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Using Structural Equation Modeling to Propose a Model for Shopping Complex Design Based on Universal Design Concept

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Abstract: Universal design (UD) is a design style that promotes the design for all people regardless of their abilities and sociodemographic features. The UD is also viewed as an element of social sustainability. Shopping complexes, as one of the main places for leisure activities, can be designed and assessed based on UD to enhance the usability for all shoppers. At present, no clear definition of UD is available in shopping complex design criteria. Consequently, a very limited number of design and assessment guidelines are based on UD. The present study remedied this shortcoming in knowledge through translating and defining the conceptual components of features of UD for shopping complexes. The contribution of shopping complexes' design elements also was identified. The aforesaid objectives were achieved through a comprehensive literature review. The findings of this review contributed to the development of conceptual models to define UD in shopping mall design. This study administrated a questionnaire to collect data, and the data were tested for model fitness using structural equation modeling. The UD translation can help practitioners and researchers to design and assess the shopping complexes to ensure all shoppers are served on an equal basis.

Keywords: universal design; shopping complex design; shopping complex assessment; structural equation modeling

1. Introduction

Shopping is a social experience and practical necessity for many shoppers [1,2] and it has been noted that the shopping environment might affect the shopper behaviors [1,3]. Shopping complexes are popular places for both the city's inhabitants and visitors [4]. Since the shoppers vary in terms of age, gender, and physical condition [1,5], it is crucial to design shopping complexes that serve individuals regardless of their personal characteristics and physical abilities.

In recent decades, various design ideas came to the theory and practice of architecture in order to serve people based on non-discriminatory criteria. To end discrimination against people with disabilities (PWDs), regulations such as the American with Disabilities Act (ADA) was enacted. While this act benefited people with disability [6], full accessibility for this population is not yet achieved in shopping complexes. Concerning the theory, a limited number of architecture studies consider the variability of the users of public buildings, particularly shopping complexes. In fact, the literature mostly assumes shoppers without disabilities in the design and theorization of shopping centers.

The present study uses universal design (UD) to propose a platform for the design and assessment of shopping complexes. In other words, this study attempts to define the characteristics of UD in shopping complex design. UD is widely viewed as an important component of social and environmental sustainability [7,8]. Universally designed environments support and enable people

to sustain their life by increasing their inclusive community involvement and nurturing their social development. UD is in line with other sustainable design solutions such as the circular economy which creates multiple shared advantages so that both solutions attempt to improve the flexibility in the use of spaces and make them equally efficient under all circumstances [9,10]. UD is also widely applied in the planning for sustainability in general, and to create a smarter, greener, and more livable future in particular [11]. To this end, sustainability research considers UD as an integral component of energy efficiency planning in the buildings and study the comfort as a common ground between UD and energy efficiency [12].

To the best of the authors' knowledge, the existing body of knowledge does not sufficiently cover the application of UD and its principles in designing and improving shopping complexes. In fact, there is no clear definition of UD in the shopping complex design criteria; consequently, no design and assessment guidelines are based on this concept. According to the literature and experts' opinions, this study proposes UD conceptual models for shopping complexes. The proposed conceptual models then are tested for fitness using the structural equation modeling (SEM) method. To conduct this effort, the study is structured as follows. The following section reviews the UD definition and its principles, translates the general concept of UD into the shopping complex design criteria, identifies the main characteristics of UD for shopping complexes, and identifies the contribution of shopping complex design elements in the main aspects of UD for shopping complexes. In the following sections, the modeling methodology and case study are presented. The paper is concluded with discussions, limitations, and recommendations for further research.

2. Background

2.1. Sustainability and Universal Design

Sustainability is a crucial principle of design in the present century. Three main aspects of sustainability are economic, environmental, and social. The social aspect of sustainability received less attention, despite its potential importance. The impacts of the environment on the human quality of life can be discussed in the context of social sustainability. Hence, creating built environments that adhere to the social sustainability principles through smart planning and design should be emphasized in the discussions of mainstream sustainability. Sustainable design is considered as a guiding concept to create the built environment that "meets the needs of the present without compromising the ability of future generations to meet their own needs" [13]. In addition, the social sustainability supports the cultural and social life, as well as social amenities through combining the design of the social world and the design of physical realm [14].

Recently, UD is regarded as an idea that might help sustainable design goals through enabling the built environment to cater the present user's needs and sustain the inclusivity for future communities [15]. According to Duncan [8], UD creates a supportive and enabling environment which promotes inclusive community involvement and fosters social development; thus, it can be viewed as an element of social sustainability. A universally designed built environment also enables people to be actively involved in the community over the lifespan [15]. Respecting the principles of social sustainability and introducing universally designed elements into built environment spaces can have a significant impact on increasing the level of involvement and integration of users and residents, through ensuring flexible and adaptable spaces designed for all users and for different activities.

2.2. Universal Design in Shopping Complex Design

Universal design is a design style that attempts to serve a wide range of users irrespective of their abilities and sociodemographic features [16]. In 1997, the Centre for Universal Design with the cooperation of a group of American experts developed the UD and its principles. The UD principles aimed to guide the design process and educate both designers and consumers on the features of usable design solutions [17,18]. UD covers a wide range of non-discriminatory design approaches

in architecture, automobiles infrastructure, information technology, and urban environments [19,20]. In terms of architecture, the UD sought to achieve two main goals: First, to provide unhindered circulation for all people and, second, to provide full accessibility to different spaces and furniture for people with various abilities.

At the scale of public spaces, the aim of UD is to provide people with an inclusive environment that accommodates everybody regardless of individual's characteristics; in other words, everyone should be a part of society while using the public buildings [21]. This inclusiveness can be achieved by providing people with a built environment, information, and services that are responsive to evolving human diversity [22]. In large urban centers, shopping complexes are the most important places for leisure activities. The UD, as a holistic approach, ensures that all shoppers are equally welcome and that all people can use the shopping complexes' facilities with no stigmatization. In fact, integrating the UD and its principles into the design process enhances the life quality of shoppers, improves flexibility, and provides autonomy [22]. The seven principles of UD are defined as follows: (1) Equitable use; (2) flexibility in use; (3) simple and intuitive use; (4) perceptible information; (5) tolerance of error; (6) low physical effort; and (7) size and space for approach and use [17].

The usability and non-discriminatory aspects of universal design involve certain UD principles such as equitable use, flexibility in use, simple and institutive use, and perceptible information. One of the main goals of UD and its principles is to avoid special designs for people with a disability which can segregate them from the others.

From a general viewpoint, the usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [23]. Architecturally, Afacan and Erbug [24] defined usability as "making buildings and facilities as universally usable as possible for everyone, rather than for the vast majority of a target population". The overarching goal of the usability feature is satisfaction; thus, it is essential to determine the design elements influencing the satisfaction of users of public buildings, especially shopping complexes. Various guidelines and studies have noted design factors and elements involving elevators, ramps, pedestrian pathways, doors, signage, benches and waiting areas, toilets, car parks, ATM machines, public phones, and flooring material. Accordingly, these elements have affected the usability of shopping complexes and satisfaction of their users.

The shopping complexes should be accessible to all people especially those with the disability. However, the existing definitions of accessibility might segregate and stigmatize the users of such buildings. The current definitions of "accessible design" consider prescribed codes and specialized designs for disabled people that might reflect the discriminatory image of design [17,25–27]. To this end, the UD concept and principles attempt to design products and environments that are usable by the broadest possible number of people. Integration of usability and accessibility features from the beginning of design is crucial to properly implement the UD principles [28]. This integration can remove the stigma and yield the social inclusion of the greatest diversity of users. Using firm and non-slip surface to maintain shopper's movement is a relevant example of incorporation of usability and accessibility features, especially at the beginning of shopping mall construction to benefit diverse users, such as wheelchair users, seniors, and children.

The principle of "tolerance for error" refers to the safety aspects of design. Based on Crews and Zavotka [29], the sense of safety among the people with diverse abilities would be improved by implementing the UD and its principles. Safety provisions make the urban life and spaces more inclusive, easy, and enjoyable for all members of society [30]. Concerning the safety provision in shopping complexes, Afacan and Erbug [24] translated the principle of "tolerance for error" into an attempt to minimize the hazards and errors of the designs. Therefore, the safety can be classified into two main types in shopping complexes: (1) Safety from falling and (2) safety from crime. Safety from crime refers to those elements of the shopping complex that increase the sense of personal safety and reduce the fear of crime among shoppers. On the other hand, safety from falling involves design

factors that can reduce the risk of falling and injury among the shoppers. Appropriate design of elements such as stairs, hallways, and corridors can help to reduce the abovementioned risks.

The UD principles of "low physical effort" and "size and space for approach and use" refer to the comfort aspects of design. Based on Almusaed [31], comfort in architecture is defined as "the sensation of complete physical and mental wellbeing". This so-called wellbeing can be achieved if a high level of ease, convenience, and contentment are provided to the users. The comfort might include the attractiveness features of design that invite the people to use the product of interest. With regards to shopping complex design, the elements of design should minimize the sustained physical effort and the important elements should be in the line of sight for any user, whether seated or standing. The shoppers also should be provided by a clear space for an approach to the design elements [24]. It worth to note that comfort aspects of design might have a certain overlap with usability aspects since, if the design is usable to a variety of users, then it provides a level of ease to the same users. Various design elements might contribute in providing a level of comfort in the shopping complexes, including escalators, and architectural and graphical wayfinding. Table 1 presents the UD definition in shopping complex design and its design aspects, as well as the design recommendations based on UD principles implementation.

Table 1. Universal design characteristics in shopping complex design.

Statements	Definitions
Universal design in shopping complex design	The shopping complex should serve all visitors and shoppers regardless of their physical abilities and backgrounds. The design of shopping complex should be usable, safe, and comfortable to all shoppers.
Aspect I: Usability	The shopping complex and its facilities is usable by all shoppers regardless of the shoppers' abilities and preferences. Main aspect aim: To provide equal access and use to all shoppers (PWDs, seniors, children, and people with strollers/boxes). Design recommendations The design should not segregate of stigmatize any shoppers. The design should be attractive to all shoppers. Alternative methods of use should be provided to the shoppers. The design should be simple and easy to understand/use for the shoppers. The essential information should be presented clearly, legibly, and in a number of formats to the shoppers.
Aspect II: Safety	The shopping complex is a safe environment for shoppers. Main aspect aim: To maintain the shopper's movement and prevent from falling or conflict. Design recommendations The design elements of shopping complex should minimize the risk of falling. The shoppers should be provided with hazards warning signs or signals.
Aspect III: Comfort	The shopping complex design is attractive to shoppers and provides level of ease, convenience and contentment to them. Main aspect aim: To improve the level of ease and comfort of shoppers. Design recommendations The furniture should allow the shoppers to maintain a neutral body position. The design elements should minimize the continuous physical effort of the shoppers. All shoppers whether seated or standing should be able to reach and use furniture and facilities. All facilities should have sufficient maneuver space to be used by those who use assistive devices.

2.3. Shopping Complexes' Design Elements

2.3.1. Circulation Elements

Stairs were the primary mean of shopper's vertical movement within the different levels of shopping complexes. However, in the recent shopping malls (those built in the last 30 years) escalators have become substitutes for the stairs; and instead, the stairs are used for emergency evacuation. A standard escalator provides an equal opportunity and avoids any segregations for vertical movement for people with different ages and genders [8,32]. However, for people with assistive devices like a wheelchair, and those who carry a stroller or boxes, it might be more usable to use the elevators. In addition, escalators can improve the level of ease and comfort of circulation by minimizing the need for stepping on the stairs.

Elevators complement the escalators and staircases, through providing an equal opportunity to PWDs, seniors, and people with stroller/boxes to move within the mall levels [8]. The separate provision of elevators and escalators allow the elderly to have a chance for travel to another level corresponding to their physical ability [33]. The elevators also improve the level of comfort among shoppers from different ages and physical abilities in several ways: (1) The elevators with sufficient dimensions provide adequate space for those who use assistive devices; (2) any seated or standing shopper can use and reach the elevators when the buttons are installed in proper height; (3) the elevators can minimize the sustained physical shoppers by minimizing the need for stepping [34]. The risk of falling for shoppers with assistive devices, stroller, or boxes can be minimized by substituting the use of stairs and escalators with elevators.

Ramps are normally installed at the areas with a significant change of levels and can provide a soft transition within the levels. Thus, it facilitates the vertical and horizontal transition to wheelchair users, parents with a stroller, and shoppers with bags/boxes [35]. Apparently, it might prevent from falling due to floor leveling.

Hallways and corridors are the most important design elements of indoor circulation. Corridors with sufficient width facilitate the circulation by providing sufficient space for easy passage of shoppers whether they walk or use assistive devices such as walkers and wheelchairs [36]. Proper illumination and flooring materials (distinguishable and non-slippery) also make it easy for people with disability and seniors to easily circulate within the corridors and hallways [37]. The abovementioned features of the usable hallways and corridors provide a level of ease and comfort for people with different abilities. These also help the shoppers to avoid any conflicts between the shoppers and minimize the risk of falling of people with disability (e.g., those with visual impairment and wheelchair users), seniors, children, and parents with a stroller.

2.3.2. Entering and Exiting Elements

Doors in entering/exiting areas are the passages from outside to inside, functioning as important elements in the shopping complex. A desirable design of these areas can facilitate equal, safe, and easy entering/exiting of the shoppers. The three main design elements of these areas are the appearance of doors, path of travel to the entering/exiting doors, and maneuvering space of entering/exiting areas. The appearance of the doors is important, since it helps to distinguish the main door and to differentiate the entering and exiting doors [36]. These can be achieved through providing cues, particularly multi-sensory ones such as tactile design properties [36,38]. These sensory cues can provide equal access and use to the entering/exiting doors to people with visual impairments and other shoppers alike. Apparently, these cues make it easier for all shoppers to distinguish and use the doors. In addition, the conflicts between the shoppers can be minimized, if the cues show the differences between doors and prevent the exiting shoppers to use the entering doors and vice versa.

A path of travel to the entering/exiting doors that is free from level changes, obstructions, and is perceptible by all shoppers facilitates access to the doors. An even path provides an equal opportunity to all shoppers including PWDs, seniors, children, parents with strollers to access the doors. The path

should be unobstructed to not impede the shoppers to use the path and doors which provide a higher level of comfort and safety [36]. The path is safer if the risk of conflicts between the shoppers is reduced, and this can be achieved through removing the barriers on the path that hamper the movement of shoppers.

Maneuvering through the entering/exiting doors is critically important, particularly for those who use the assistive devices or their hands are occupied. The use of automated doors provides greater maneuver opportunity to the shopper and allows them with different abilities to get through the doorways [34]. Thus, the entering/exiting doors can be more usable, comfortable, and safe to all users when automated doors are installed.

2.3.3. Wayfinding Elements

The wayfinding elements help the shoppers to easily determine their current location and intended destinations. The ease with wayfinding prevents shoppers from feeling frustrated, stressed, and increases the mall's functional efficiency, usability, accessibility, and safety. The wayfinding elements can be divided into architectural and graphical [36]. The architectural and spatial elements include paths, markers, nodes, edges, and zones. The graphical wayfinding including texts, pictograms, maps, photographs, and diagrams. An understandable signage within shopping complex provides usability to the shoppers in several ways: (1) It eliminates the complexities of wayfinding, (2) it provides information to people with a wide range of literacy and language skills, (3) it maximizes the legibility of essential information, and (4) it provides the information in different methods including pictorial, verbal, and tactile. The wayfinding elements within the shopping complex also provide the shoppers with warnings of hazards. Thus, these elements contribute in the safety aspects. In addition, these elements warn shoppers about any directional change [39]. The proper wayfinding elements can also improve the comfort level of shopping by preventing any repetitive actions as well as sustained physical efforts by the shoppers.

2.3.4. Obtaining Products and Services

Easy product and service access are the ultimate goal of any shopping complex. This easiness can be achieved by designing proper service desks, waiting areas, and machines. Service desks provide an equal opportunity to all shoppers to have a sustainable relationship with the people at the service desks who provide the shoppers with help in meeting their needs during the shopping [36]. The service desk contributes to the usability of the shopping malls in several ways, including: (1) A proper design of service desks can be appealing to all users; (2) it can minimize the unnecessary complexities; and (3) it serves equally the physically enabled people and wheelchair users (same contribution to comfort alike). A universally-designed service desk also contributes to the comfort aspect of design in two ways: (1) It provides sufficient space for the use of assistive devices, and (2) it is easily reachable by seating and standing shoppers and allows them to maintain their neutral body position. Insufficient knee space of service desks can force the shoppers to wait or obtain their services in contorted postures, and create bumping hazards to the shoppers (safety aspect) [24].

The waiting area provides convenience, safety, and privacy to the shoppers during the time of waiting to have services and products from the shop malls [36]. To be usable, the waiting area and its furniture should be appealing to all shoppers, and the design should be in a way that can be used by people with disability. To be safe, the waiting areas should be located within the circulation path of shoppers and this prevents shopper conflicts [38]. A comfortable waiting area and its furniture should provide enough space to assistive devices users like a wheelchair. It also should provide a high level of ease to all shoppers to use the furniture within the waiting area [40].

2.3.5. Public Amenities

The main goal of public amenities such as the restrooms is providing comfort and enjoyment to the shoppers [41]. A restroom with appropriate size and dimensions provides accessibility to different

users [39]. The restroom elements should be installed in a proper height to provide accessibility for people with disability and children, in order to reduce the risk of falling [24]. These elements provide equal access and use to all shoppers. A universally-designed public telephone with proper dimension and size, as well as accessible features, enable people with diverse abilities and ages to use these facilities. Placement of a shorter/smaller water fountain next to the normal drinking fountain provides accessibility to the children and people with disability. The sitting areas with proper size provide accessibility to people with different abilities, since the area is appropriate to the shoppers' circulation.

Given the relationship between the general concept of universal design and shopping complex design criteria, the present study identifies a wide range of shopping complex design elements that contribute to each UD aspect. This study derives 13 design elements based on grey and peer-reviewed literature. Table 2 presents a list of the selected design elements as well as their contribution to the identified UD aspects. Table 2 can also be used as a base for developing UD conceptual models for shopping complexes.

Table 2. Selected design elements and their contributions in universal design aspects.

Design Elements		Contribution(s) in UD Aspects
Stairs	Usability	Sufficient width of stairs allows all people to equally use the stairs [42,43].
	Safety	Stairs with tactile pavement, non-slippery surface, and handrails might prevent people from falling. Sufficient width of stairs prevents people from conflicts [42,43]
	Comfort	Sufficient width of stairs allows easy passage for people [42,43]
Elevators	Usability	Proper height of elevator buttons provides equal access and use to all people. Using brail characteristics on the buttons along with audible signals allow people with visual impairments to equally use the elevators [42,43]
	Safety	Proper height of elevator buttons allows wheelchair users to maintain their normal posture and prevent them from falling due to stretch to reach the buttons [42,43]
	Comfort	Elevators with sufficient dimension and size allow people to easily carry their trolley and boxes into the elevator [42–44].
Escalators	Usability	Sufficient width of escalators allows all people to equally use the escalators [45,46].
	Safety	Good lighting and color contrast in escalators define edges or boundaries of objects and minimize tripping hazards and aid in safe navigation by all users [45,46].
	Comfort	Sufficient width of escalators allows faster people to go around [46].
Ramps	Usability	Ramps must be installed at any significant change in level to serve wheelchair users and people with visual impairment and others alike [26,47].
	Safety	Ramps with sufficient width and slope, as well as handrails, allows an easy passage without any conflicts. The people with a disability also can grasp the handrails and minimize tripping hazards [26,47].
	Comfort	Ramps with sufficient width and slope, as well as handrails aid to all people to move easily [26,47].
Hallways and Corridor	Usability	Hallways and corridors with sufficient width allow all people to pass each other [48].
	Safety	Hallways and corridors with sufficient width minimize the risk of conflict among the people [48].
	Comfort	Hallways and corridors with sufficient width allow people (e.g., wheelchair users, people with trolley) to pass each other comfortably [48].

Table 2. *Cont.*

Design Elements		Contribution(s) in UD Aspects
Doors Appearance	Usability	Entrance doors with sufficient width allow all people to pass each other [48].
	Safety	Entrance doors with sufficient width minimize the risk of conflict among the people [48].
	Comfort	Entrance doors that use audio clues and artificial lighting make it easy to distinguish the entrance doors from the rest of the building [48].
Path of travel to the entrance or exit doors	Usability	An unobstructed travel path to the entrance doors allows all people to reach the doors [48].
	Safety	An unobstructed and free of level changes travel path to the entrance doors minimize the risk of collision and tripping [48].
	Comfort	A travel path to the entrance doors that use a change in the surface texture of pavement helps people with visual impairments to easily find the entrance doors.
Maneuvering space of entrance or exit areas	Usability	Entrance doors with sufficient width allow wheelchair users, people with visual impairments; parents with strollers and those with walking aids to equally maneuver. Providing automatic doors can also make buildings easy to access and useable for everybody.
	Safety	Providing automatic doors can prevent wheelchair users from collision due to stretch to reach the handrails [48].
	Comfort	Entrance doors with sufficient width allow wheelchair users, people with visual impairments; parents with strollers and those with walking aids to easily maneuver. Providing automatic doors can also make buildings easy to access and useable for everybody.
Architectural wayfinding	Usability	Easy to understand and well-designed paths, markers, nodes, edges, and zones improve the usability of buildings by easier determination of current location and intended destinations [36].
	Safety	Handrails as edge features help people with disability particularly those with visual impairments to maintain their movement and minimize tripping hazards [36].
	Comfort	Easy to understand and well-designed paths, markers, nodes, edges, and zones make it easy for different people to determine their current location and intended destinations [36].
Graphical wayfinding	Usability	The signage that present information using tactile, audible, and visual is usable, informative, simple, and easy to understand to all [43,49].
	Safety	The signage improving the safety of the buildings by warning people of potential hazards [43,50].
	Comfort	The signs with proper height and accessible locations make it easy for both standing people and wheelchair users to use the signage by considering their angle of vision [43,50].
Service desks	Usability	A universally-designed service desk with different heights and proper illumination is usable, accessible, and understandable to all people in general and wheelchair users and people with visual impairments in particular.
	Safety	A universally-designed service desk with sufficient knee space prevents people from contorted postures and create bumping hazards to the people.
	Comfort	A service desk with a proper location is easy to find from key internal circulation routes provides. In addition, a universally-designed service desk with sufficient knee space might provide comfort for wheelchair users [51].

Table 2. *Cont.*

Design Elements		Contribution(s) in UD Aspects
Waiting areas	Usability	Waiting areas with proper dimension and size provides sufficient space for wheelchair users as well as others. Well-designed waiting areas that use a different style of seats can suit different people. Well-designed waiting areas that provide visually contrasted seats can help people with visual impairments to distinguish the seats from surrounding surfaces.
	Safety	The waiting areas with proper dimension and size prevents any conflicts among people [51]
	Comfort	Waiting areas with sufficient space for wheelchair users make it easy for them to pass each other. Well-designed waiting areas that provide visually contrasted seats can help people with visual impairments to easily distinguish the seats from surrounding surfaces.
Restrooms	Usability	Restrooms with proper dimensions that are facilitated by handrails are accessible to people with diverse abilities [44,45].
	Safety	Availability of handrails in restrooms minimizes tripping hazards [44,45].
	Comfort	Restrooms with proper dimensions that are facilitated by handrails make easy for people with various abilities to use the restrooms [44,45].

3. Methods

The research gaps of the current study included a lack of studies on UD translation into the shopping complex design criteria, lack of studies on significant design elements of the shopping complex, and lack of studies on the contribution of design elements to UD aspects. To fulfill these gaps, the authors used a three-step approach which is shown in Figure 1.

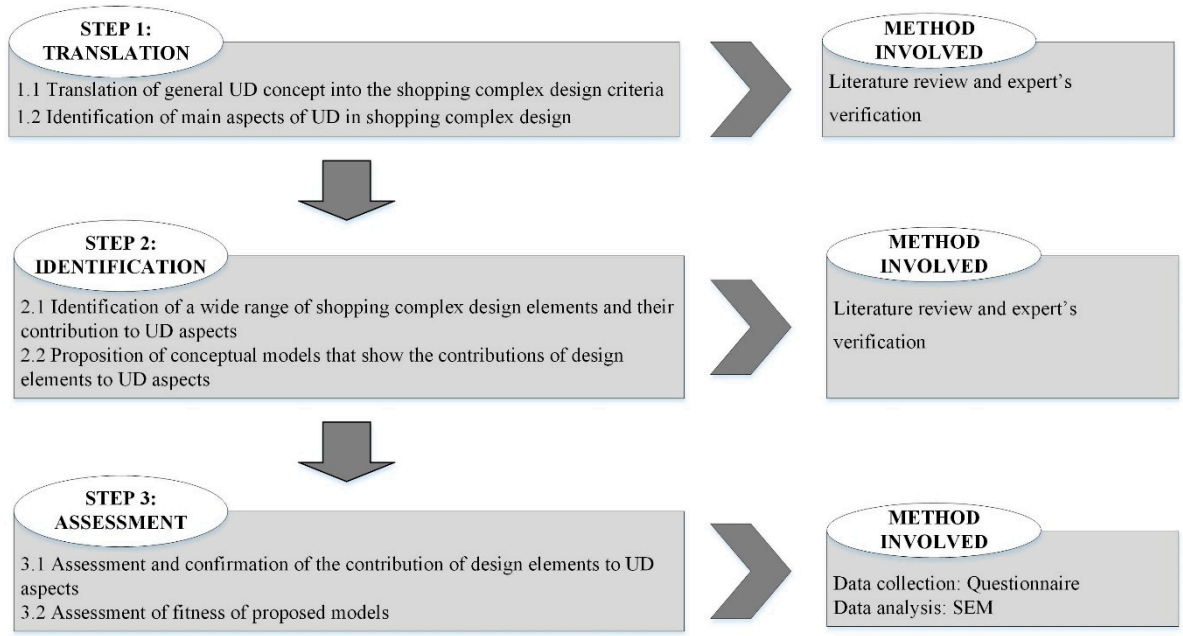

Figure 1. Universal design (UD) steps to fulfill the research gaps.

The present study conducted a literature review to first, translate the general definition of UD and its principles into the shopping complex design criteria; and second, to identify the widest range of design elements of shopping complexes and their contributions to the UD translated. The authors used expert opinions in two rounds. In the first round, the UD translated and the design elements identified were sent to a panel of experts who were asked to read and discuss the translations and the design elements. They were instructed to comment on each translation and design element, as well as to identify important elements that were missing or should be deleted. Thus, the authors made some

modifications based on the expert's comments. For example, in terms of UD translation and the new categorization, a number of unclear definitions (e.g., definitions of usability and comfort) were clarified to create a comprehensive theoretical classification. Concerning the design elements and their contribution to the UD translated aspects, the experts suggested that we add a number of design elements (e.g., stairs) to the list. The experts also considered more contributions of design elements to the UD translated aspects (usability, comfort, and safety). In fact, the experts confirmed that all the design elements identified have contributions to all three aspects of usability, comfort, and safety.

3.1. Survey

After revising the UD translations, design elements, and the contributions in light of expert's comments, the authors designed a questionnaire to assess the association between the observed variables (design elements) and the latent variables (usability, comfort, and safety) in the UD translated conceptual models (Tables 1 and 2). The questionnaire included two main parts. In the first part, the personal information and sociodemographic status of respondents were collected. In the second part, the level of agreement with statements related to the UD translated models was assessed. The 39 statements assessed the contribution of the derived design elements to the three aspects of UD translated, including usability, comfort, and safety. The respondents were asked to indicate their level of agreement with the attitude statements using a 1 (strongly disagree) to 5 (strongly agree) Likert scale. The questionnaire did not include open-ended questions. The respondents were among the shoppers who do shopping frequently in the selected shopping complexes. Hence, only randomly selected shoppers who did shopping frequently in the selected shopping malls were selected as respondents.

Once the questionnaire was designed, it was validated by the experts and suggestions were applied accordingly i.e., the wording for some of the statements was modified to clarify the unclear statements. Concerning the questionnaire administration, the experts asked the research team to explain the UD definition and its aim to the respondents. It should be clear for the respondents while answering the questionnaire that the main aim of UD in shopping complex design is to design and build a shopping complex that serves all shoppers regardless of their abilities.

The questionnaire was originally proposed in English and translated into Kurdish by the language experts proficient in both Kurdish and English. After the translation of the questionnaire, a pilot study was conducted to test the communicability and practicability of the questionnaire. Thus, the questionnaire was pilot tested among 34 individuals. The authors made minor modifications to clarify the unclear statements and added image guidance to some statements.

The research team conducted the survey in six shopping complexes of Sulaymaniah-Iraq. The field observations of the team showed that the shopping complexes of Sulaymaniah suffer from poor universally designed elements. For example, some of the stairs within the shopping malls lack handrails and elevators lack maneuvering space. The restrooms also are not designed to be used by the people with disability. In addition, the shopping malls lack tactile pavements, and many flooring materials are slippery. The authors provided a list of shopping complexes in Sulaymaniah, then six shopping malls were selected randomly, namely Family Mall, Majidi Mall, City Center Mall, City Star Mall, Kaso Mall, and Rand Gallery Mall.

The research team conducted the survey between December 2018 and February 2019. The data collection team included six students who were enrolled in an architect course. The students were familiar with the UD concept and its importance in the design of shopping complexes as it was widely discussed and taught in the related courses. The students were grouped into three teams and each team was assigned two shopping complexes. The teams were instructed by the first author to carefully interview the respondents, then explained the study aims, and clarified the values and the importance of UD.

3.2. Structural Equation Modeling (SEM)

The present study used structural equation modeling (SEM) to assess whether the collected data fit the proposed models. SEM is widely used in sustainability research to test the hypotheses and conceptual models. SEM is a method that combines the factor analysis and multiple regression analysis, in order to analyze the structural relationship between latent constructs and observed variables [5,52]. In SEM, first, the conceptual model should be drawn and specified using path diagram symbols, then the model parameters can be estimated. To estimate the SEM parameters, the present study used the maximum likelihood (ML) technique which is suitable to assess whether the collected data fit the conceptual model. This technique attempts to extract the factors which might lead to the parameters that are most probable to represent the observed correlation matrix. For factor extraction and significant factor identification, the present study used squared factor loading values higher than 0.5 [53].

Several tests were used to assess the reliability of the models, as well as test the fitness of the proposed models. The Cronbach's alpha was used to assess the reliability. The present study also utilized the common SEM model fitting tests, namely root mean square error of approximation (RMSEA), the comparative fit index (GFI), the adjusted goodness-of-fit index (AGFI), the comparative fit index (CFI), the normed fit index (NFI), the Tucker-Lewis Index (TLI), and the normed chi-square (CMIN/df) to test the fitness of the proposed models. The models with indices exceeding the following criteria were acceptable: RMSEA <0.08; GFI $\geq$0.9; AGFI $\geq$0.9; CFI $\geq$0.9; NFI $\geq$0.9; TLI $\geq$0.9; and CMIN/df <5. [54,55].

Several tests were used to assess the reliability of the models, as well as test the fitness of the proposed models. Cronbach's alpha was used to assess the reliability. An alpha more than 0.6 shows the reliability of construct [54]. This study also used Amos version software 22 to examine the structural equation modeling (SEM) of study models.

4. Results

The present study has identified the factors influencing the usability, safety, and comfort of shopping complexes. In addition, the general concept of UD was applied to the shopping complex design criteria in this study. Figure 2 presents the conceptual models of UD in shopping complex based on the literature review and shows several effective design elements for the principal design aspects of UD in the shopping complexes. The fitness of the models was tested by SEM technique using 380 completed questionnaires. The fitness of the proposed models was tested using the SEM method.

The usability model shows that service desks had the strongest relationship with usability, followed by restrooms, maneuver space of entering/exiting areas, door's appearance, ramps, and stairs, in that order. In the comfort model, the strongest relationship with usability belonged to the appearance of doors, followed by the path of travel to the exiting/entering doors, stairs, escalators, architectural wayfinding, service desks, hallways and corridors, maneuvering space of entering/existing areas, and graphical wayfinding, in that order. The safety model indicates that service desks had the strongest relationship with the safety aspect of UD, followed by restrooms, waiting areas, the appearance of doors, hallways and corridors, and stairs, in that order.

The estimated models show that the majority of the observed variables contributed to usability, comfort, and safety of the shopping complexes. Meanwhile, a number of the observed variables were dropped because of their insignificance, but this does not imply that the removed design elements did not have a contribution to the latent variables. It is worth noting that the majority of the literature is pertaining to Western countries. Nevertheless, the shoppers in Kurdistan might have different perceptions of the shopping complexes. Figures 3–5 show the final constructed models for the main aspects of UD for shopping complexes. Table 3 indicates the reliability of the final constructed models for the main aspects of UD in the shopping complexes. Table 4 shows the fitting indices of the models.

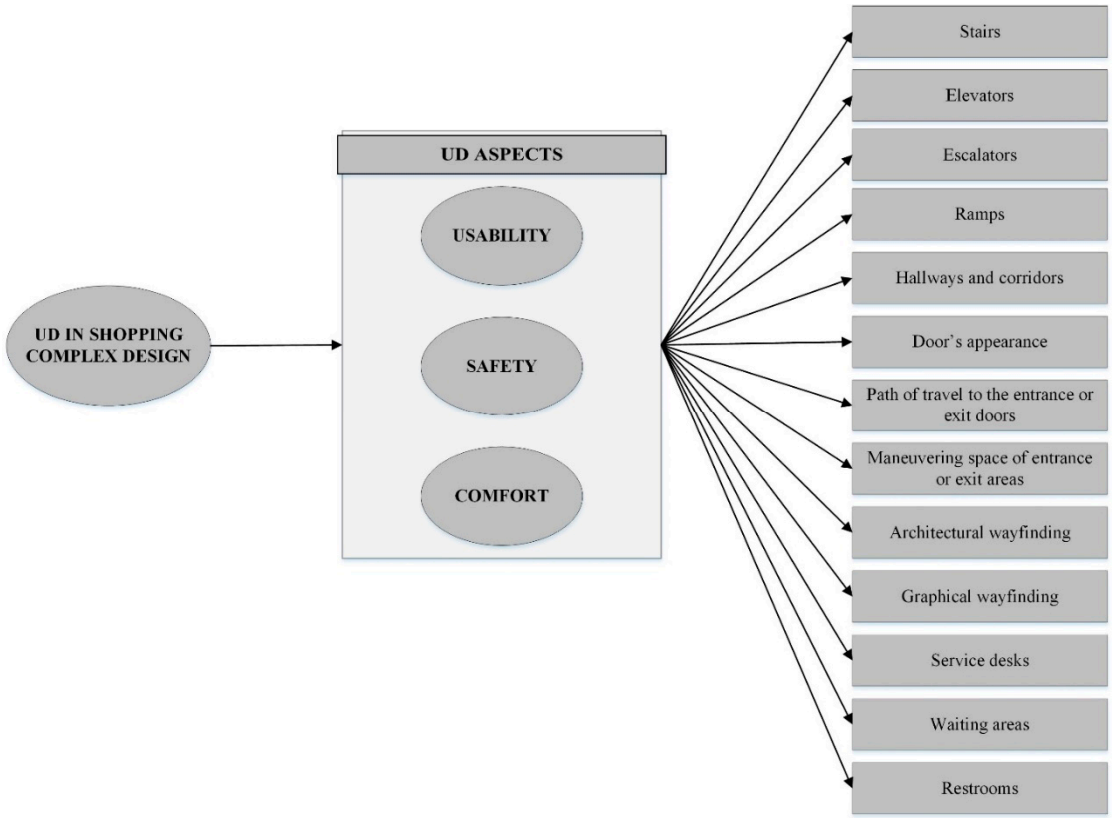

Figure 2. UD for shopping complex conceptual based on the literature.

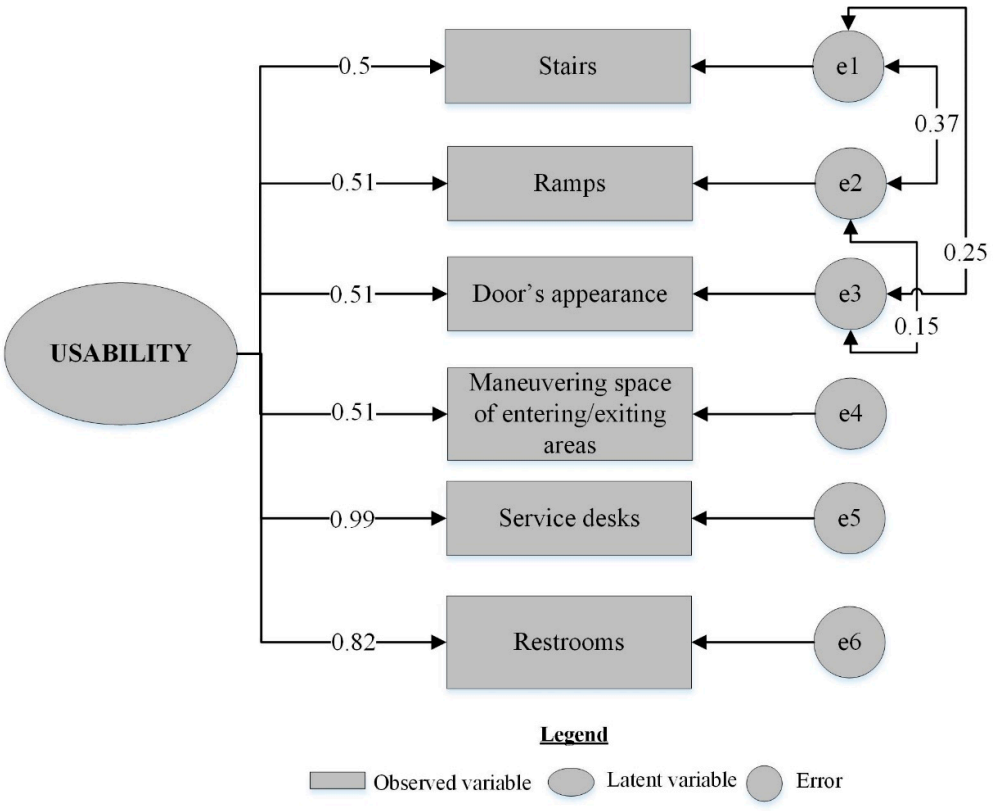

Figure 3. The estimated model of contributing design factors to the usability of shopping complex design.

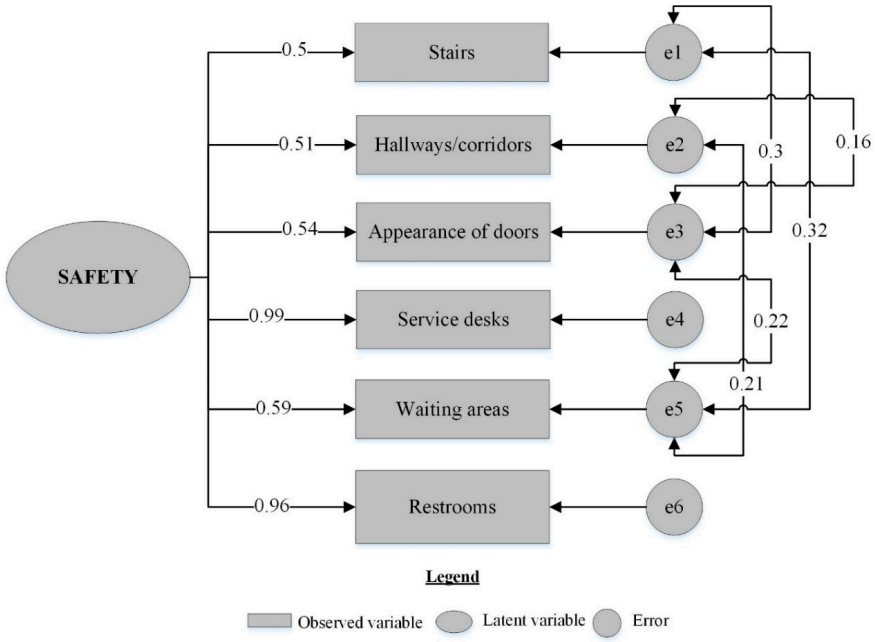

Figure 4. The estimated model of contributing design factors to the safety of shopping complex design.

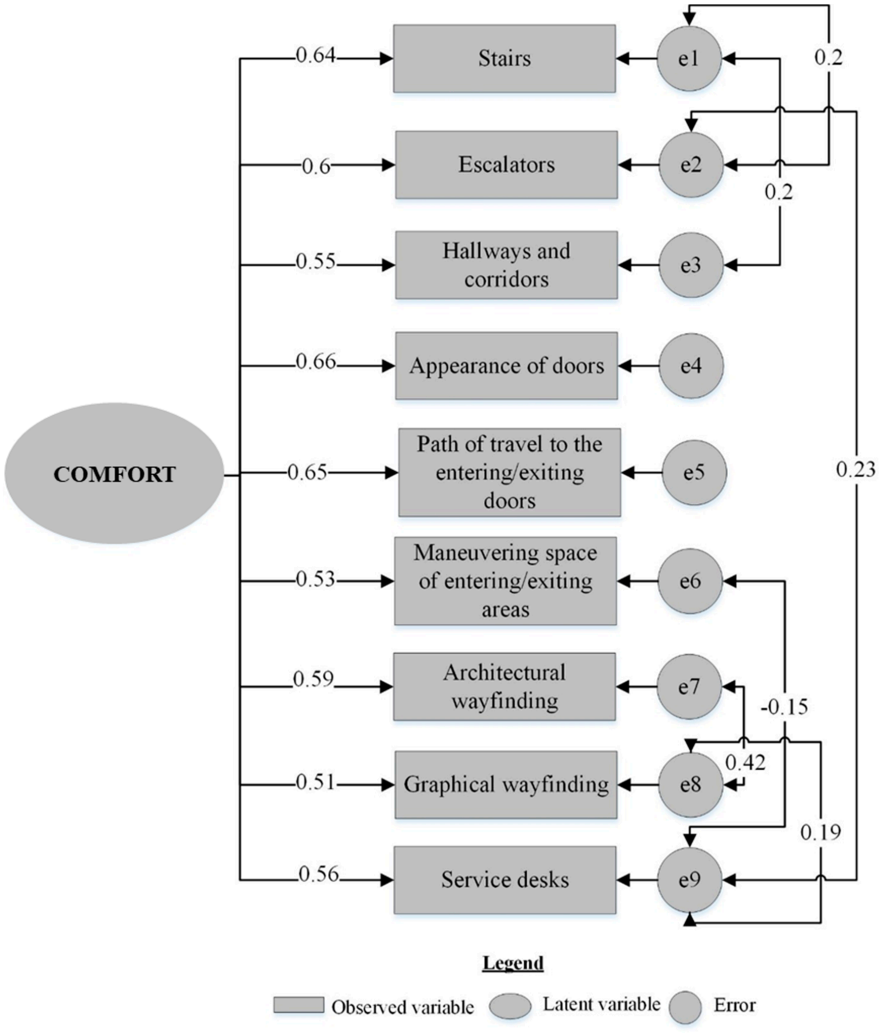

Figure 5. The estimated model of contributing design factors to the comfort of shopping complex design.

Table 3. Cronbach's alpha test results for the usability, comfort, and safety models.

	Usability	Comfort	Safety
Cronbach's Alpha	0.858	0.881	0.823
N of Items	13	13	13

Table 4. Model-fitting indices for usability, comfort, and safety models.

Indices	Usability	Comfort	Safety
Approx. Chi-Square	12.70	68.294	8.735
RMSEA	0.054	0.077	0.056
GFI	0.989	0.964	0.992
AGFI	0.961	0.923	0.959
CFI	0.992	0.954	0.997
NFI	0.986	0.936	0.994
TLI	0.981	0.922	0.988
CMIN/df	2.117	3.252	2.184

5. Discussion

The present study aimed to translate the general concept of universal design (UD) into the shopping complex design criteria and to determine the main design aspects of UD for shopping complexes. UD is a paradigm that serves people irrespective of their abilities or sociodemographic characteristics. The UD and its principles are not well-implemented in shopping complexes in Sulaymaniah and these shopping malls do not serve shoppers on an equal basis. In addition to the benefits of the UD translation, in the design stage it allows the researchers and architects to develop tools to assess the shopping complexes to find the shortcomings and take actions to improve them. In other words, these tools are useful in finding a mechanism to systematically and practically assess the condition of shopping complexes and quantify the improvement levels required.

The present study identified the factors that contributed to the aspects of UD. To the best of the authors' knowledge, a very limited number of studies are available that define the characteristics of UD in shopping complex design. However, several design guidelines and studies independently have pointed out the contribution of shopping complexes" design elements to the usability, comfort, and safety. Based on the results of SEM, the majority of the identified design elements had a contribution to the aspect of usability. These findings are consistent with those of Duncan [8], Duncan, Brenny [32], and Ibrahim Anous [36], who pointed out that design elements such as stairs, elevators, ramps, hallways and corridors, door's appearance, maneuvering space of entering/exiting areas, and service desks have a contribution to the usability of public places. The findings also confirm those of Afacan [22], Ibrahim and Anous [36], and Aghaabbasi and Moeinaddini [39], who noted the contribution of design elements including stairs, escalators, hallways and corridors, appearance of doors, oath of travel to the entering/exiting doors, maneuvering space of entering/exiting areas, architectural wayfinding, graphical wayfinding, and service desks to the comfort of public places. In addition, the results of the present study confirm those of other studies the showed the importance of factors including stairs, hallways and corridors, appearance of doors, service desks, waiting areas, restrooms in the safety aspects of public spaces [26,36,39].

According to the study findings, the strongest relationship between observed variables and usability in the model belonged to the stairs. It can be explained by the fact that the condition of stairs is not satisfactory in the selected shopping complexes. In some stairs within the case studies, the stairs lack sufficient width, detectable warnings, and handrails. Concerning the comfort aspect of UD, the door's appearance had the strongest relationship with the aspect of comfort. A possible explanation for this is the lack of efficient cues, especially tactile design properties on the entering/exiting doors of the selected case studies. It might hinder the shoppers to easily distinguish the doors. The strong relationship between the service desks and safety can be explained by the fact that there is insufficient

knee space of service desks which forced the shoppers to wait or obtain their services in contorted postures and create bumping hazards to the shoppers.

In the present study, the model was developed based on the context of six shopping complexes in Sulaymaniah. For other shopping complexes around the world, the researchers can consider using the factors of this study, since the factors have been identified from the studies conducted worldwide. Meanwhile, the architectural styles and shoppers' needs might be different around the world, and it will be interesting to assess the fitness of the factors in other countries. Shopping complexes in Sulaymaniah represent the shopping malls in developing countries where the overall condition of shopping malls is not desirable with respect to UD. Hence, the results of the fitting test might not be transferable to developed countries.

Limitations

Several limitations of this study also deserve comment. The main limitation of the model is believed to be related to the lack of scientific evidence supporting the contribution of design elements to the UD principles and aspects. Another limitation of the study is that a limited number of people with disability were involved in data collection. This is because the shopping complexes are not desirable for vulnerable shoppers in Sulaimaniah and this led to limitations with regards to inclusive sampling.

6. Conclusions and Future Research

The issue of designing shopping complexes to be usable for people with various abilities and backgrounds is crucial. While several studies addressed the general concept of UD and its principles, a very limited number of studies defines the main aspects of UD in designing of shopping complexes. In addition, no study identified the contribution of shopping complex design elements to the UD aspects. In the present study, the authors translated the general concept of UD into the shopping complex design criteria and used the UD concept to propose a platform for inclusive shopping complex design and assessment. Usability, safety, and comfort were identified as the main aspects of UD in shopping complex design. The authors then proposed conceptual models based on the literature and the translation and related the design elements to each UD aspect. They then assessed the fitness of these models and assessed the contribution of each design element in the UD aspects using SEM. According to the results of SEM, service desks had the strongest relationship with usability and safety. In addition, appearance of doors had the strongest relationship with comfort.

Further studies can develop tools to assess whether public places, especially shopping complexes, serve shoppers with various abilities on an equal basis based on the findings of the present study. Design guidelines can be proposed based on the findings of this study, in order to obtain a design of new shopping complexes that are available and accessible to all shoppers. Future studies can critique and discuss the UD translation, including how the translation allows the practitioners to universally design shopping complexes, as well as how researchers and practitioners can develop an assessment tool to ensure the universality of shopping complexes.

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