Purchase	Competence	33	76.7	8	18.6	2	4.6
Keep a promise	Order tracking	Integrity	29	67.4	13	30.2	1	2.3
Overall interaction	All	Predictability	24	55.8	14	32.5	5	11.6

A small number of users (2.3–11.6%) were negative regarding the effect of the virtual environment functions in shaping trusting beliefs in the vendor's benevolence, competence, integrity and predictability. These users said that these beliefs can only be formed through repeated interaction and not through the functionality provided within the virtual environment.

6.1 Implications

The findings emanating from our study of the virtual reality e-commerce environment illustrate that (a) virtual reality e-commerce environments can be superior to and preferred over conventional web sites for online shopping, and (b) virtual reality e-commerce environments can promote trust building, especially the formation of customer trusting beliefs in the benevolence, competence, integrity and predictability of the online vendor. Several implications for theory and practice arise. These are summarized in the following paragraphs.

A virtual environment serves as a metaphor of a bricks-and-mortar store, creating an illusionary sense of a realistic commercial context, consistent with the customer mental model of a physical shopping experience. In this way a customer can draw a parallel with the experience held from the interaction in physical settings and apply it while interacting within the virtual environment. As a result, a virtual shopping environment raises perceptions of being familiar, simple, understandable, convenient and easy-to-use, and to a higher degree than a web-based one. In this way it can be more appealing to use and gain customer preference over a conventional online store. At the same time, it facilitates customer judgments about the trustworthiness of the vendor. This is in agreement with Fogg et al. (2001), where it was found that a real-world feel is the most important factor affecting web site credibility. The association of the environment with the electronic equivalent of a physical shopping place reduces the cognitive effort that would normally be demanded for assessing the trustworthiness of a traditional web vendor, thus precipitating the formation of trust. This is also supported by other works that have found that familiarity has a positive impact on trust either directly (Gefen 2000) or indirectly through its effect on perceived ease-of-use (Gefen et al. 2003; Fogg et al. 2001), which also influences trust.

In addition, the visualized spatial representation of a shopping environment, where a customer can see and interact with virtual products, salespersons and other customer offers an enhanced in intuitiveness and user-friendliness interface. This allows for an augmented interaction, compared to that in conventional online store, which is also more pleasant, convenient and attractive. It enables a full view of products in 3D and facilitates navigation, product comparisons or even head-to-head competition in a virtual mall setting. As such visualization also results in a trust-engendering environment; a finding that is consistent with a number of other studies that have found that trust is influenced by perceived site quality (McKnight et al. 2002), good interface design (Fung and Lee 1999), navigation (Sultan et al. 2002; Consumer Reports WebWatch 2005), presentation and artistic design (Sultan et al. 2002) and product images (Shim et al. 2002).

In all levels of the shopping process, the salesperson agent is the medium of customer contact with the Internet vendor, serving as the surrogate of a human vendor. Instead of completing forms, clicking on links and viewing messages, for shopping activities, as in web-based stores, in a virtual environment the customer can engage in a personal dialog with a virtual salesperson, through, for example, a chat-style facility using natural-type language. As such, the faceless interaction with the usual web interface is advanced to

a human-like communication, where the customer talks and has a virtual eye contact with the salesperson. In addition, a virtual salesperson can promote customer trust as it facilitates the projection and assessment of a vendor's benevolence, competence, integrity and predictability. This is in line with the findings of (Urban et al. 2000) and (Cassell and Bickmore 2000) showing that virtual personal advisors can enhance trust. Thus, this study confirms previous works (Lee and Chung 2005; Ye et al. 2005; Shen et al. 2002) showing that virtual reality in combination with agent technology has a powerful potential for the development of e-commerce environments and contributes in this direction by showing that such a combination can offer an advanced customer experience which is preferable compared to that of conventional ones and builds trust. Further research is needed to fully explore the possibilities of these two technologies for e-commerce environments as well as the adoption and use of such environments in practice.

The study showed that a virtual reality shopping environment can deliver the functionality of a typical e-store with the expressiveness of a physical, face-to-face interaction. In this way, a virtual reality e-commerce environment offers a shopping experience that is preferred over conventional web stores and enables the projection and assessment of an e-vendor's trustworthiness.

As mentioned earlier, this is attributed to the perceived satisfaction resulting from the interaction stages with welcome, recommendations, search, product and product-related information view, order placement, purchase and order-tracking functions. Such functions are currently typical of conventional online stores, such as Amazon.com, provided through a web interface with forms, links and text messages. However, the same functions, when provided within a virtual reality shopping environment, can be preferred by customers and can also build a customer's trust in the e-vendor's benevolence competence, integrity and predictability.

Our findings show that virtual reality can be successfully applied for e-commerce environments and the functions associated with shopping activities, especially for welcome, recommendations, search, product presentation, product information and purchase functions. In specific, virtual reality, and particularly the use of a virtual salesperson, is suitable for welcome and search functions. In addition, virtual reality should be applied for product presentation. The 3D representation of products allows for a rich product experience and a complete view and examination of the product, which is missing from conventional online stores. A prerequisite for this is that the virtual representation of the product is of high quality. Furthermore, recommendations, purchase and order-tracking functions can also be provided through a virtual salesperson. On the other hand, the use of virtual reality and specifically the use of a virtual salesperson should be adopted with caution for order placement and order view. Possible alternative ways in which such functions should be provided within a virtual reality environment, either with or without the intervention of a virtual salesperson is an issue that requires further research. These functions could possibly not be provided through a dialogue with a virtual salesperson. This implies that these functions should be made available in a different way, either without involving a dialogue with a virtual salesperson or by enabling a communication with the virtual salesperson by different means than typing text or by providing a hybrid interaction combining communication with the virtual salesperson in combination with other means of interaction. In any case, the interaction with the functions through a virtual salesperson should be easy-to-use, simple and fast, without demanding much typing or other time-consuming actions by the customers.

The study shows that functions in a virtual reality e-commerce environment build trusting beliefs in the online vendor. Welcome recommendations and search build benevolence. Product and product information view, order placement, order view and purchase build competence. Order tracking builds integrity. The overall interaction builds predictability. However, customer beliefs, particularly in the integrity and predictability of the vendor, are partially formed through the interaction within the virtual environment. The assessment of these attributes is completed over time, after repeated interactions and depending on customer satisfaction from the actual order delivery as well as from after sales services. These findings confirm those from the empirical testing of the model regarding the influence of these functions on trust. A question that emerges and needs further research is whether a virtual reality e-commerce environment is more effective in building customer trust than a conventional web one. A comparative study is needed of the trust-building effectiveness of these functions between a virtual reality shopping environment and a conventional web one. This will enhance our understanding regarding the effectiveness of virtual reality shopping environments for building customer trust. In addition, it will provide further insights regarding the suitability of applying virtual reality in e-commerce.

Virtual reality shopping environments can be more attractive and suitable for novice, inexperienced users,

who are often daunted by web sites. However, this might not hold for experienced users, as shopping in such an environment can be deemed as time-consuming or boring, largely because of their familiarity with existing sites.

Besides the functionality related to conducting commercial transactions, a virtual environment allows for the development of customer communities, as customers can view others and communicate with, for example using a chat facility. The evaluation study presented was focused on customer interaction within the virtual mall in terms of pure shopping activities. However, it was possible to understand from the analysis and interpretation of the participants' comments that a virtual reality e-commerce environment provides a pleasant and rich shopping experience, which includes social elements of a physical one. Customers, apart from conducting pure commercial transactions, can engage in shopping-related activities of social nature, that are not available in a typical web store, such as browsing, window-shopping, moving around stores, seeing other shoppers, going shopping with others or socializing. Further research should include the evaluation of the interaction among customers within the virtual environment. Such a study would enhance our understanding on social dimensions of virtual reality shopping environments. In addition it would advance the evaluation of the effectiveness of a virtual environment for building trust and of the preference of such environments over conventional shopping sites.

7 Conclusions

Virtual reality emerges as a promising technology for a new breed of e-commerce applications that can address the critical need for integrating both technical and social aspects of online shopping. However, the research agenda on virtual reality applications for e-commerce is technology-focused and should be expanded to incorporate social and behavioral issues.

In this direction, this paper contributes by providing an empirical assessment of the potential of virtual reality shopping environments for building customer trust and gaining preference over web commerce sites. A prototype virtual e-commerce environment designed on trust-building principles was presented and evaluated with a qualitative study. The participants were experienced Internet users with a computing background. Such a profile might suggest bias in the results of the assessment, both positive, as it was easier for such users to use the virtual environment, as well as negative, as they were more demanding from average users. The study showed that a virtual reality shopping environment can deliver the functionality of a typical e-store with the expressiveness of a physical, face-to-face interaction thus allowing for a superior and trust-building online shopping experience. The analysis and interpretation of the results provided further insights as to how and why virtual reality environments for e-commerce can enable the building of customer trust and can be preferred over conventional web stores for online shopping.

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