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It's all about perceptions: A DEMATEL approach to exploring user perceptions of real estate online platforms

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ABSTRACT

Real Estate Online Platforms (REOPs) are used for conveying real estate and property-related information to potential users (buyers, renters, or sellers). The information leveraged through REOPs supports these users in reaching conclusive rent or buy decisions. Despite their promised utility, user perception about accepting online information through REOPs is unexplored. Using a comprehensive questionnaire and data collected from 65 users, the current study captures the users' perception of REOPs. Risk, service, information, system, technology adoption model (RSISTAM) is proposed comprising of seven users' perceptions: risk (PR), service quality (PSEQ), information quality (PIQ), and system quality (PSYQ) from the information systems success model, and usefulness (PU), ease of use (PEU) and behaviour to accept (BAU) from TAM. The results are analysed using the decision making trial and evaluation laboratory (DEMATEL) approach, which shows that PIQ, PSEQ and PEU are the causes and PR, PSYQ, PU and BAU are the effects. Among the criteria, the order of prominence is PEU > PSEQ > PIQ, and for net effects, the order is PU > BAU > PSYQ > PR. For addressing the causes, the REOP managers must provide more transparent, high quality and voluminous information to the users, focus on the system, services, and information qualities, and add more enjoyable, immersive and easy-to-use content through REOPs. This study contributes to the body of knowledge by exploring user perceptions and proposing methods to improve the quality and reliability of REOPs in line with Real Estate 4.0 and industry 4.0 aims.

1. Introduction and background

Online platforms (OPs) provide information to users worldwide in various fields, laying the foundation of online business, e-commerce, and e-services. These OPs include websites, mobile applications and other online media. OPs have significant impacts on their users and dictate how they interact with the businesses. Balkhi [1] estimated that as much as 95% of all global purchases would be made through OPs like websites and apps by 2040. As per DataReportal [2], there are 4.66 billion active internet users, 4.28 billion unique mobile internet users, 4.14 billion social media users and 4.08 mobile social media users as of October 2020. According to Kemp [3], more than one million people went online for the first time each day from January 2018 till January 2019.

Further, there are 5.11 billion unique mobile users in the world today, up by 100 million (2%) in the past year. An increase of 366 million (9%) users occurred in January 2019 compared to January 2018. Furthermore, the world's internet users spend 6 h and 42 min online each day on average. Among these users, in terms of e-commerce, 2.818 billion people purchased something online or used a service, raising the penetration of e-commerce to as much as 37% in 2018 [3]. Similarly, 71% of consumers who had a positive experience with a brand's OPs are likely to recommend it to friends and family, whereas 73% of marketers believe in the OPs' effectiveness in their business development and customer attraction [4]. Overall, e-commerce spending has grown by 14%

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since 2018 and expected to cross US$1.78 trillion in the near future [3].

In the case of Australia, 80.8% of people shop online as of 2019 [5]. Accordingly, there will be approximately 22 million online buyers and the e-commerce market penetration rate will reach 85.2% by the end of 2021. This is positive news for online technologies adoption and an indicator for potential investment attractions in the OPs. In 2019, Australians spent 20.3 billion AUD in the e-commerce market, which is expected to show an annual growth rate of 7.0 by 2023 [6]. More than 70% of people believe they will get a better deal online, which is one of the most cited reasons for using OPs. Among these, 55% of people search for online reviews and recommendations before making a purchase, and 47% visit the company's OP in addition to it. Similarly, 73% of users prefer doing business with brands that personalise the online shopping experience, and 82% of people want an immediate response to their marketing or sales queries posted online [7,8]. Thus, online businesses are gaining popularity throughout the world, and Australia is no exception.

Australian real estate is a key contributor to the e-commerce sector. Once considered the most tedious commercial property investments, the warehouses and other associated real estate are now at the heart of institutional investment interest. This is due to the surge in online shopping due to COVID-19 propelling demand for logistics space. Of other goods, services, and commodities bought and sold online, real estate is one of the most important assets transacted in-person or online. It facilitates lodging and housing, work and business, and pleasure and recreation. The real estate market estimated revenue in 2019 was US$461.7 billion, valued in the United States alone [9]. The industry employment increased by 2.6% p.a. from 2011 to 2019, and it is expected that the industry revenue will increase by 2.3% p.a. from 2019 to 2024. In Australia, as per Statista.com [10], it is estimated that the value of commercial building activity and real estate will reach AUD 43.2 billion by 2025 with more than a 5% annual change in volume. Further in terms of the distributions of transactions in the retail sector, the neighbourhood and regional investments lead the chart with 23% share each followed by large retail (19%), sub-regional (12%), CBD (8%) and others (14%).

According to Ullah et al. [11], the highest used sources for online home search are real estate online platforms (REOPs), with as much as 95% of the entire home searches on the internet, making it more critical to the real estate online business and interactions in Australia. These REOPs provide the potential buyers, sellers, renters, or general users the information related to properties and real estate present in various global regions. An interactive REOP such as a website, coupled with the features like 360° videos, 3D tours or disruptive technologies, affects the user motivations to return to it or make purchase decisions that contribute to improving online real estate business performance [11–13]. The REOPs offering accurate, timely, novel, and appropriate information help users buy, rent, be fascinated, and keep using the service [11]. Thus, the information availability, accuracy, novelty, and distribution systems of the REOPs are critical to user decisions. Accordingly, the user needs must be considered, discussed in meetings at both internal and external levels and relevant information made available for better user decisions and subsequent real estate business management [12]. However, when it comes to REOPs, the state of scholarly research is not up to the mark. The online aspects of real estate sales, rents and investments have not been thoroughly explored that must be investigated to lay the foundations for smart real estate management and move towards the holistic goals of Real Estate 4.0 in line with industry 4.0 goals. This provides a research gap that is targeted in the current study. In the COVID-19 era, this is becoming more important as most real estate businesses are forced to go online to survive in the global market [14].

While multiple studies highlighted the need to consider user needs and their decision factors to use online platforms [11,15–17], the state of REOP user decision factors that shape their perceptions have not been investigated by scholarly research. Accordingly, REOPs user perception of accepting online information has never been investigated. Due to the absence of such perception assessment, regrets are on the rise due to poor decisions made based on information provided through the REOPs [18,19]. According to Ullah and Sepasgozar [20], there has been an alarming 18% increase in users regrets related to the poor quality of the information provided to them through REOPs in the last five years. These regrets can be addressed by assessing users' perception of REOPs, identifying the critical factors required for positively influencing these perceptions and providing high-quality information to them using REOPs.

Schaer et al. [21] discussed in most online business decisions, the allocation of resources, inventory decisions, or the planning of marketing expenditures are based on forecasts dependent on users' perceptions. Positive perceptions create more demand that makes the use of online information for demand forecasting more contentious. However, no study has captured the REOP users' perception to date, presenting a research gap. Further, the associated factors have not been classified into the cause-and-effect criteria to manage the online information better and attract more users. Such classifications are expected to separate the causes and effects criteria and help decision-makers, REOP developers and managers focus the user needs. Accordingly, more resources can be allocated to address the cause perceptions that will shape positive effect perceptions, leading to more users' accepting the REOPs information. In the absence of such classifications and assessments of users' perception, the state of regrets can only worsen, resulting in loss of business for REOPs. This gap is targeted in the current study, where the user perception factors are investigated, grouped in criteria, and classified into causes and effects using systematic decision-making tools.

Multiple theories analyse the factors in details and their systematic grouping, including the Technology Acceptance Model (TAM) that models how a user accepts a technology [22]. TAM has the key constructs of perceived ease of use (PEU), perceived usefulness (PU) and behaviour to accept or use (BAU) a service or technology [17]. A detailed investigation of TAM research helped identify another gap in the literature, highlighting the need to assess the two-way relation between the TAM constructs. For example, Abdullah et al. [23] highlighted that PU affects PEOU. However, Chen et al. [24] have the opposite opinion and stress that PEOU affects PU. Similarly, Hackett [25] adopts an intermediate approach and argues that there is a binary relation, and any of the two factors can affect the other one. This presents a challenge pointing at the unclear relationship between user perceptions of TAM constructs and online information acceptance. The two-way relationships between overall TAM criteria have not been assessed in detail to date, and there is ambiguity about which criteria affects the other. Therefore, a holistic approach is required where all the TAM criteria are investigated for their relationships.

Another theory used in the current study is that of the Information Systems Success Model (ISSM) that uses Service (S), Information (I) and Systems (S) Qualities (Qual) presented by DeLone and McLean [26]. SISQual dictates the users' acceptance of technologies [17]. The associated qualities of the SISQual determine the success of any information system by enhancing user satisfaction and inducing an increased willingness to use the online service by developing a positive perception. This empowers the business to attract more or retain existing users [26]. The same message is conveyed by TAM, where the users' acceptance of technologies is investigated through the PU and PEU of the information and associated systems. Thus, SISQual can be linked with TAM.

However, the SISQual and TAM have not been integrated into REOP contexts to date, providing a gap targeted in the current study. Thus, the current study investigates and establishes the relationships between REOP user perceptions related to criteria for accepting the online information using TAM and SISQual models. Seven relevant perceptions that affect the acceptance of online information by REOP users are explored in the current study. These perceptions are related to each of the three SISQual and TAM constructs and an additional perception of the REOPs usage risks. Thus, the perceptions are Perceived Information Quality (PIQ), Perceived Service Quality (PSEQ), Perceived System Quality (PSYQ), PEU, PU, BAU and Perceived Risk (PR).

Further, the two-way relationship between all perception constructs and online information acceptance by REOP users is also investigated in the current study. This investigation examines and establishes the relationships between the constructs and separates the cause-and-effect constructs using the state of the art DEMATEL method. For this purpose, theories such as the ISSM and TAM are merged to form the current study's RSISTAM model. DEMATEL, multicriteria decision-making (MCDM) tool, has been used in other studies in similar contexts.

The rest of the paper is organised as follow. Section 2 discusses the TAM and SISQual approaches used in the current study and general real estate context. Section 3 introduces and discusses the DEMATEL approach and its advantages over other MCDM tools. Section 4 provides an overview of the method used in the current study, the steps of DEMATEL and the data collection procedure and considerations. Section 5 presents the conceptual RSISTAM model proposed in the study. Section 6 presents and discusses the study results. Lastly, Section 7 concludes the study and presents the key findings, limitations, and directions for futuristic expansion.

2. User perception and theoretical underpinning

User perception drives the acceptance and utilisation of any service. It creates a make-or-break situation for the service providers where the positive perception means more business opportunities, and negative perception leads to lesser usage of the services [27–30]. Sharma et al. [30] investigated user perception of the effectiveness of performance management systems. They argued that the accuracy and fairness of these systems help develop positive user perception that leads to increased service usage. Bourgonjon et al. [31] investigated students' perceptions of video games in the classroom and argued that their preference is directly affected by the perceptions of usefulness, ease of use, learning opportunities, and personal experience with video games. Lui and Jamieson [27] investigated the trust and risk perception of e-commerce users. They argued that perceived risk is a direct antecedent of intention to transact, and various dimensions of trust have a positive influence on perceived risk.

Similarly, Ndubisi [28] investigated user perception and intention to adopt internet banking and argued that PU and PEU are strong determinants of behavioural intention to adopt internet banking. In the case of real estate and property sectors, Ullah et al. [22], Ullah et al. [32] and Ullah and Al-Turjman [33] discussed the usage of Big9 technologies, including drones, the internet of things (IoT), clouds, software as a service (SaaS), big data, 3D scanning, wearable technologies, virtual and augmented realities (VR and AR), and artificial intelligence (AI) and robotics for shaping positive user perception of adopting real estate technologies. Felli et al. [13] proposed using 360° videos and mobile laser measurement technologies for immersive visualisation of real estate to shape its positive perception and image. Ullah et al. [34] investigated the managerial perspective on barriers to the digitalisation of Australian Smart Real Estate. The authors argued that high costs and complex systems, lack of will to invest in digital technologies and government support, regulations, and standards lead to technology non-adoption in the presence of positive user perception. Similarly, Ullah et al. [11] reported that REOP design shape positive user perception. Further, lack of information on the REOPs such as property photos, neighbourhood insights, and delayed response from real estate agencies is responsible for the lesser utilisation of these platforms.

In terms of the theories used for modelling or assessing the user perception and acceptance of technologies, TAM, ISSM, Diffusion of Innovation (DOI) [35], and Hedonic Demand (HDT) [36] are evident from published literature. DOI deals with how, why, and what of the rate of new ideas and technology spread. It has five key categories: innovators, early adopters, early majority, late majority, and laggards. These refer to types of users accepting the innovation or technologies. Similarly, HDT deals with the value offered by a service or technology and explains that users are willing to pay for technology or service equivalent to its value offered [36]. Thus, the price an individual is happy to pay for a technology reflects the users' perceived value or usefulness of the technology. TAM and ISSM are among the two most utilised theories for modelling and capturing user perceptions. Accordingly, these are utilised in the current study and explained subsequently.

2.1. Technology acceptance model (TAM)

Davis introduced TAM in 1985 as an extension of the theory of reasoned action [37]. TAM models the user acceptance or adoption of any technology or service. It strongly relies on the users' perceptions, as evident from its key constructs: PU, PEU, and BAU, to use the service. As the current study assesses user perceptions, TAM constructs align with the aim of this study. Accordingly, in TAM, PU corresponds to how technology can increase the user's job performance. PEU refers to the technology being free of effort and hence deemed easy to use. These two constructs help satisfy users as they can get things done through technology and develop a positive perception. As a result, users are inclined to change their behaviour towards adopting technology or using the service [22]. Various extensions have been presented for TAM, such as TAM2 and TAM3. In these extensions, additional constructs such as subjective norm, voluntariness, image, job relevance, output quality, and result demonstrability are incorporated [38,39].

As presented by Davis and Venkatesh [33], TAM links PU and PEU with the BAU. However, with time and more research on the subject method, the relationship became complicated. For example, considering the relation between PU and PEU, there exist contradictions about which criteria affect the other and its relational strength. This casts doubts over TAM's reliability for assessing user perception. According to the original Davis model, Abdullah et al. [23] and Schnall et al. [40], PEU affects the PU of the technology. However, Phichitchaisopa and Naenna [41], He et al. [42] and Chen et al. [24] have opposing ideas and argued that it is the other way around where PU dictates PEU of the technology. This does not stop here as researchers such as Sengars and Grover [43] and Hackett [25] taking an intermediary approach, argued that both could affect each other depending upon the scenario. This seems like the most appropriate approach in the current study that equal opportunities should be provided to all the criteria to affect the other or vice versa, thereby separating the cause-and-effect criteria following the DEMATEL approach.

2.2. Information system success model (ISSM)- SISQual approach

ISSM, proposed by DeLone & McLean in 1992, deals with evaluating the success of any information system [44]. It comprises six criteria for evaluating the success of an information system:

service quality, information quality, system quality, user satisfaction, the effect on the individual user, and the effect on the organisation. All these qualities are pivotal to the success of an online system. Based on the assessment of the service (S), information (I) and system (S) qualities (Qual), the ISSM is also known as the SISQual approach [26]. The SISQual components directly influence user perception and associated satisfaction.

In the SISQual components, service quality refers to services provided to the users. These services positively influence users' perceptions, leading to higher satisfaction. In real estate, these services include providing rich content, familiar technology, interactive 3D models, immersive content, page customisation, interactive maps, interactive graphical statistics, ease of search, and learning tutorials [45–49]. Information quality refers to the measure of the information system outputs. For REOPs, these include information reliability, credibility, accuracy, novelty, transparency, historical information disclosure, updated information, transaction costs information, legal information, and inspection information [28,50–55]. System quality refers to the measures of the information processing system. In REOPS, the associated factors include response time, content structure, loading speed, loading query results, user location display, platform design, hyperlinks, user support, professionalism of web team, graphical consistency, and better navigation tools [29,56–59].

Overall, SISQual and TAM have not been integrated for REOPs to date, presenting a research gap targeted in the current study. The current study uses integrated TAM-SISQual for assessing user perception of REOPs. Among very few studies that have integrated these two, Chen and Tsai [60] has integrated TAM and ISSM for determining the behavioural intention to use the personalised location-based mobile tourism application.

3. The DEMATEL approach

DEMATEL was initiated between 1971 and 1976 and used by the Battelle Memorial Institute of Geneva for its Science and Human Affairs Program. The purpose was to visualise the relationship and structure of complicated cause-and-effect models through matrices and graphs [61]. DEMATEL is vital to the success of countless applications that involve the process of reaching appropriate decisions. Developers or decision-makers need to understand the factors influencing service quality and use DEMATEL to easily establish the key relations between criteria through a network relationship map [62]. It has been commonly used for extracting the interdependencies and interrelationship between multiple design criteria and characteristics based on cause-and-effect models. It is accepted as an effective tool for analysing the structure and relationship among criteria.

DEMATEL defines and divides the design characteristics of a system as cause-and-effect groups for relevant decision-making. It ranks the criteria based on the type and importance of interrelationship among them [63]. The criteria having more influence on others are classified into the "cause" group, whereas those influenced by others are classified as "effect" groups. Using these two groups, the interdependence among criteria is identified and converted into an intelligible cause-effect structural model using digraphs [64]. It has been utilised to rank and shortlist real estate agents based on their service quality before contacting them for business by Tseng [65]. The author reported that user expectations from real estate agents are based on multiple dynamic variables with a binary relationship with parameters of service provided by the agents, thus making it a complex problem.

Similarly, DEMATEL has been used for evaluating the innovative capabilities of real estate firms by Kumar et al. [66]. Utilising factors obtained from an extensive literature review, the authors ranked criteria and factors of developing innovative capabilities and evaluating existing capabilities of real estate firms using DEMATEL. The authors argued that the causes and effects of underperformance and lack of innovation in real estate firms could be evaluated using DEMATEL and improved for gaining a competitive business advantage.

3.1. Advantages of DEMATEL

DEMATEL was initially developed to obtain an integrated solution to complicated social problems, such as energy security, environmental protection, and race. Nowadays, it has been applied in operational practices whereby the consumers or users require commodities to satisfy the indices of multiple quality attributes [67]. Although widely utilised in addressing modern MCDM problems, DEMATEL has not seen a wider penetration in property and real estate management sectors.

DEMATEL is a preferred method since it provides a two-way consideration for relationships instead of the traditional one-way approach. It can model, map and improve satisfaction, raise the understanding of issues, interacted factors and groups, criteria and sub-criteria, and provide a feasible solution by introducing and mapping a hierarchical network and relevant solution [68]. The results of user choices are displayed using charts and visualised structural models to help the decision-makers and managers arrive at informed conclusions. This help in understanding and analysing the complicated and intertwined problems [64,67].

DEMATEL is more successful than other analyses techniques as it is mostly theory-driven compared to the data-driven models requiring extensive data collection. It examines and re-examines the causal relationships among factors and dimensions that are established based on expert opinions. These causal relationships need to be identified to separate the causes from effects, a dilemma the decision-makers face while dealing with multiple dynamic decision-making factors. Additionally, a cause might have multiple effects or vice versa that can be tackled using DEMATEL compared to other MCDM techniques. These relationships formulate the initial model that can be tested to find out problems or propose the amendments. Further, the path relation, modelling errors, capitalisation chance error, and maintaining the nature of confirmatory and over-fitting model can also be addressed using DEMATEL [69].

DEMATEL offers both visual and numerical advantages for visualising the intensity of the relations and their importance using graphs theories and matrix computations [70]. It improves the complex system by visualising and quantifying the associated degree of interrelationship across features [71]. It improves problem understanding, entangled problems and paves the way for a workable solution by establishing interdependences among various system elements through causal diagrams. These causal diagrams use bidirectional digraphs instead of directionless graphs for portraying the key contextual relationships and the influence strength among the elements of a system [72].

3.2. Comparison of DEMATEL with other MCDM techniques

In comparison to other analytical techniques, DEMATEL offers multiple advantages. Factor analysis divides factors into groups and assigns equal weights to them. However, the weights between these factors may differ. Hence, it may not always be suitable to have equal weights for all the factors. DEMATEL technique can be useful to overcome these insufficiencies of factor analysis as it provides a systematic method to determine the causal relationships and impact degrees between various factors constituting a complex system. With this critical information, the key factors can be better focused, saving time and reducing development costs [62].

Compared to established techniques involving cause-and-effect models or pairwise comparisons such as the analytic hierarchy process (AHP) and the analytic network process (ANP), DEMATEL provides a more holistic approach. It provides a two-way scoring and relation management whereby factor A affecting B may have a different effect when B affects A. The previous techniques assign equal and opposite weights to the criteria, but in DEMATEL, a criterion having more effect on another will have a higher priority and, consequently, be treated as a cause. Similarly, if the criterion is more affected by another criterion or criteria, it will have a lower priority and be treated as an effect [63].

Compared with AHP or interpretative structural modelling (ISM), DEMATEL allows for a wider and broader judgement of the underlining measures. For example, DEMATEL allows for bi-directional multi number relations as compared to ISM having only 0–1 levels. Similarly, fuzzy ISM specifies hierarchy and interrelationship, whereas AHP has a unidirectional relationship that requires multiple separate matrices to be solved and interpreted through complex integration [73]. Compared to statistical techniques such as structural equation modelling (SEM) and regression analysis, DEMATEL provides two key advantages. It requires data collection from a limited number of respondents, thus saving time and labour in data collection. Secondly, it considers all the possible interactions among the factors based on existing model architecture to facilitate improved decision-making [74].

Other MCDM methods have been reported in the literature related to various fields such as transportation, campus and facilities management. For example, VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), ELimination Et Choice Translating REality (ELECTRE III), Preference ranking organization method for enrichment evaluation (PROMETHEE), Complex Proportional Assessment of alternatives (COPRAS), MultiAtributive Ideal-Real Comparative Analysis (MAIRCA), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Multi-Attributive Border Approximation Area Comparison (MABAC) have been used for an integrated decision-making framework for vehicle selection in shuttle services [75]. Similarly, DEMATEL and Multi-objective Optimization On the basis of Ratio Analysis (MULTIMOORA) methods have been explored in providing transport shuttles services [76]. Other studies include the game theory approach [77], electric vehicle routing problem [78], environment-friendly school bus routing [79], adaptive signal control [80] and evaluating ramp metering deployment through eclipse small ubiquitin-related modifier (SUMO) [81] for addressing MCDM problems. This shows the maturity of MCDM techniques in other fields; however, the state of research is below par and must be uplifted when it comes to real estate studies. Hence this study explores the DEMATEL approach in modelling users' perception of REOPs.

3.3. Motivation to use DEMATEL in the current study

DEMATEL has been used in this study because it can help establish the structural models and relationships among RSISTAM constructs based on calculations instead of using the hit and trial method. It can assess the two-way relationship between REOPs user perceptions and TAM constructs to address their interrelationships. DEMATEL can separate the cause-and-effect constructs of REOP user perceptions. The associated matrix-based calculations make it easy to have real-time data instead of using the traditional hypothesis-based approach due to its visually structured matrix generations. The convenient sample size requirement is an added advantage where real experts based on set criteria can be involved and reach a logical conclusion. It has been used in similar studies related to modelling user perceptions and decisions for using different online services and web tools [62,72,82,83].

4. Method and materials

The current study uses DEMATEL to assess user perception of REOPs. Following the standard DEMATEL process, a set of criteria are defined by clustering the factors associated with REOPs users' perceptions. Afterwards, a questionnaire is developed to collect data. The criteria are classified into causes and effects based on responses and associated DEMATEL analysis. All these steps are explained below.

4.1. DEMATEL process

The flowchart in Fig. 1 provides an insight into the DEMATEL process. It can be summarised in the following steps using Wu et al. [84] and Costa et al. [85]

4.1.1. Step 1: Compute the average matrix (Z)

The data is collected from respondents on a five-point Likert Scale from 0 to 4, where 0 = no influence, 1 = low influence, 2 = medium influence, 3 = high influence, and 4 = very high influence. The respondents are asked to evaluate the direct influence or strength of the relationship between any two criteria (binary relation) in a matrix form. An $n \times n$ matrix A_y is derived from the y^{th} expert's response. The $x_{ij}(y)$ represents the degree of influence of criterion CR_i on CR_j, which then forms the influence matrix A_y. Suppose k is the number of respondents consulted, the average matrix Z is found by averaging the scores of all the respondents as shown in equation (1).

$$Z = \frac{1}{k}\sum_{m-1}^{k} x_{ij}^{m} \; where \; 1 \le m \le k \tag{1}$$

4.1.2. Step 2: Calculate the normalised initial direct relation matrix (D)

Normalise the initial direct-relation matrix (D) so that each element in matrix D falls between zero and one. Using the average matrix Z, the normalised initial direct matrix (D) can be obtained using equations (2) and (3).

$$D = \frac{Z}{S} \quad where \quad 0 \le every \quad element \quad of \quad D \le 1 \tag{2}$$

and

$$S = max\left(\sum_{j=1}^{n} Z_{ij}, \sum_{i=1}^{n} Z_{ij}\right) \tag{3}$$

4.1.3. Step 3: Calculate the total relation matrix

Determine the total relation matrix (T) using equation (4). In the solution, I is an $n \times n$ identity matrix with 1 as all its values corresponding to elements in the $n \times n$ matrix.

$$T = (DI - D)^{-1} \quad where \quad "I" \quad is \quad the \quad nxn \quad identity \quad matrix \tag{4}$$

A continuous decrease of the power along D occurs in the same lines as an absorbing Markov chain matrix [85] that guarantees a convergent solution as worked out in equation (5).

$$T = \sum_{n=1}^{\infty} D^{i} = D + D^{2} + D^{3} + \cdots + D^{n} = \frac{D(I - D^{n})}{(I - D)} = \frac{D(I - D^{\infty})}{(I - D)} = \frac{D}{(I - D)} = (DI - D)^{-1} \tag{5}$$

4.1.4. Step 4: Calculate the sum of rows and columns

Determine row (R_i) and column (C_j) sums for each row(i) and column(j) from the total relation matrix (T) as given in equations (6) and (7).

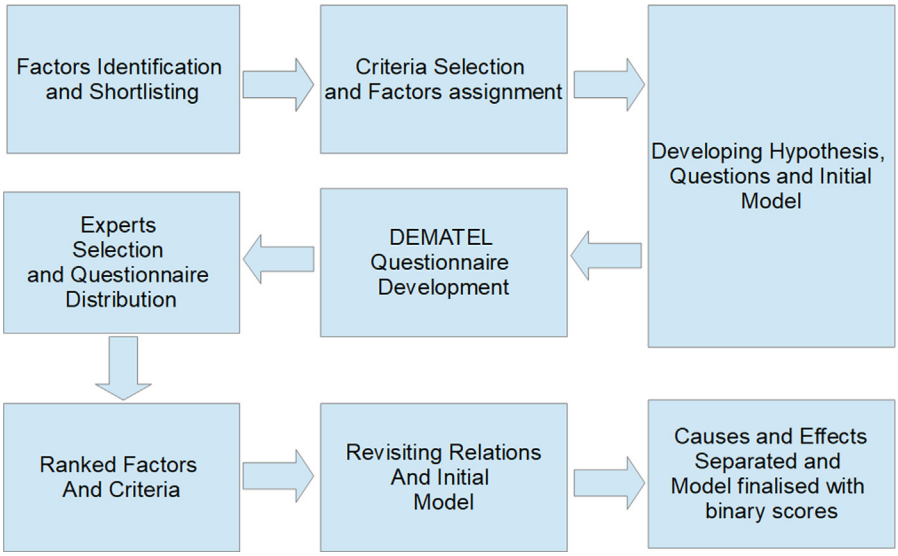

Fig. 1. The stepwise DEMATEL process.

$$R_i = \sum_{i=1}^{n} T_{ij} \forall i \tag{6}$$

$$C_j = \sum_{j=1}^{n} T_{ij} \forall j \tag{7}$$

4.1.5. Step 5: Determine the overall prominence and the net effect

Using equations (8) and (9), calculate the overall prominence (P_i) and the net effect (E_i) of factor i. The value of prominence corresponds to the value of P_i. So, the larger the value of P_i, the greater will be the overall prominence of factor i in terms of its overall relationship with other criteria. If E_i greater than 0, then factor i is a net cause or starting point of other criteria. Similarly, if E_i less than 0, then factor i is a net effect of other criteria.

$$P_i = [R_i + C_j | i = j] \tag{8}$$

$$E_i = [R_i - C_j | i = j] \tag{9}$$

4.1.6. Step 6: Setup a threshold value (α) and draw the cause-effect diagram (digraph)

A threshold value (α) must be set up to filter out the negligible effects in the total relation matrix (T) and keep the complexity of the system at a manageable level for explaining the structural relationships between the criteria. If the value is too low, the resultant digraph will be too complex to show the essential information for proper decision-making. Similarly, if the value is too high, many criteria will emerge and be presented as independent criteria without exhibiting any other criteria. Thus, to obtain a suitable cause-and-effect diagram and obtain adequate information for decision-making, an appropriate threshold value is necessary. In this study, the threshold value (α) is set up by computing the average of the elements in matrix T. The digraph is acquired by mapping the data-set of ($R_i + C_j$, $R_i - C_j$).

4.2. Grouping of factors and development of criteria

In previous DEMATEL studies, different factors are grouped into criteria and constructs for convenient and systematic analysis. Accordingly, in this study, 35 factors are identified from the literature and grouped in a manageable number of criteria. One of the hurdles in applying the DEMATEL method is the huge data collection and entry time requirements and associated computations. This can get tough if the factors under investigation are too many. Ideally, the factors or clusters should be up to 10 as evident from the studies of Namjoo and Keramati [86], Yeap et al. [87] and Lin et al. [88] with seven assessment factors, Shao et al. [73] with eight assessment factors and Costa et al. [85] with ten factors.

Although few studies use DEMATEL for more than 20 factors, they are usually limited to very few respondents, single organisation or are generally exploratory due to the over-involvement and time requirements from the respondents [89,90]. Therefore, owing to the published literature, factors are grouped in criteria when their number is above 20. The investigation is focused on the effects of criteria rather than individual factors. These criteria usually bring the number to less than ten and make the data collection, time requirements from respondents and associated computations more realistic and achievable. Such grouping has been performed in the DEMATEL related studies by Malekzadeh et al. [69], where the 36 factors related to organisational intelligence of Iranian public universities were grouped into eight criteria. Wu and Chang [91] investigated the critical factors for green supply chain management, reduced 25 factors to 20 using literature and grouped these into four criteria for applying the DEMATEL method. Similarly, more relevant to the current study, Kumar and Dash [72] explored user decision-making in the electronic marketplace and constructed an influential network relation map using DEMATEL. They grouped 36 factors into eight criteria.

Accordingly, in the current study, 35 factors are grouped into seven criteria based on relevant literature, expert opinion and in-house discussion, as shown in Table 1. Table 1 displays the four criteria related to perceptions, whereas the remaining three are adopted directly from TAM. These include PU, PEU and BAU that have been previously defined and discussed. The experts involved in the in-house discussions consisted of 19 PhD students and professors working in construction and property management. They were involved in the study through a pilot survey and follow up discussions to group the factors.

4.3. Evaluation criteria, sample size and experience considered by previous DEMATEL studies

Various studies have used different evaluation criteria and variables to apply DEMATEL. The criteria are generally between four to

Table 1
The RSISTAM constructs, definitions and accompanying factors.

Criteria	Definition	Factors	Other Constructs in Literature
Perceived Information Quality (PIQ) [52,92]	It refers to the measure of the information system outputs provided through REOPs	Information Reliability [28] Credibility [50] Information Accuracy [54] Historical Information Disclosure [96] Information Novelty [95] Transparent Information [52] Updated Information [53] Transaction Costs Information [54] Legal Information Disclosure [55] Inspection Information [97]	• Perceived Trust [93] • Perceived Credibility [50] • Perceived Effectiveness [30] • Perceived Understanding [59] • Perceived Accuracy [94] • Completeness [94] • Perceived Novelty [95] • Information Disclosure [96] • Legal Policy Sufficiency [27] • Latest Information [53]
Perceived Service Quality (PSEQ) [98]	It refers to the quality of services provided to the users through REOPs	Content Richness [45] Technology Familiarity [45,46] Interactive 3D Models [16,103] Content Immersion [102] Page Customisation [103,104] Interactive Map Features [48,49] Interactive Graphical Statistics [107] Ease of Search [108] Computer Self-Efficacy [98,108] Learning Tutorials [109]	• Perceived Compatibility [99] • Perceived Enjoyment [100] • Perceived Playfulness [101,102] • Perceived Attractiveness [45] • Customisation [103,104] • Perceived Mobility [48] • Convenience [94] • Personalisation [94] • Personal Awareness [105] • Effort Expectancy [106] • Technology Anxiety [98]
Perceived System Quality (PSYQ) [110]	It refers to the measure of the information processing system of REOP	Response Time [101] Content Structure [111] Loading Speed [12] Loading Query Results [113] User Location Display [60] Platform Design [56,114] Hyperlinks [115] User Support [57] Team Professionalism [57] Graphical Consistency [29] Navigation Tools [100,101]	• Design [56] • Structure [111] • Content Quality [110] • Speed [12] • Service Representative Reliability [57] • Perceived Wait Time [57] • Technical Support [112]
Perceived Risk (PR) [93,96]	It refers to the user-perceived risks in using REOPs	Information Privacy [54] Information Security [54]	• Perceived Security [54] • Uncertainty [116] • Perceived Privacy Risks [50,117] • Perceived Vulnerability [106]
Others		Benefits [106,118] Return [95]	• Perceived Benefits [96] • Perceived Reward [95] • Performance Expectancy [106]

ten, and the factors or variables are between 10 to 30. Table 2 summarises some of the previous studies and their considerations for factors and criteria.

In terms of the sample size requirements for DEMATEL, different studies have involved three to ten experts in general. Shao et al. [73] involved three experts from three companies with more than $1000 million investment in research and development and more than 500 employees. Lin and Tzeng [68] investigated two case study projects with 23 respondents (16 in executive positions such as managers and directors and seven in non-executive positions such as engineers and staff) from one case study and 11 (seven executive and four non-executive personnel) from the other case study project. Asad et al. [119] involved 20 respondents, including university professors and students, as potential experts. Cebi [83] involved five expert website designers who assessed three online shopping websites. Hsu and Lee [62] included eight experts (four bloggers, two interface designers and two researchers). Five website design experts were asked to assess shopping websites by Cebi [63]. Six experts, including three consumers, one professor and two managers, were involved in evaluating and ranking the nine factors affecting consumers behaviour to buy a product by Atthirawong et al. [82]. In summary, the numbers are increased or decreased based on the experience of the respondents.

In general, the studies through DEMATEL across various disciplines, including website and online tools management, online shopping, blog quality assessments, and human–computer interactions, have used up to five years of relevant experience to select their respondents or panel of experts [62,72,82]. For example, Kumar and Dash [72] involved customers who make a regular purchase, spend approximately $600 on online purchases monthly and have five years of internet experience. Hsu and Lee [62] involved bloggers with three years of experience, interface designers with five years of experience and researchers with publications in human–computer interactions. Two senior researchers with a PhD degree and one with seven years of managerial experience were involved in the study of Shao et al. [73].

Table 2
DEMATEL usage, factors and sample size in previous studies.

Industry and context	Purpose	Factors	Criteria	Sample Size
Environment-friendly products used in automobile companies [73]	To visualize the prioritisation and interrelationships among barriers between environment-friendly products and their consumers in the European automobile industry	8	–	3
Technology parks value creation [68]	To compare various industrial clusters to establish industrial structures using four aspects of human resources, technology resources, invest environments and market development	28	–	23
University websites usage[71]	To adopt an expert opinion and re-establish the causal relationship and the degree of the interrelationship of a decomposed theory of planned behaviour (DTPB) variables for university websites	13	–	23
Consumer satisfaction in internet banking [119]	To study the key factors affecting customer satisfaction in the internet banking system to prioritizing them based on the cause-and-effect relationship	27	7	20
Consumer decision-making in e-marketplace [72]	To construct an influential network relation map (INRM) of consumer decision-making in the e-marketplace	34	8	30
Consumers evaluation of smartphone features [64]	To investigate the consumer preference for a feature and need to consider many features at the same time to simplify their decision-making process for smartphones purchase	–	11	121
Website design parameters importance [83]	To determine the importance degree of website design parameters	19	7	5
Quality evaluation of blog interfaces [62]	To explore the critical factors influencing the quality of blog interfaces and the causal relationships between these factors, enabling blog interfaces to be designed more effectively	8	4	8
Design quality of online shopping websites in Turkey [63]	To evaluate the perceived design quality of websites while considering the interactions among design characteristics.	19	6	5
Causal relations of technological innovation capabilities of Thai technology-based firms [120].	To analyse the technology innovation capabilities (TICs) evaluation factors of enterprises	16	6	11
Sustainable supply chain management in a case electronics company [90].	To identify and analyse criteria and alternatives in incomplete information for ensuring sustainable supply chain management	22	4	20
Factors affecting consumers decisions to buy a product [82].	To explore the relationship of factors affecting consumers' behaviours in buying green products	–	9	6

Note: Factors refer to the key variables, features or performance factors, whereas criteria refer to the groups of these factors

In terms of the educational requirements, in most relevant studies, a minimum bachelor's degree in the relevant field is set as the basic criteria for involving experts. Shao et al. [73] included PhD and master degrees holders in their study. Asad et al. [119] included three bachelors, nine masters and eight PhDs. A minimum of bachelor's degree was set as the requirement by Kumar and Dash [72], whereas a tertiary level of education was set as the inclusion criteria by Tan et al. [64]. Considering the above relevant studies and the associated definitions of experts, this study involves over 50 REOP users with at least two years of REOP usage experience or at least five successful rents, purchase or sales using REOPs. Educational requirements are set at a minimum of a high school degree or diploma as REOP usage does not need higher qualifications. Table 3 lists the requirements for different groups in the context of this study.

Table 3
Criteria and their details and justifications for the current study.

Criterion	Details
Groups	Users (buyers, renters, owners, sellers)
Basic Requirements	A minimum of five rent, buy or sale decisions using real estate websites for buyers, renters, or sellers.
Experience	Used the REOP websites for more than two years
Education	At least a high school degree/diploma
Language	Fluent in English
Data collection procedure	Online
Approaching the Respondents	Emails, social media (LinkedIn, Facebook, WhatsApp)
Responses Requested	125
Completed Responses Received	65

4.4. Questionnaire Development, sample Targeting, distribution and validation

A comprehensive questionnaire was developed for assessing the user perception of REOPs. The questionnaire has been developed following the standard DEMATEL procedure of matrix-based data collection. The questionnaire consisted of two parts: basic details and criteria assessments. In the basic details sections, the gender, age, education, type of users, and experience of using REOPs were inquired. A descriptive section was also provided where the users were requested to list down the key factors that dictate their decisions to use or otherwise refrain from using a REOP. In the criteria assessment section, the seven criteria were presented to the users and requested to rank them against each other. Since there are seven assessment criteria in this study, seven matrices are used to collect data for all criteria shown in Table 1 and their influence on each other. The resultant matrix was the average of these seven matrices in the form of a 7x7 matrix. Standard DEMATEL questions were included for the influence of all criteria on each other. The respondents were asked to rate the degree of influence of the criteria on each other. A scale of 0 to 4 was provided in the matrix, and the respondents were asked to choose the pertinent number corresponding to the degree of influence of constructs on each other. As such, 0 refers to no influence, and 4 refers to very high influence in line with the standard DEMATEL questionnaire.

Non-probability sampling approach was adopted in this study. Accordingly, mixed approaches, including convenience sampling and snowball sampling approach, were used. Table 3 summarises how the respondents were targeted and approached for convenience sampling. The users were approached through online means such as university emails, official emails taken from LinkedIn, property management and real estate organisations working in Australia. The respondents were approached through online means as in-person distribution was not allowed due to Australia's COVID-19 restrictions. The questionnaire was shared and distributed with them through the UNSW Qualtrics platform. For the snowball sam-

pling approach, these respondents were requested to recruit other users and share the survey with them. All the respondents were asked the inclusion criteria question first, i.e., if they have been using the REOPs for more than two years or have made at least five successful rents, purchases or sales using REOPs and if they are fluent in English? If the answer to all these questions was affirmative, they were requested to be part of the data collection process; otherwise, the survey was not shared with them.

For the sample size, various studies have indicated the sample requirement for similar contexts to be between 40 and 60 respondents [121–123]. Accordingly, the study of Farooq et al. [124] used a sample of 53 respondents calculated using Cochran [122] formula as given in equation (10). Where n refers to the sample size, m to the margin of error, p to the sample mean and t to the factor linked with the confidence level. In the pertinent study, the assumptions were a margin of error ± 15%, confidence level 95% and the sample mean 50% resulting in 43 respondents' requirements. The same logic is applied in the current study. Thus, a total of 125 users were requested to be part of the study. Among them, 67 agreed to participate. Out of these, 65 attempted the questionnaire properly, whereas two did not complete it; thus, their responses were rejected. Accordingly, a response rate of 52% is achieved in the current study.

$$n = \frac{t^2 p(1-p)}{m^2} \tag{10}$$

The questionnaire was validated through a pilot survey of 17 respondents. These respondents comprised 11 academic researchers, including PhD students and lecturers, and six real estate agents based in Australia. They validated the survey questions and proposed changes in case of ambiguities—this ensured clarity of communication and logic. Further, the content validity and the construct validity for the survey questions was ensured. The internal consistency of the data was assessed using the Cronbach alpha test, where for checking the reliability of the questionnaire, the value of alpha greater than 0.7 are acceptable [125].

5. Developing the conceptual model

The conceptual RSISTAM model is presented in Fig. 2. As Lee [103] discussed, the user-perceived risk (PR) influences the PU of the information system. According to Huang et al. [103], perceived information quality (PIQ) affects PU and PEU. Similarly, as per Sánchez and Hueros [112], perceived service quality (PSEQ) affects the PEU. Lastly, as per Calisir et al. [110], perceived system quality (PSYQ) affects PEU. All these relations have been combined to visualise an RSISTAM model proposed in the current study, as shown in Fig. 2.

Further, as discussed in the TAM section (section 2), a gap was uncovered where the two-way relationships between the TAM constructs are differently visualised in various studies. Thus, the current study addresses this gap. Accordingly, Fig. 2 shows the assumptions for RSISTAM constructs investigated in the current study using DEMATEL. In the RSISTAM model, all criteria are visualised to be interconnected, and a final decision will only be made after DEMATEL analyses to separate the causes and effects. In Fig. 2, the solid lines show forward relations, whereas the dashed lines represent backward relation or influence.

6. Results and discussions

In the first section of the questionnaire, basic details such as the demographics of the users were inquired that are discussed subsequently.

6.1. Respondents Demographics

Most of the respondents identified themselves as males followed by females, and none was identified as a binary or third gender, as shown in Table 4.

In terms of the age of the respondents, most respondents of the current survey are younger or mid-aged users. Though a contributing factor to this may be the respondents targeted through university emails and profiles, the age was not considered while recruiting the respondents. In this case, the only limit was that of respondents being above 18 years for legal purposes. This finding of younger respondents being more willing to participate in such surveys is in line with other studies of similar context. As discussed by Ullah and Sepasgozar [20], most of the young generation is tech-savvy or tech zombies since they are more technology aware. This validates the findings of the current study in line with other studies like Low et al. [126]. Nevertheless, more than 90% of the current study respondents are aged less than or equal to 40 years, with around 60% ageing between 18 and 30. Only six respondents were declared to be above 40 years of age.

Further, as evident from Table 4, more than 60% (42) of respondents were identified as buyers or renters or potential buyers or renters. Similarly, 17 users identified themselves as general users who were not looking to buy, sell or rent anything but keeping themselves aware of the REOPs. The remaining five respondents were identified as owners or sellers, or potential sellers. In terms of the jobs or roles of the respondents, more than 60% of the respondents are classified as students/researchers or academic lecturers/professors. Again, this is attributed to the users being contacted through university emails.

More than 30% of the respondents identified themselves as industry or field professionals, and four respondents selected the "other" category. In terms of the education of the respondents, it is positive to see that more than 80% of the respondents have a higher qualification, i.e. masters or PhD. Overall, only two respondents were identified to have an education level below a bachelor's degree. However, they were experienced in REOPs usage and had more than two years of user experience and made successful purchases and rents using REOPs. A high level of education allows the respondents to understand the key factors effectively. Accordingly, the data can be trusted to have high quality due to the highly educated respondents in the relevant fields.

In terms of using the REOPs, more than 65% of the respondents had REOP usage experience of more than two years. Twenty-two respondents reported having less than two years of experience who were only involved in the study because they had made more than five rent, buy, or sell decisions using the REOPs in line with the inclusion criteria of the study. Most of the respondents had around 2–5 years of REOP usage experience, followed by less than two years, 6–10 years, and 11–20 years.

6.2. Statistical calculations

In line with the DEMATEL calculations, the average matrix is calculated first. For calculating the average matrix (Z), the influence of all criteria on each other is assessed through an influence matrix. In the current study, this was captured through the questionnaire survey. Table 5 presents the influence, the percentage of respondents agreeing, standard deviations, variances, and mean values of the responses. For almost all of the constructs, the influence is in the range of medium to a high level representing the presence of a two-way relationship or mutual dependence of the constructs on each other. This also signifies the importance of these perceptions and validates the grouping of factors formulated in the current study. The differences are observed for the influence of PR on PEU and PEU on BAU, where the mean values are between

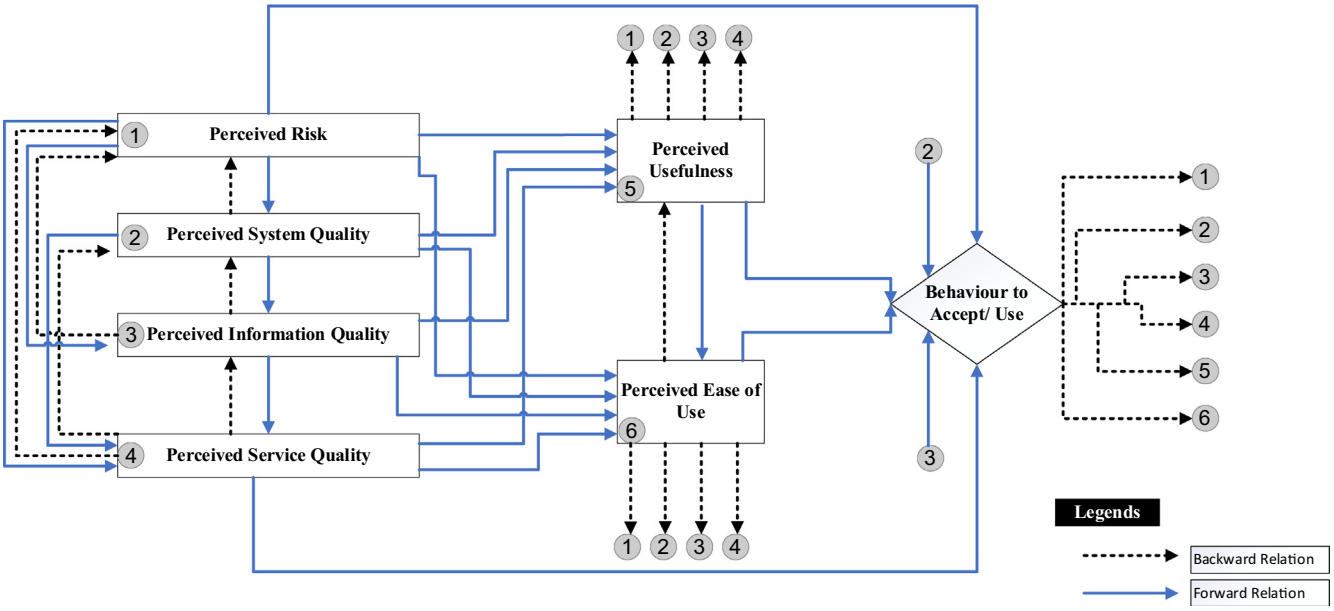

Fig. 2. RSISTAM constructs and their two-way relationships assumptions for DEMATEL.

Table 4
Demographics of the respondents.

The Demographics Characteristics	Frequency	Percentage	
Gender	Male	52	80
	Female	13	20
Age	18–30	38	59
	31–40	21	32
	41–50	02	03
	Above 50	04	06
Education			
	High School	02	3.07
	Bachelors	09	13.85
	Masters	41	63.08
	Doctoral	13	20
Job/Role	Student/Researcher	36	55.38
	Academic Lecturer/Professor	06	9.23
	Industry/Field Professional	20	30.77
	Other	04	4.62
Respondent Type	Buyers or renters or potential buyers or renters	42	64.62
	General user (not looking to buy, rent or sell)	17	26.15
	Owner/seller or potential seller	05	7.69
	Other	1	1.54
REOP Usage Experience	Less than 2 years	22	4.62
	2–5 years	35	53.85
	6–10 years	05	7.69
	11–20 years	03	4.62

high to very high influence. Further, no values were observed to be peaking at no influence to low or low to medium ranges, signifying mutual relations between the perceptions.

Once all the influences are determined, the mean values are generated for all criteria on each other. All the values are around one standard deviation from the mean showing a consensus among the respondents. In some cases, the values are on the upper side of one compared, indicating a wider spread of responses comparatively.

The average variance was calculated for all constructs to investigate the homogeneity of the variances for factors. All the values are homogeneous except for PU, where the variance is almost double the remaining constructs. This reinforces the claims of lack of consensus on PU in line with the studies of Chen et al. [24] and Abdullah et al. [23]. Abdullah et al. [23] highlighted that PU affects PEOU, whereas Chen et al. [24] stressed that PEOU affects PU. This highlighted the lack of consensus on PU. The current study shows similar results where except for PU, all the variances are within or around one standard deviation from the mean, reflecting greater consensus among the respondents.

Cronbach alpha value was calculated to determine the internal consistency between the respondent's opinions related to the influence of criteria on each other. The Cronbach alpha value was determined to be 0.948, which is well above the acceptable limits of 0.7. This verifies the consistency and hence the reliability of the data for the analyses conducted in the current study.

6.3. DEMATEL calculations and discussions

As explained in the method section, the first step in DEMATEL analysis is to calculate the average matrix (Z), which is formulated using the mean values of the responses. A 7 × 7 average matrix is presented in Table 6 that is used for DEMATEL analysis.

After formulating the average matrix, it is normalised in the next step. For this purpose, Equations (2) and (3) are used. Firstly, the sum of the rows is calculated. The highest number is recorded as the denominator for dividing all the average matrix values to get the normalised matrix (D), as shown in Table 7. In the current study, the highest row sum value was 18.02, and all the values are divided by it to get the values in the normalised matrix.

In the third step for calculating the total relation matrix (T), the identity matrix is required that must be equal to the $n \times n$ matrix used for the study. In this case, a 7 × 7 identity matrix (I) is used. Once the identity matrix and the normalised direct matrix are finalised, Equations (4) and (5) are used to calculate the total relation matrix (T). For this purpose, following Equation (4), the I-D matrix is presented in Table 8. For calculating this matrix, all the matrix D values are subtracted from the identity matrix (I).

Similarly, following Equation (4), the inverse of I-D is calculated that is shown in Table 9. For this purpose, the array function in MS Excel was used with the MINVERSE function (=MINVERSE(array)) for calculating the inverse matrix.

Table 5
Influence of criteria on each other.

Influencing Criteria	Criteria Influenced	Med-High Influence	High-Very High Influence	Percentage of Agreement	Mean Value	Std Deviation	Variance	Average Variance
PR	PSYQ	✓		76.92%	2.08	0.85	0.72	0.997
	PIQ	✓		64.61%	2.35	1.03	1.06	
	PSEQ	✓		75.38%	2.32	0.95	0.9	
	PU	✓		69.23%	2.51	1.02	1.05	
	PEU		✓	60.00%	2.65	1.12	1.24	
	BAU	✓		70.77%	2.62	1	1.01	
PSYQ	PR	✓		66.15%	2.31	1.09	1.2	0.903
	PIQ	✓		73.85%	2.45	0.91	0.83	
	PSEQ	✓		80.00%	2.46	0.84	0.71	
	PU	✓		72.31%	2.69	0.91	0.83	
	PEU	✓		61.54%	2.65	1.06	1.12	
	BAU	✓		78.46%	2.40	0.86	0.73	
PIQ	PR	✓		60.00%	2.37	1.08	1.16	1.068
	PSYQ	✓		69.23%	2.31	1.04	1.07	
	PSEQ	✓		64.61%	2.35	1.12	1.24	
	PU	✓		61.53%	2.78	1	1	
	PEU	✓		70.77%	2.57	0.98	0.95	
	BAU	✓		67.69%	2.68	0.99	0.99	
PSEQ	PR	✓		64.61%	2.29	1.11	1.22	1.008
	PSYQ	✓		67.69%	2.32	0.99	0.99	
	PIQ	✓		72.30%	2.40	0.99	0.98	
	PU	✓		67.69%	2.71	0.99	0.98	
	PEU	✓		64.61%	2.68	0.96	0.93	
	BAU	✓		63.08%	2.71	0.97	0.95	
PU	PR	✓		64.62%	2.46	1.3	1.69	1.832
	PSYQ	✓		73.84%	2.48	1.2	1.45	
	PIQ	✓		66.15%	2.83	1.39	1.93	
	PSEQ	✓		55.39%	2.92	1.52	2.32	
	PEU	✓		66.16%	2.98	1.29	1.68	
	BAU	✓		61.54%	3.02	1.39	1.92	
PEU	PR	✓		55.38%	2.15	1.13	1.27	1.085
	PSYQ	✓		60.00%	2.45	1.08	1.17	
	PIQ	✓		67.69%	2.49	1.01	1.02	
	PSEQ	✓		64.62%	2.62	1	1.01	
	PU	✓		58.47%	2.65	1.06	1.12	
	BAU		✓	64.61%	2.82	0.96	0.92	
BAU	PR	✓		56.92%	2.35	1.18	1.4	1.003
	PSYQ	✓		64.62%	2.46	1.04	1.08	
	PIQ	✓		66.15%	2.68	0.98	0.96	
	PSEQ	✓		69.23%	2.71	0.94	0.88	
	PU	✓		69.23%	2.71	0.94	0.88	
	PEU	✓		67.69%	2.78	0.9	0.82	

Table 6
Average matrix (Z).

	PR	PSYQ	PIQ	PSEQ	PU	PEU	BAU
PR		2.65	2.67	2.62	2.74	2.50	2.75
PSYQ	2.46		2.65	2.66	2.80	2.74	2.79
PIQ	2.66	2.75		2.73	3.06	2.80	3.04
PSEQ	2.64	2.76	2.67		3.14	2.90	3.09
PU	2.78	2.95	3.02	2.96		2.90	2.95
PEU	2.90	2.90	2.86	2.96	3.20		3.19
BAU	2.87	2.70	2.94	2.96	3.18	3.04	

Table 7
Normalised initial direct matrix (D).

	PR	PSYQ	PIQ	PSEQ	PU	PEU	BAU
PR		0.15	0.15	0.15	0.15	0.14	0.15
PSYQ	0.14		0.15	0.15	0.16	0.15	0.15
PIQ	0.15	0.15		0.15	0.17	0.16	0.17
PSEQ	0.15	0.15	0.15		0.17	0.16	0.17
PU	0.15	0.16	0.17	0.16		0.16	0.16
PEU	0.16	0.16	0.16	0.16	0.18		0.18
BAU	0.16	0.15	0.16	0.16	0.18	0.17	

Once the I-D and its inverse matrices are calculated, the total relation matrix (T) can be calculated using Equation (5). For this purpose, the Microsoft Excel function of matrix multiplication (=MMULT(array1,array2)) is used in arrays. Multiplying the I-D and its inverse gives the total relation matrix (T), as shown in Table 10.

Table 8
I-D matrix.

	PR	PSYQ	PIQ	PSEQ	PU	PEU	BAU
PR	1.00	−0.15	−0.15	−0.15	−0.15	−0.14	−0.15
PSYQ	−0.14	1.00	−0.15	−0.15	−0.16	−0.15	−0.15
PIQ	−0.15	−0.15	1.00	−0.15	−0.17	−0.16	−0.17
PSEQ	−0.15	−0.15	−0.15	1.00	−0.17	−0.16	−0.17
PU	−0.15	−0.16	−0.17	−0.16	1.00	−0.16	−0.16
PEU	−0.16	−0.16	−0.16	−0.16	−0.18	1.00	−0.18
BAU	−0.16	−0.15	−0.16	−0.16	−0.18	−0.17	1.00

After calculating the total relation matrix (T), the sum of rows and columns was calculated using Equations (6) and (7). Further, these were used to calculate the overall prominence and the net effect using Equations (8) and (9). Table 11 lists the prominence, net effects and classification of the criteria into causes and effects.

As stated in the method, the factor with a positive net effect is a cause, and the one with a negative net effect is an effect. Table 11 shows that PIQ, PSEQ, and PEU are the causes and PR, PSYQ, PU and BAU are the effects. The highest prominence is observed for PEU followed by PSEQ and PIQ respectively among the cause groups, whereas among the effect group, the net effect is highest for PSYQ followed by PU, PR and BAU.

Once the criteria are classified into causes and effects, a threshold value (α) is set up, and the cause-effect diagram (digraph) is drawn. As discussed in the method section, the average of the total relation matrix (T) gives the threshold value. For this purpose, the average function of Microsoft Excel for all members of the matrix is used. Accordingly, the threshold value (α) in the current study is equal to 2.638. Table 12 lists all the values among the total relation matrix (T) above the threshold value. These are used to draw the digraph and establish the direction of the relation between the criteria.

Important findings from the digraph values are summarised in Table 13. The current study highlights two-way relationships between PSYQ and PU in contrast to existing studies that suggest PSYQ affecting PU and lacking the backward relationship between the two constructs. This highlights that the REOPs managers should use high-quality systems to make the most of their online portals. These high-quality systems will positively influence the PU of the users. On the other hand, poor quality systems used on REOPs will discourage the users from adopting them.

Similarly, other two way relationships for PU are observed with PIQ, PSEQ, PEU and BAU. These relationships highlight the make or break situations for REOP adoption where high quality, reliable and transparent information provided through REOPs encourages the users to adopt or use the REOPs and develop positive perceptions about them. The usefulness perception is further strengthened by providing a better quality of services, prompt responses to queries and follow-ups by REOP managers. Further, the users' perceptions of the PEU of REOPs also enhance their usefulness perceptions. Lastly, the PU depends on users' behaviour and users with positive behaviour and more willingness to experiment with REOPs develop positive users' perceptions and vice versa.

In the absence of the qualities mentioned above and related features, the users will likely develop a negative PU of the REOPs, leading to lesser utilisation. Compared to existing literature, the current study established a two-way relationship between these perceptions. In comparison, the published literature mainly focuses on the one-way relations between them. The only agreement is in the case of PU and PEU affecting each other; however, multiple studies think one way or another about the influence of this relation. Table 13 provides a comparison of current study findings with existing studies. Other important findings of the current study are backward relation or back loop from PEU to PR, PSYQ and PIQ. A similar loop exists from BAU to PSYQ and PR. Previous studies have not explored these relations, as evident from Table 13.

Based on the data in Table 11 and 12, the relationships between the proposed RSISTAM model criteria are visualised in Fig. 3. PU and BAU get influenced by most criteria. In return, BAU influences all criteria in the RSISTAM model. Similarly, based on the row-wise values in Table 12, all linkages are established. PEU also affects all other criteria; PU affects all criteria except PR. Similarly, PSEQ affects PU, PEU and BAU. PIQ affects PU and BAU; PSYQ affects PU only, whereas PR affects none of the seven criteria. However, it is affected by PEU and BAU, as evident from Fig. 3. Comparing the two-way relationships, PEU, PSEQ, PIQ, and BAU have a slightly stronger influence on PU than PU's influence on them. However, PU has a stronger influence on PSYQ. Thus usefulness creates the perceptions of higher systems quality. Similarly, PEU, PSEQ and PIQ have a higher influence on BAU, comparatively reinstating their roles in dictating the users' behaviour to adopt or use any system.

Based on the linkages of the RSISTAM model and the values in Table 12, the DEMATEL digraph is drawn, as shown in Fig. 4. The combined prominence and causal relationship graph present several types of information in a combined view that can be analysed from different perspectives. The x-axis in Fig. 4 shows the prominence. This corresponds to the prominence or relevance of the criteria. Thus, further to the right, the barrier is perceived as more prominent or relevant. The y-axis shows the net causes and effects. Accordingly, the values above zero indicate net causes, whereas negative values indicate net effects. Looking at the negative y-axis, four criteria are categorised as net effects: BAU, PR, PSYQ and PU. Among them, PR is the least prominent or relevant criteria, followed by PSYQ and PU. In comparison, PU and BAU are the most prominent criteria in effects groups which are in line with the main assumptions of the TAM model. Considering the positive y-axis,

Table 9
Inverse I-D matrix.

	PR	PSYQ	PIQ	PSEQ	PU	PEU	BAU
PR	3.280	2.455	2.468	2.475	2.626	2.471	2.589
PSYQ	2.425	3.352	2.492	2.503	2.656	2.506	2.617
PIQ	2.550	2.604	3.485	2.626	2.795	2.629	2.754
PSEQ	2.569	2.625	2.634	3.515	2.820	2.654	2.778
PU	2.617	2.675	2.691	2.699	3.717	2.697	2.816
PEU	2.678	2.731	2.743	2.757	2.930	3.617	2.887
BAU	2.638	2.683	2.706	2.717	2.887	2.721	3.695

Table 10
Total relation matrix (T).

	PR	PSYQ	PIQ	PSEQ	PU	PEU	BAU
PR	2.28	2.45	2.47	2.48	2.63	2.47	2.59
PSYQ	2.42	2.35	2.49	2.50	2.66	2.51	2.62
PIQ	2.55	2.60	2.48	2.63	2.79	2.63	2.75
PSEQ	2.57	2.62	2.63	2.52	2.82	2.65	2.78
PU	2.62	2.67	2.69	2.70	2.72	2.70	2.82
PEU	2.68	2.73	2.74	2.76	2.93	2.62	2.89
BAU	2.64	2.68	2.71	2.72	2.89	2.72	2.70

Table 11
Prominence, net effect and factor identity.

Factor	Prominence r + c	Net Effect r-c	Identity
PR	35.121	−0.395	Effect
PSYQ	35.675	−0.573	Effect
PIQ	36.662	0.224	Cause
PSEQ	36.888	0.303	Cause
PU	38.340	−0.518	Effect
PEU	37.637	1.048	Cause
BAU	38.183	−0.089	Effect

PIQ, PSEQ and PEU are classified as net causes. Among these, the order of prominence is PEU > PSEQ > PIQ. In terms of the causes, the order is PEU > PSEQ > PIQ.

The identification of the net causes such as PIQ, PSEQ and PEU highlights that the user behaviour is shaped by their perceptions of the quality of the information, the system through which this information is provided, and the ease of use of the REOP. While most of the TAM studies have categorised BAU as the last or final part of the technology acceptance, the current study highlights that it is more of an iterative step shaped by PIQ, PSEQ and PEU. Thus, the behaviour is dictated by the perceptions, and there is a back loop where behaviours specific to individuals will dictate their usage of REOPs. This is also supported by Chen and Tsai [60], who argued that PIQ, PSEQ and PEU affect the user intentions and behaviours to accept or use a service or technology. The same is supported by some of the respondents who highlighted that if they perceive a REOP to be fraudulent or misleading, they will never use it. This highlights the dependencies of behaviours on users' perceptions.

For the dynamism and interdependencies of the criteria, it is important to assess both the forward and backward relations, as outlined in the current study. None of the studies published so far has taken this strong backlink of TAM constructs into account especially the PU and BAU, which is a humble contribution to the current study. Among the very few studies, Lin [108] has discussed the role of BAU in shaping the perceptions and corresponding intentions to use websites. However, the strength of this link has not been assessed and contextualised to REOPs. Accordingly, when shaped positively through high-quality, transparent websites with voluminous information, users' behaviours incline them to accept and use the REOPs.

PEU, which is the highest-ranked criteria among the causes, has been declared a precursor for BAU by Hussain et al. [49]. The authors argue that the PEU has the highest influence in shaping the users' BAU which supports the findings of the current study. For shaping the PEU of users, it has been recommended by the respondents and pertinent studies to provide more learning tutorials, more options to filter out the results, videos, and visualised materials [13,17,62]. This is also in line with the TAM main constructs where it is stated that the easier it is to use the information system, the efficacy of using it by the users will increase. Such perceived efficacy and ease of use of the REOPs will certainly shape positive users' perceptions to motivate more users to use and recommend the REOPs.

The second most important criteria is that of PIQ. Chung and Tan [102] discussed that a well-designed site helps ensure a positive user experience and repeated usage. Furthermore, playful content ensures more usage as it affects the cognitive aspects of the users. This is in line with Felli et al. [13], who recommended more playful and immersive visualisations of the properties using 360° videos and other latest tools. The current study contextualises and reinforces the findings of these studies in the real estate context and implies that more playful, immersive, and visualised content should be provided on the REOPs to attract or retain more users. When provided with such immersive experiences, the users will develop positive perceptions that will incline them to accept the REOPs and rely on them for making better, informed, and intelligent decisions. This will also tackle their regrets related to the quality of the information provided on REOPs.

The third important cause is that of PSEQ. Barua et al. [93] discussed that perceived reliability, perceived security and perceived control helps shape the PSEQ. Pei and Zhenxiang [134] supported this and suggested adding more personalisation options to the web portals to attract more users. Thus, REOP managers must provide more reliable services that are more secure and empower users to take control. Provisions of high-quality services, follow-ups based on the feedbacks of the REOP users, and having an internal assessment system to regularly assess and improve the quality of the services provided to the users will paint positive perceptions of the REOP users. This will bring more business to the online real estate business.

Table 12
Values about the threshold for drawing the digraph.

	PR	PSYQ	PIQ	PSEQ	PU	PEU	BAU
PR							
PSYQ					2.656		
PIQ					2.795		2.754
PSEQ					2.820	2.654	2.778
PU		2.675	2.691	2.699		2.697	2.816
PEU	2.678	2.731	2.743	2.757	2.930		2.887
BAU	2.638	2.683	2.706	2.717	2.887	2.721	
	Legends						
	Backward Relation	Forward Relation	Not Possible	Below Threshold			

Table 13
Important relationships highlighted in the current study.

Relationships	Relationship Type	Interpretation in this context	Comparison to Published literature
PSYQ ⟷ PU	Two-Way	High-quality REOP systems such as websites and apps positively influence the users' perceptions related to the usefulness of REOPs and vice versa.	PSYQ affects PU [127]. Backlink not considered
PIQ ⟷PU	Two-Way	High-quality, reliable and transparent information positively influence the users' perceptions related to the usefulness of REOPs and vice versa.	PIQ affects PU [128]. Backlink not considered
PSEQ ⟷PU	Two-Way	Better quality of services, prompt responses, and follow-ups by REOP managers positively influence the users' perceptions related to the usefulness of REOPs and vice versa.	PSEQ affects PU [129]. Backlink not considered
PEU ⟷PU	Two-Way	The ease of use of REOPs, enabled through immersive playful contents and improved self-efficacy of the users, positively influence their perceptions related to the usefulness of REOPs and vice versa.	PEU affects PU [23,40,130]. PU affects PEU [41,42]. Both affect each other [21,25]
BAU ⟷PU	Two-Way	The behaviour of the users to use REOPs positively influence their perceptions related to the usefulness of REOPs and vice versa.	PU affects BAU [130]. Backlink not considered
PSYQ ⟷PEU	Two-Way	High-quality REOP systems such as websites and apps positively influence the users' perceptions of ease of use of REOPs and vice versa.	PSYQ affects PEU [110]. Backlink not considered
BAU ⟷PEU	Two-Way	The behaviour of the users to utilise REOPs positively influence their perceptions related to ease of use of REOPs and vice versa.	PEU affects BAU [130]. Backlink not considered
PIQ ⟷BAU	Two-Way	High-quality, reliable and transparent information positively influences users' behaviour to start using the REOPs and vice versa.	PIQ affects BAU [128]. Backlink not considered
PSYQ ⟷BAU	Two-Way	High-quality REOP systems such as websites and apps positively influence the users' behaviour to start using the REOPs and vice versa.	PSYQ affects BAU [110]. Backlink not considered
PEU → PR	Back Relation	The ease of use of REOPs enabled through immersive playful contents and improved self-efficacy of the users influences their perceptions related to risks of REOPs.	PR affects PEU [24,118]. Reverse link not considered, which is more significant in the current study.
PEU → PSYQ	Back Relation	The ease of use of REOPs enabled through immersive playful contents, and improved self-efficacy influences their perceptions related to systems used by REOPs.	PSYQ affects PEU [30,110,128]. Reverse link not considered, which is more significant in the current study.
PEU → PIQ	Back Relation	The ease of use of REOPs enabled through immersive playful contents, and improved self-efficacy influences their perceptions of information quality on REOPs.	PIQ affects PEU [128,131].Reverse link not considered, which is more significant in the current study.
BAU → PSYQ	Back Relation	The behaviour of users to utilise REOPs influences their perceptions related to the quality of systems used by REOPs.	PSYQ affects BAU [110,132,133]. Reverse link not considered, which is more significant in the current study.
BAU → PR	Back Relation	The behaviour of the users to utilise REOPs influences their perceptions related to the risks of REOPs.	PR affects BAU [24,118]. Reverse link not considered, which is more significant in the current study.

PR, PSYQ, PU and BAU are categorised as the net effects. As discussed by Chen et al. [24], PR negatively relates to PEU and PSEQ, meaning that more PEU and better PSEQ reduce PR. Modern smart users tend to avoid risky REOPs where personal information or security may be compromised. This is evident from millions of users leaving the famous messaging platform WhatsApp over its recent policy changes where the users' data may be shared with other platforms. WhatsApp was forced to explain this context; however, the doubts created in users' minds inclined many users to switch to other platforms. The same applies to this study where the users avoid risky REOP with misleading, false, or misrepresented data and an insecure portal where the users' data may be compromised due to the negative risk perceptions. Thus, to have lesser PR, the REOP managers and developers must focus on the net causes and improve the user perceptions through addressing the causes such as PIQ, PSEQ and PEU.

For PSYQ, as discussed by Al-Jabri and Roztocki [92], there is a strong relationship between PU and PSYQ that is dictated by the usefulness of the information and the system through which the information is provided to the web users. To shape positive PSYQ, the REOP managers must provide transparent, high quality and more information to the users through high performing systems. These include providing high-speed results, easy to use web portals, well-structured content and immersive user experience through high-quality designs of the REOPs.

Lastly, the most prominent net effects are that of BAU and PU. This is in line with the main assumptions of TAM, where PU is among the two most prominent construct of TAM. Multiple studies have argued that for having more BAU and PU, it is imperative to focus on the qualities of systems, services, and information provided to the users [23,49,99]. Abdullah et al. [23] suggested adding more enjoyable, immersive, and easy to use content to the websites to help attract and retain more customers and improve the PU and BAU of the REOP users. Similarly, McDowell et al. [131] stressed the need for accurate, reliable and high-quality information to shape the PU of the users for accepting technologies. The current study reinforces these findings for the REOPs' context, which aligns with the respondents' opinions. Accordingly, multiple respondents stressed the need for more user-friendly, responsive, and easy to understand REOPs that present new and updated information, updated market prices and properties, and have a variety of listings, large range of properties and provide a comparison of two or three similar properties.

6.4. Respondents discussion analysis

To correlate the study findings with individual respondents' opinions and discussion, an open-ended question was asked from the respondents to discuss the factors that motivate them or bar them from using REOPs as mentioned in the method section. The word cloud presented in Fig. 5 shows the most repeated or cited keywords mined from the obtained responses. Accordingly, the most cited reasons include information quality or presence cited by 32 respondents (49%), content on the REOP (35%), platform quality, rankings and recommendations (29%), easy to use (28%), easy to understand (22%), more property details (20%), more real estate options (18%), speed such as loading and response (17%), platform design (15%), new or novel information (15%), accurate information (11%), more factors (11%), search results (11%), lesser time and quicker response (9%) and more user recommendations (8%). These are mentioned by at least five respondents each.

A respondent highlighted the problems of REOPs and stated, "*I have used Gumtree (an Australian REOP). The problems I have faced are that there are often irrelevant top listed or advertised items. Some*

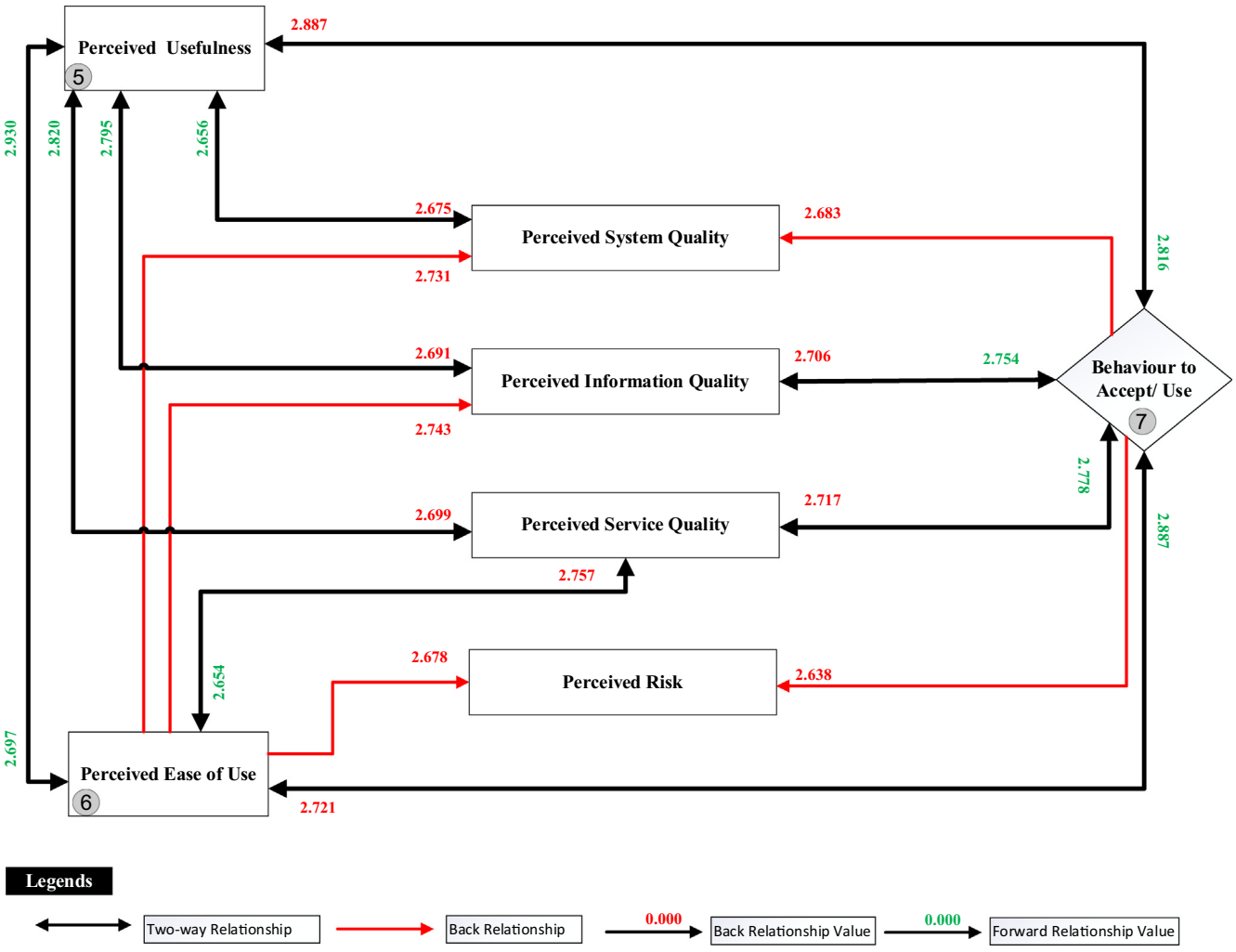

Fig. 3. RSISTAM Linkages.

advertised items have no image or details, which I think must be mandatory. The veracity or authenticity of data/images is another issue as some images do not reflect the reality of the properties. Further, if someone is concerned about the exact location of a property, he/she might sometimes find it difficult to locate it." This reinforces the findings of the study, where the PIQ is identified as a cause for REOPs' perception. Accordingly, any poor quality, false or misleading information provided on the REOP paints a negative user perception leading to the users avoiding such portals. Thus, the users must be provided with more playful, immersive, and visualised content on the REOPs. Based on immersive experiences, these users will develop positive perceptions about the REOPs, thus tackling their regrets related to the quality of the information provided on REOPs. This will enhance the REOPs business due to more happy and satisfied customers.

The issues of poor information quality are further exacerbated in the COVID-19 era, where the users cannot inspect the properties in person and must rely on online information. A respondent proposed using virtual tours and virtual reality powered platforms and stated, "*some information is not given on the platform and can only be obtained after manually visiting the property. There should be a virtual platform that can give everything we need without manually visiting*". Again, this is a valid concern where people do not want to inspect the properties due to fears of COVID-19 and social distancing rules. However, as suggested by the respondent, providing immersive visualised tours and the ability to furnish and move the property furniture around virtually can help the users better visualise their dream homes. This will create a sense of belonging that will shape positive perceptions and induce more inclinations to rent or buy the property through REOPs.

A respondent highlighted the design of the REOP as an impediment to its adoption or usage by the users. The respondent stated, "*design is important as it can make the REOP user friendly and subsequently affect the ease to use. Content is also important as sometimes content mentions the most important points that are very important for searching on a real estate app.*" Another respondent reinforced the design aspects and stated, "*the user experience through friendly and easy to use user interface is the most critical factor that dictates my decision to use a platform*". Others stressed adding more filters and options to the REOP for attracting more users. A respondent stated their decision to use a REOP is influenced by the "*ability to filter search results using lots of choices for filters, ability to add viewing times to calendar directly, and ease of contact with viewing agent*". A respondent suggested updating and upgrading the REOPs and stated, "*easy to use REOP means more traffic on the platform thus the REOPs management need more updated content, adaptation and up-gradation with time to stay in business*". These are in line with the PSYQ highlighted in the current study. The positive perceptions related to the quality of the system of the REOPs are painted through reliable, high-quality information, quicker responses and loading speeds, well-structured content, and high-quality designs of the REOPs as outlined in the findings of this study. The respon-

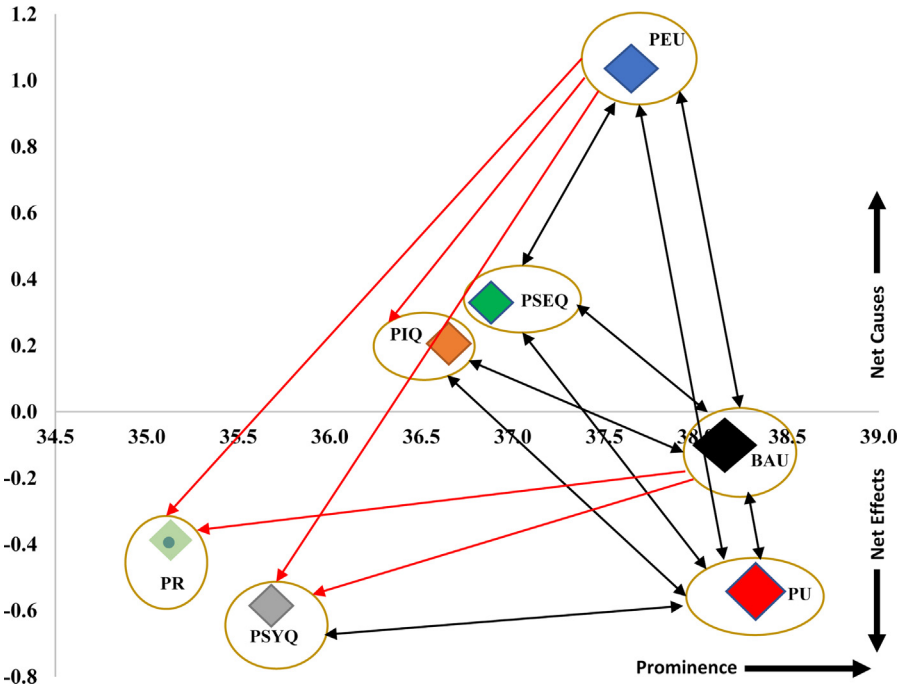

Fig. 4. DEMATEL Digraph.

Fig. 5. Word cloud of the responses.

dents' opinions reinforce these statements; thus, the REOP managers must provide voluminous, transparent, and reliable information to the users through high performing systems.

Other respondents insisted on the accuracy, quantity, quality, and details of information provided on the REOPS in addition to the content. A respondent stated, "*coverage of information, use of*

analytics to search more relevant options, quality and reliability of the content are my key factors to use a REOP." This is reinforced by another respondent who stated, "*most important is content and information put on the website. Detailed information, good graphics, ease of use, quick response from [the] real estate agent and answering to client queries dictate the usage of REOPs*." Another respondent had a similar view and stated, "*the key decisions to use REOPs include accuracy of information presented, amount of information on site, the ease of navigation that lead to appropriate outcomes. Further, issues that limit use include complex navigation systems,* i.e., *Domain.com installing QR code readers for more information on a property was a deterrent*." Another respondent stated four main reasons for the usage or refraining from any REOP as accuracy, interactivity, content, and privacy. The respondent states the following:

"*Accuracy - I will tend to use a platform that provides up to date and accurate information. Occasionally there are times where I find inconsistencies, and it becomes a factor as to whether I will use that platform again. For example, searching for 2-bedroom apartments sometimes provides results that are one-bedroom or studio apartments or inaccurate locations (*e.g., *Western Sydney property showing in the CBD on a map).*

Interactivity - I prefer to use more interactive platforms, e.g., with a map that updates based on my search as I move to different suburbs.

Content - Coming from an architectural background, I tend not to engage well with platforms that do not provide accurate floorplans or that use deceptive photography. I also like to use platforms that provide content regarding the current and historical costs of a property.

Privacy - I will use platforms that enable me to gather detailed information about a property without disclosing too much personal data. E.g., I do not enjoy receiving multiple emails about additional and sometimes irrelevant properties from doing one price check. Other factors would include the speed, user interface and response times of a platform but are somewhat secondary in my experience to the factors listed above."

These are in line with the PSEQ construct getting identified as an important cause for shaping REOPs users' perception. The PSEQ related positive perceptions could be developed by providing high-quality services, follow-ups, internal quality assurance, control and assessment systems and listening to the users as key stakeholders. Accordingly, more accurate, reliable, quick, and true information should be provided to the users coupled with more graphical statistics, easy to use and interactive web portals, and reliable and friendly real estate agents to shape positive perceptions of services provided to the users through REOPs.

Privacy is a key user concern. A respondent reinforced the privacy concerns and stated, "*the ease of use of the online platform and personal information security impact the decision of using a specific website designed on dealing with real estate*." A respondent suggested monitoring the REOP information by a competent authority to filter out irrelevant or fraudulent information. As stated by another respondent, "*the key factor to dictate my decision to use real estate platform is to avoid fraudulent REOPs and to find housing at the convenient location. I refrain [from] such [a] platform because one has to fill in a long application form which most of the time has no outcome*." Thus, the process of acquiring properties through REOPs and misleading information also impede their usage. The same is highlighted by another respondent who stated, "*the mapping of real estate inventories, their precision, and unrealistic price of properties are constraints in the usage of real estate platforms*." These are in line with the PR getting highlighted as a key cause of poor quality and unreliable information, and misleading REOPs. REOP users avoid risky platforms due to misleading, false, or misrepresented data shaping negative risk perceptions. Therefore, to avoid losing users due to such perceptions, the REOP managers must provide transparent, reliable, true, and relevant information with more details to the REOP users. More pictures, 3D and 360° videos and virtual tours of the property may help reduce the risks of REOPs and associated user regrets. Further, using reliable banking channels, secured transactions, and reliable third-party guarantors such as insurance agencies and banks will also help shape positive perceptions of REOPs. Other factors highlighted by the respondents include user-friendly design, quick response, new information, accessibility, informative content, updated information and updates, fast and easy system, easy access, updated market prices and properties, easy to understand portal, variety of listings, large range of properties, convenience, flexibility, recent trends about property prices to buy or rent, variety of content, the correctness of the information, and comparison of two or three similar properties.

7. Conclusions

The current study investigated the user perception of REOPs. A total of 35 factors were identified from the literature and grouped into seven criteria. These criteria include the SISQual from the ISSM model and the PU, PEU and BAU from TAM. A criterion of PR was also added to develop the RSISTAM model for assessing user perception of REOPs. The two-way relationship between the perceptions is assessed through the DEMATEL approach.

Data were collected from 65 REOP users using a comprehensive questionnaire to capture their perceptions. The most repeated or cited keywords presented by the respondents in an open-ended discussion include information quality or presence, content on the REOP, platform quality, rankings, and recommendations, easy to use and understand portals, more property details, more real estate options, speed such as loading and response, platform design, new or novel information, accurate information, more filters and search results, lesser time and quicker response and more recommendations. Other factors include updated market prices and properties listing, easy to understand system, the convenience of usage, flexibility, recent trends about property prices to buy or rent, the correctness of the information, and comparison of two or three similar properties. Further, the reasons for usage or refraining from using REOPS include irrelevant top listed or advertised items, need to manually visit to verify the information, complicated design of REOPs, non-friendly user interface, lack of filters and options, inaccurate information, quantity, quality, and details of information provided on the REOPs, coverage of information, lack of interactivity, poor content, and privacy concerns of the REOPs users. The statistical analysis shows a consensus between most respondents based on the standard deviations and variance of the responses. Further, most of the criteria have medium to higher influence on all other criteria pointing to stronger two-way relationships between the perceptions.

For the DEMATEL analysis, following the standard stepwise procedure, PIQ, PSEQ and PEU are classified as causes and PR, PSYQ, PU and BAU are classified as effects. The highest prominence is observed for PEU, followed by PSEQ and PIQ among the cause group, whereas among the effect group, the net effect is highest for PSYQ, followed by PU, PR and BAU. Further, PU and BAU have the highest influence among all criteria, where BAU affects all other criteria in the RSISTAM model. PIQ affects PU and BAU; PSYQ affects PU only, whereas PR affects none of the seven criteria. PIQ can be ensured through a well-designed site, playful content, and immersive visualisations of the properties to help attract or retain more users. For PSEQ, perceived reliability, perceived security, perceived control, and more personalisation options help attract more users. In the case of PEU, providing more learning tutorials, more options to filter out the results, immersive videos, and visualised materials can help attract more users. In terms of the net effects, PR, PSYQ, and PU are the key criteria. For addressing these, the

REOP managers must provide more transparent, high quality and more information to the users, focus on the qualities of systems, services and information provided to the users, add more enjoyable, immersive, and easy to use content to the websites, and provide accurate, reliable, and high-quality information.

The current study is a humble contribution to the body of knowledge concerning REOPs users' perception. It is the first study to develop the RSISTAM model and conduct associated DEMATEL analysis to assess the two-way relationship between REOP users' perception. The causes, as identified in the current study, can help the REOP web managers and developers target user-specific aspects and improve the online platforms in line with user perceptions to attract more or retain existing users. BAU is shaped in iterative steps by PIQ, PSEQ and PEU, and if the users perceive a REOP to be fraudulent or misleading, they will never use it. Accordingly, when shaped positively through high-quality, transparent websites with voluminous information, users' behaviours incline the users to accept and use the REOPs. For shaping the PEU of users, more learning tutorials, more options to filter out the results, videos, and visualised materials should be provided. Such perceived efficacy and ease of use of the REOPs will shape positive users' perceptions to motivate more users to use and recommend the REOPs. For shaping the PIQ of the REOP users, more playful, immersive, and visualised content should be provided on the REOPs to attract or retain more users. Based on such immersive experiences, the users will develop positive perceptions that will result in more usage of the REOPs. This will increase their confidence to make better, informed, and intelligent decisions due to the higher quality of the information provided to them. For addressing the PU of the REOP users, more enjoyable, and easy to use contents on the REOPs coupled with accurate, reliable, and high-quality information will shape a positive PU of the REOP users. Thus, more user-friendly, responsive, and easy to understand REOPs should be provided to the users to develop positive perceptions. These REOPs should offer new and updated information, updated market prices and properties, various listings, a large range of properties and filters to compare similar properties.

The current study has both theoretical and practical implications. In the case of theoretical implications, it humbly adds to the body of knowledge by integrating two well-known information system theories and contextualising them to the real estate sector. This lays the foundations for multiple studies to follow up and explore various contexts of REOPs, including their user perceptions, managerial perceptions, agents, and other stakeholders' perceptions. The RSISTAM model constructs can be individually explored by futuristic studies to build upon the current work and explore the model in context-specific scenarios. Further, the method can be aided through other MCDM techniques such as system dynamics and structural equation modelling to compare the performance of DEMATEL with these techniques. In terms of the practical implications, this study has perks for both users and managers. The users can have better and more informative REOPs to make better decisions, and the managers can enjoy more users and business through REOPs, thus creating a win–win situation. Such measures can be used to tackle the regrets of REOP users related to poor or low-quality information provided to them, as highlighted by Ullah and Sepasgozar [20]. This is vital for resuscitating the real estate and property industry out of the COVID-19 effects and helping it transform into a smart real estate industry in line with industry 4.0 requirements. This will help move towards Real Estate 4.0 goals.

The current study is limited to Australian REOP user perception only, mostly young-middle-aged users that can be expanded in the future to include people from different age groups. In terms of the model, the study is limited to seven key perceptions that can be expanded in the future. Further, the study uses the DEMATEL approach that can be extended and complemented with the system dynamics model to build upon the current study. In future, similar studies can be conducted to include REOP web management team, real estate agents and web developers to develop a holistic framework for all-inclusive REOP adoption. Further, the risks and barriers associated with the REOP technologies adoption is another area that can be explored in future studies. Similarly, the study repeated in a developing country can be compared to the current study to highlight the perception difference of REOP users.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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