

A 3D e-Commerce Applications Development Model: A Systematic Literature Review

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Abstract—Due to limitations of current e-commerce websites and today's highly competitive e-commerce environment, businesses using Virtual Reality technologies to improve customers' interactivity, by providing shopping experiences with their products and services similar to the real-life shopping, are better recognized. In this paper, the key aspects of 3D e-commerce research areas are investigated by using a systematic literature review approach. In the review, research areas such as design, trust, marketing, Augmented Reality and product presentation, business practices, interface quality, shopping experience and behavior as well as consumer learning along with other related issues are identified and discussed. A conceptual model is then proposed to highlight and provide insights for future research on how to develop a business model in 3D e-commerce environments.

Index Terms—e-Commerce; 3D e-Commerce; SLR; Business Model Development; Virtual Reality; Augmented Reality.

I. INTRODUCTION

The Internet services have become correlative of our daily life nowadays. Latest data of the Internet usage as stated by the Internet World Stats [1], the total number of Internet users worldwide becomes 3.1 billion by the end of December 2014, computed from around 42.4% of the total world's population and growth rate 753% from year 2000 to 2015. Consequently, an emerging technology evolution, and advances in computer Information Communication Technology (ICT), social media, and Web 2.0 leads to new innovations, improved business models for e-commerce such as social commerce [2] and 3D e-commerce [3]. E-commerce refers to the commercial activities that performed digitally, such as buying and selling of products and services. The goal of e-commerce is to reduce the cost, business expansion, and to improve customers' satisfaction as well as loyalty towards business providers.

Current 2D e-commerce Internet websites provide limited information for the users to access the available products and services because the websites have a simple interface based on pictures and texts. In this type of e-commerce, customers lack of real shopping experience as in a traditional brick-and-mortar. The main difference between e-commerce and conventional brick-and-mortar physical commerce is the digitization of the business transactions. Several problems are envisaged in 2D e-commerce website interfaces such as lack feeling of presence [4], interactivity [5], collaborative shopping experience [6], and ineffectiveness of trust formation [7], trust Management [8][9], and customers' unattractive interaction with products [10][11].

Nowadays, (ICT) improvement in terms of expanded network data transfer capacity, computing and the increasing ability of processing power lead to the development of the 3D Virtual Reality (VR) technologies [12]. These technologies are applied to the different applications such as education as well as learning and training [13], museums for virtual visits, architecture and virtual cities, virtual communities, as well as e-commerce and product visualization. These applications are categorized into two: non-immersion and immersion websites. Non-immersion websites display interactive 3D models of objects embedded into HTML 2D Web pages to allow customers to experience 3D models of products, for example, virtual car, virtual furniture, and virtual house. Therefore, users can manipulate and experience these 3D models from different angles of view. Immersion sites or multi-user environment is mainly based on 3D spaces, allowing the user to navigate in virtual space through their avatars as in the real environments. This category is suitable especially for simulation of business services like real life counterparts such as virtual city, virtual bank, virtual museum (Second Life) [14]. In an e-commerce domain, 3D e-commerce provides users a simulation of real store, 3D product models, and allows shoppers to navigate and experience shopping capabilities as in the real physical counterparts [15]. As stated by [16] there are a four periods in the VR development process diachronically from the 1950s to present, namely tele-presence, interactivity, connectivity, and synthesis. In the synthesis period, it helps businesses to synthesize immersive experience for users to create business opportunities that lead to increasing in sales figures and hence increase in profits. VR provides the future exploration of new technological applications in e-commerce domain by offering the hedonic shopping experience for users. Therefore, future research in e-commerce should be exploiting VR capabilities and functions to introduce an innovative new business model to different e-commerce applications such as Internet banking services to solve the challenges of conventional e-commerce websites including trust, shopping experience, interactivity and so on.

The objective of this review paper is to investigate the key aspects of 3D e-commerce research by applying the practice of "Evidence-based Software Engineering" (EBSE) for software engineering studies in Systematic Literature Review (SLR) [17]. The SLR methodology of the previous studies in 3D e-commerce was conducted for the period from 2005 to 2014 as part of e-commerce domain to be starting point of our research regarding conducting

business model of a 3D internet banking service as one of the business models in 3D e-commerce. This paper also proposed a business model for e-commerce applications by using a VR technology.

II. METHODOLOGY

As mentioned in [18], the main purpose of SLR is to synthesize the best quality scientific studies regarding specific research topics or research questions that lead to a methodologically rigorous review of research findings in the software engineering research. By conducting a SLR in the 3D e-commerce area, it will serve as research roadmap or initial stage that realizes the process of problem finding, which is a significant part of any research. A SLR involves five main steps as follows:

- The formulation of the research question
- Search process and inclusion and exclusion criteria of primary studies
- Quality Assessment (QA)
- Data collection and data analysis
- Results and interpretation

The details of QA, data collection and analysis have been extracted but not included in this paper. The processes involved in the methodology are showed below:

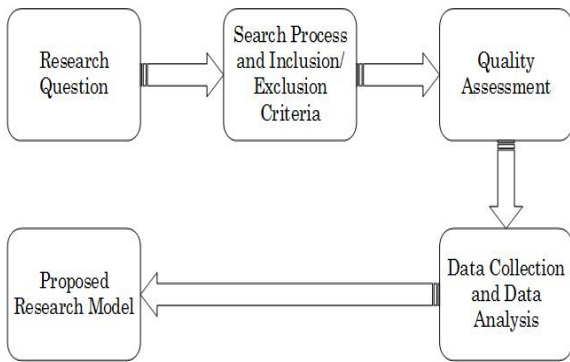


Figure 1: Research methodology processes for SLR

A. Research Question

To clarify the direction of SLR, the following research question is addressed:

- What topics of interest are evident in 3D e-commerce research?
- What methods do researchers employ to ground 3D e-commerce research?
- What is the theoretical background for 3D e-commerce research?
- Who is leading of 3D e-commerce research?

In this review only first question is considered. After answering the research question, a conceptual model of 3D e-commerce for developing a new business model in this emerging technology is proposed.

B. Search Process and Inclusion and Exclusion criteria

The search process in this study is a manual search based on web-based search engines as main tools for source collection. This paper focuses only on specific journal papers, conference proceedings, and book chapters for research scope between 2005 and 2014. Search strings to find related papers were used and apply inclusion and exclusion criteria for selected papers. The electronic version

of papers was saved in the EndNote X7 software [19] for easy access during the review. The following search engines are used from the UPM library [20] resources:

- Google scholar
- Science Direct
- Scopus
- IEEE Xplore, IEEE Computer Society
- ACM Digital Library

The articles were included if they contain the following criteria:

- Should be related to the 3D e-commerce research
- Written in English
- Should contain conceptual framework/model and/or experimental method for the research topic.

All studies not related to the above-mentioned criteria and duplicated papers for the same study such as paper published in conference proceedings and journal for the same issue were excluded, journal paper is chosen.

C. Quality Assessment

Each paper was evaluated based on the following quality assessment (QA) criteria:

- Does the study contain framework or model?
- Is the study employed an experimental method to validate the research problem?
- Is the paper employed 3D technique or prototype to process an experiment?

D. Data Collection and Data Analysis

The data were extracted from each study as follows:

- Classification of source type (journal or conference) and full reference
- Number of papers based on year of publishing
- Classification of the research area in 3D e-commerce
- Author affiliation details (name, institution, number of researchers, according to their countries)
- The research question issue and objectives
- The number of primary studies used in the paper
- Research areas in 3D e-commerce
- Types of method / experiment that are employed
- 3D techniques / software development tools that are employed
- Practitioner implications and contributions.

III. RESULTS AND DISCUSSION

In this section, the results of the research question were reported. After extensive review of the literature, research areas and issues are identified and discussed. Table 1 presents research study areas in 3D E-Commerce (2005-2014). In this table seven different research areas are highlighted. After answering this research question, a conceptual model of business practice was proposed (Figure 1) in order to contribute to the development process in 3D e-commerce research. The details of the research areas along with the issues are presented and described below:

A. Design

The design topic in 3D e-commerce is the first topic that researchers addressed especially in the early stage of the research. The 3D Web technology is based on 3D spaces that contain 3D models as well as the media content of 2D Web-based hypermedia. In this environment, users navigate

by moving in 3D spaces (e.g. walking, flying and teleporting) as well as hyperlinks. Also, there are additional interactive capabilities such as the manipulation of 3D objects [15]. Therefore, the development of 3D e-commerce applications require a new alternative technique, modifications, design approaches, and user modeling that is different from traditional design approaches in 2D interfaces in order to adapt and integrate such application. As a

Table 1
Research studies areas in 3D e-commerce (2005-2014)

No	Research Area	Issues
1	Design	Shopping Mall Design and Strategies Product Model Design and Retrieval 3D Web Frameworks and Architectures Recommendation Systems Reputation Management Trust Building
2	Trust	Product Presentation Presence and Social Presence Customer Service Representatives (CSRs) Brand Equity Interactive Marketing
3	Marketing	Consumer Product Preferences Virtual Shopping Consultants Innovation Management
4	Shopping Experience, Behavior and Consumer Learning	Designing Shopping Experience Social Presence and Perceived Security Consumer Learning About Products
5	AR and Product Presentation	AR Hand Gesture-Based Interface
6	Business Practice	Business Lead Users Business Value Creation Affordances and Capabilities Virtual Transactions Business Model Development
7	Interface Quality	Customer Service Interface Quality Quality Measurement

result, several issues are envisaged such as shopping mall design strategies, products models design and retrieval, 3D Web frameworks and architectures. Several researches have been conducted to address these issues on how to develop 3D e-commerce interfaces [21,22,23] as follows:

a. Design Shopping Mall Design and Strategies

Inevitability for using of 3D VR technology in present e-commerce websites lacks the real-life shopping experiences and multi-user interaction like brick-and-mortar shopping shops. New business models and new techniques for designing are needed to develop shopping malls in such environments. By addressing this issue, several studies proposed different approaches for designing VR shopping malls that tackle these problems. To provide consumers with intelligent services and advanced shopping experience for business activities, [21] proposed shopping mall design technique that integrates and adopts 3D virtual technology with current e-commerce shopping websites.

b. Products Models Design and Retrieval

Unlike conventional 2D product model based on picture-based design, 3D product visualization simulates product shapes and functions by exploiting the capabilities of VR technologies. Therefore, researchers proposed many 3D products modeling techniques so that customers can

experience such products in a realistic manner as in the real shops. One of these techniques is Cult3D technology for realizing the functions of displaying products in 3D format by 3D furniture models prototype [22].

c. 3D Web Frameworks & Architectures

The development process of 3D Web and architecture is more complicated than 2D Web architecture in term of design process. To develop an advanced Web3D e-commerce applications, researchers need to introduce a new 3D Web framework and architecture that can be integrated with the latest Web application technologies in order to provide effective and valuable Web 3D in e-commerce domain. By integration of 3D VR technologies and recent Rich Internet Applications (RIA) such as Flex, Sturts2, Spring, and Hibernate (SSH), [23] proposed framework for users' interaction and improvement experience with the web application.

B. Trust

The 3D e-commerce environments simulates real-life commerce sites which offers 3D space, product models, several communications capabilities, and avatars to represent a sale-person agents [3]. 3D e-commerce researches addressed the limitations of trust of the traditional e-commerce websites, including recommendation systems, reputation management, trust building, product presentation, presence and social presence, and Customer Service Representatives (CSRs) [7,8,24,25,26]. The following steps provide a detail description of each limitation:

a. Recommendation Systems

Traditional recommendation systems in a current E-e-commerce websites required user ratings and reviews for personalized product recommendation. However, these systems suffer from problems such as user motivation to provide ratings, and ratings given after purchasing stage before the user actually tried the product. Many techniques are proposed to solve such problems. [8] Proposed a prior rating technique by using 3D virtual shopping environment so that users can experience product prior purchase stage.

b. Reputation Management

To design an effective reputation mechanism in the 3D e-commerce environment, [7] proposed a five-sensory feedback oriented technique to simulate five-senses of humans and taking advantages of VR technology characteristics compared with the traditional reputation mechanism.

c. Trust Building

To examine the effectiveness of 3D interfaces for trust building, [24] proposed a prototype based on principles from an empirically validated model that shows 3D interface is preferred over the traditional online shopping websites for conducting shopping activities.

d. Presence and Social Presence

In complete virtual immersion Web shopping experience such as a 3D Web mall in the Active Worlds virtual environment, a study [25] indicates the presence and social presence factors that affect users' perceived ease of use and

perceived usefulness which in turn lead to the development of trust and intention of using 3D e-commerce.

e. CSRs

Consequent to the limitations of current traditional Live Help interfaces in the e-commerce websites that use text chatting and instant messages. [26] empirically demonstrates that using voice and 3D human avatar in such interfaces significantly increase customer's emotional and cognitive trust toward CSRs.

C. Marketing

3D VR is exploited as a marketing tool for performing marketing research because it provides a richer environment to conduct marketing activities and to get customers interactive and immersive experience over the conventional websites [27,28,29,30,31,32]. Issues related to marketing researches are discussed as follows:

a. Brand Equity

Businesses can use 3D VR technology for their brand promotion as a good opportunity to conduct marketing activities, taking advantages of a high degree of engagement, and richness of the environment. Therefore, their customer's experiences and engagements can enhance brand equity and intentions of shopping by using products and services associated with a brand throughout the simulation of real world's brands in the immersive virtual environment such as Second Life [27]. [28] Proposed a conceptual model to guide future research and industry practices on businesses by identifying the affordances of 3D virtual worlds for business brand value.

b. Interactive Marketing

By using 3D interactive marketing tools such as virtual spokes-avatar advertising, [29] investigates the improvement on the consumers' involvement, attitudes, and enjoyment of online shopping by using a real-life store prototype in the Second Life environment.

c. Consumer Product Preferences

To conduct marketing tests for physical goods in the real world's stores can be complex and costly. By making a 3D virtual product prototype as a marketing tool, manufacturers can obtain feedback about consumer product preferences [30].

d. Virtual Shopping Consultants

3D avatars, as the representation of human life characters, play a role of virtual shopping agents in the e-commerce websites. [31] empirically shows that avatars influence consumers' trust positively towards the product and service providers and effectively established trust on the Internet.

e. Innovation Management

VR offers an inexpensive and prototyping environment for real-life products that customer can experience compared with traditional websites. [32] uses case studies analysis of eight companies in the Second Life environment that suggested the VR can be used in innovation management in term of the new product development process.

D. Shopping Experience, Behavior, and Consumer Learning

Due to the weaknesses in the conventional e-commerce interfaces, users only navigate through by browsing many pages comprised of text, pictures, videos with lacking of shopping experiences as in the real shops, researchers of the VR technologies, develops new methods and technique for the consumer for virtual shopping experience, behavior, and consumer learning [5,9,33]. To develop interactive virtual experience in virtual environments, businesses should increase customer shopping experience by using the features and functions of VR technology that it is different from traditional shopping text and picture-based interfaces. Interactivity is the major component of VR, designing interactive virtual shopping experiences for consumers in such environments that businesses should pay attention in order to build interactive systems. [5] presents the concept and development of shopping experience 2.0 for improving interactivity that gives insights for future development of shopping experience by using the AR tool in virtual apparel shop prototype. [9] empirically shows that the impact of social presence of establishing individual's behavior in the 3D shopping mall. [33] demonstrates that 3D virtual interface enhance consumers learning about products, this study proposed a model to investigate whether VR enhance consumer learning about the products according to product type, the results support the predictions that VR interfaces increase overall consumer learning about the products.

E. Augmented Reality and Product Presentation

The Efficiency for product presentation in e-commerce websites is becoming increasingly significant. AR technologies change the way of the presentation of products. Therefore, it provides more detailed information and accuracy of product presentation during the user interaction with products than ordinary 2D interfaces, allowing users to experience a 3D product model in order to enhance system's usability. AR uses certain tools to enable full interaction with the 3D product model. By using AR hand-based gesture, [34] proposed system prototype for the virtual furniture shop which users can experience and control image by using their fingers.

F. Business Practice

Business practice models in 3D e-commerce need researches for evaluation of these models of different aspects of the development process [35] [36] [37] [38] [39]. [35] Proposed a framework for extending the lead users' business concept of the VR context. By applying this framework to the 20 pioneer companies' interfaces in Second Life virtual worlds, they identified a three lead user, namely: site developer, business firms, and avatars (users/customers). The framework used four assessment components to evaluate businesses such as virtual agents for trust, Tele-presence for sense of presence, interactivity for providing offerings and navigation aids, and also flow for users' sense. [36] Proposed framework to evaluate business value creation in VR based on the decision - tree method for guiding business strategy and business operations improvement. [37] Proposed a dynamic business model development process that deals with technical problems, environmental factors, revenue models, and sustainability of the business. [38] Identified habitability

and the appearance of realness as evidences of VR, demand for specialized skills and knowledge as a constraint. To conducting virtual transaction in 3D environment, [39] proposed a click-through model for implementation of virtual transaction (V-transaction) by directing it throughout a traditional Internet in order to solve problems associated with full implementation of transaction in such environments.

G. Interface Quality

Insufficiency of conventional websites interfaces that lacking simulation of the face-to-face interaction which can

be solved by using 3D VR technology in order to improve interface quality and increasing user satisfaction. As 3D e-commerce is a new platform of e-commerce application, the users of such interfaces require adequate quality factors to increase their experience as well as interface usability. To satisfy a suitable criteria for developing a quality interfaces in VR environments as a guideline for design development. Throughout user experience of customer service interface, [40] identified the quality factor measurement, according to the priority order of those factors for designing highly interactive user interfaces by using intuitive approach and focus group technique.

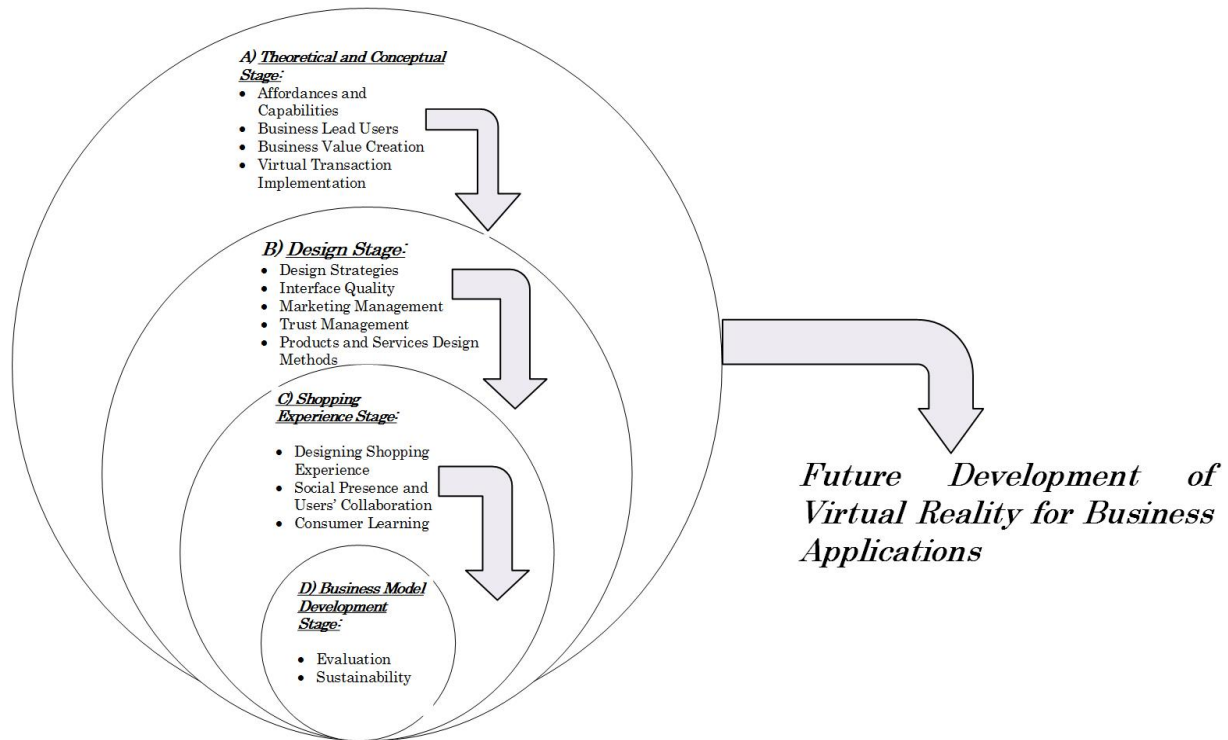


Figure 2: The proposed research model for 3D e-commerce business applications

IV. PROPOSED RESEARCH MODEL

Figure 2 shows the conceptual model of 3D e-commerce application development process adopted based on the previous research studies in SLR finding which are identified and discussed in section 3. The goal of the proposed model is to help, guide developers and businesses practitioners on how to develop a business model. The proposed research model is comprised of four stages, namely: theoretical and conceptual stage, design stage, shopping experience stage and business model development stage. These stages are adopted from the seven research areas in Table 1. The four stages are discussed as follows:

A. Theoretical and Conceptual Stage

The theoretical stage should be the first stage because it requires developers as well as business practitioners to understand what is the suitable theoretical background for certain business model, e.g., theories such as flow, presence, and Media Richness, are used as conceptual guidelines for designing components to develop a Human Computer

Interaction (HCI) interface, which explains how user experiences and behaves in this interface [6].

This phase consists of four issues: affordances as well as capabilities, business lead users, business value creation, and virtual transaction implementation. For the affordances and capabilities, developers specify suitable features and functions in order to develop a certain business model and application. For the business lead users, developer of the business interface should identify the business lead users, which include the site developer, business firms, and avatars [35]. The site developer represents the website operator who hosts and maintains the business platform; however, website operator should have an adequate experience in the development of VR technology applications such as Second Life virtual reality technology provider. Regarding the business firms, developers should recognize the need for conducting virtual reality business for these firms in terms of expanding business activities, and increasing the potential customers. The avatars represent the business firm's consumers that use the business application website. Similarly, the developer should recognize the consumers' needs such as a virtual experience, excitement, and creation

of their avatars. The needs of business firms and consumers as well can be possessed by conducting preliminary studies before actual experimental design. The business value creation process requires to the potential benefits that businesses will gain from establishing their 3D e-commerce interfaces. However, this will lead to maximizing business profits. The implementation of the virtual transaction in 3D business interface is a barrier to achieving complete virtual transactions like in traditional e-commerce websites. Therefore, developers should find proper ways to tackle these barriers such as directing such transactions to business's conventional websites [39].

B. Design Stage

This phase is made up of five issues: the design strategies, interface quality, marketing management, trust management, and product as well as service design methods because these issues are related to design process as major components. Therefore, developers, as well as business practitioners identify these issues along with their components in order to develop a practical business model that facilitate and support different types of e-commerce applications such as B2C e-commerce. For the design strategies require a proper design strategies and approaches by selecting a compatible design technique based on the recent VR technologies to develop the user interface that give users interactive experiences by exploiting the main features and functions of such technology. Also, a selection of acceptable design category for the user interface, namely, full immersion or non-immersion categories depending on the e-commerce application type [15]. The identification of user interface quality factor measurements to satisfy user's needs and interests. The marketing management requires choosing convenient marketing tools to ensure user engagement and interactivity. Similarly, identifying trust management techniques in order to get user's trustworthiness of such interface. Finally, regarding product and service design methods, developers should select the suitable product and service design methods according to the product as well as a service so that different design types can be developed.

C. Shopping Experience Stage

This phase consists of three issues: designing shopping experience, social presence as well as user collaboration, and consumer learning. After the design phase, business practitioners and developers as well need to evaluate the user shopping experience, ensuring customer satisfaction of the interface, guidelines to facilitate consumer learning, to make appropriate collaborative and social presence of users in such interfaces.

D. Business Model Development Stage

The last phase of the model development process adopted from the business practice issues (Table 1.), which is a dynamic and continuous process, and due to the rapid nature of VR technology development, developers, as well as practitioners should evaluate and address the issues that arise from actual use of the system such as technical and legal problems in order to ensure the sustainability and efficiency.

V. CONCLUSION

The 3D e-commerce applications are the promising and complementary part of today e-commerce domain. In this paper, SLR related to 3D e-commerce was conducted. The seven areas of research, comprising of design, trust, marketing, AR and product presentation, business practices, interface quality, as well as shopping experience, behaviour, and consumer learning along with other issues are identified and discussed. A conceptual model for the development of 3D applications in 3D e-commerce is proposed. The proposed model is appropriate for conducting 3D e-commerce applications; however, it provides comprehensive design stages along with issues in comparison to other 3D e-commerce application for future development of various types of business application. On the other hand, in comparison with the recent types of e-commerce such as social commerce, the proposed model will be more effective and efficient in terms of user experience. In the future work, we intend to apply this model to develop Internet banking business model in VR environments.

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