Real Estate Stakeholders Technology Acceptance Model (RESTAM): User-focused Big9 Disruptive Technologies for Smart Real Estate Management

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Abstract: **Digital disruptive technologies are an integral component of the modern world. These technologies are transforming the global industries from traditional to more innovative and adaptive. However, the state of global real estate is yet to improve and is currently lagging the technology curve. Because of this lag, useful information is either not made available to the end-users or is shared too late that is raising concerns among the online real estate platform users. This results in larger vacancy rates and post-occupancy regrets among the service consumers. The current study based on the concepts of Technology Acceptance Models (TAM), presents a conceptual Real Estate Stakeholders Technology Acceptance Model (RESTAM) for addressing the key needs of the four important stakeholders of the real estate industry including the end-users or consumers, government & regulatory authorities, agents & agencies and complementary industries. Based on comprehensive literature review of 213 articles, the needs of these stakeholders are assessed and addressed through the Big9 technologies namely drones, the internet of things (IoT), clouds, software as a service (SaaS), big data, 3D scanning, wearable technologies, virtual and augmented realities (VR & AR), and artificial intelligence and robotics. The resulting RESTAM framework with a specific focus on the online platform based real estate users are expected to lay the foundation for introducing the missing technology acceptance model for real estate stakeholders whereby these Big9 disruptive technologies are implemented in real estate industry to uplift it from traditional to smart real estate. This will reduce the post-occupancy regrets of the real estate service users and improve the relations between various real estate stakeholders.**

Keywords: **Smart Real Estate Management, Technology Acceptance Model (TAM), Real Estate Stakeholders Technology Acceptance Model (RESTAM), Big 9 Technologies, SISQual Approach.**

I. INTRODUCTION

With the introduction of recent digital technologies, global industries have transformed. Real Estate Industry is no exception to it and is trying to catch up with global innovations. However, currently, the real estate industry is lagging the global technology curve and needs to improve its state of affairs to compete with its industrial counterparts. This requires a speedy catch-up mechanism and fast-tracked innovation in global real estate. Adoption of digital disruptive technologies and innovative methods can help real estate transform its traditional rigid approach to a more up to date, advanced and smart approach.

Smart real estate, a newly introduced concept, revolves around the incorporation of the newly introduced innovative and disruptive technologies [1]. These technologies named as Big9 by Ullah and Colleagues in 2018 can help the real estate transform to smart real estate [2]. As evident from the name Big9, there are nine technologies under the umbrella of the tag. These are drones, the internet of things (IoT), clouds, software as a service (SaaS), big data, 3D scanning, wearable technologies, virtual and augmented realities (VR & AR), and artificial intelligence and robotics. These technologies have been utilized in bits and pieces in real estate currently, however, a globally accepted framework for such adoption is yet to be introduced in real estate and property sector [3].

Technology acceptance model (TAM), can help the global real estate sector adopt innovative Big9 technologies. These technologies can help address the key needs of smart real estate stakeholders. As such four key stakeholders include the end-users of technologies or consumers, the agents and their associations, the government and regulators, and the complementary industries helping the stakeholders interact with each other[2]. TAM based on its global recognition as a framework for accepting technologies by real estate stakeholders specifically the end-users can link the key needs of smart real estate stakeholders with the Big9 technologies and lay the foundation for introducing a conceptual framework for technology adoption in real estate. This conceptual framework, hereby referred to as Real Estate Stakeholders Technology Acceptance Model (RESTAM) provides an opportunity for traditional real estate transformation into a more holistic smart real estate whereby the stakeholders' needs are met, and more users are inclined to utilise the real estate services.

This paper based on a systematic literature review identifies the key needs of the real estate stakeholders and the application of Big9 technologies for addressing these needs. These are incorporated into a holistic RESTAM framework to pave the way for transforming traditional real estate into smart real estate whereby the end-users have fewer, or, ideally no, regrets based on their purchase or rent decisions made through online real estate platforms.

III. LITERATURE REVIEW

A. Smart Real Estate

Smart Real Estate is a new concept recently introduced in the property and real estate industry in 2012 by Allameh and colleagues [1]. However, it has been formally defined and explained by a group of researchers at the University of New South Wales Australia in 2018 [2]. According to the authors, smart real estate can be defined as an integration of sustainable, user-centered and innovative system and technology whereby reliable and effective information is made available and accessible to the end-user for making better and informed property purchase or rent decisions. Thus, Smart Real Estate has three key components: sustainable, innovative and user-centered. Subsequently, addressing these three components of the smart real estate ensure smart real estate management [2].

Key aspects of smart real estate management revolve around the domains of information collection or data generation and its dissemination to the end-users. Information and its dissemination are central to the Smart Real Estate as it plays a crucial role in attracting and motivating users to use online real estate platforms [3,4]. This information plays a make or break role in real estate service utilization by the real estate stakeholders especially the end-users or consumers. Currently, the situation doesn't look too good as reported by Trulia, around 44 percent of the real estate consumers in the United States alone regret their rent or purchase decisions [5]. Similarly, in the Australian context around 64 percent of the 1000 property owners interviewed reported regrets about their decisions and 41 percent of these highlighted lack of information or improper information provided through online means[6]. Thus, it is imperative to improve the current state of online information provided to the online real estate consumers to minimize, if not eliminate, the regrets of real estate consumers [4]. This, if done correctly, will pave the path for the transition of traditional real estate to smart real estate.

B. Real Estate Stakeholders

There are multiple stakeholders involved in the real estate industry, however in lines with the definition of the smart real estate four stakeholders are of key importance. This includes the end-users or consumers, the agents and their associations (AA), the government and regulators (GR) and the complementary industries (CI) [2]. Table 1 defines and enlists the basic and other important needs of these stakeholders as identified in the pertinent literature.

Table 1: Real Estate Stakeholders and their needs

Stakeholders	Definitions	Basic Needs		Other Needs
End-users (Consumers)	This group includes the end-users of the online real estate technologies such as the buyers, renters, or sellers of real estate. These are central to the system and are the main beneficiaries.	Buy/Sell or Rent	1	Neighbourhood Insights
			2	Price and Costs
			3	Mortgages
			4	Search Tools
			5	Market Awareness
			6	Proximity to Amenities
			7	Layout and Design
Government and Regulators (GR)	This includes the government and other regulatory authorities to keep the system transparent and pair.	Regulations and Protection	8	Economic Growth
			9	Political Advantages
			10	Taxes and returns
			11	Standards Imposition
			12	Ethical Checks
			13	Regulations
Agents and Associations (AA)	This includes the agents who interact with the consumers for facilitating the buy, sell or rent process. It also includes the associations present for the protection of agents' rights as businessmen.	Business – Profit	14	Supports to Members
			15	Networking
			16	Referrals
			17	Government Support
			18	Ethical Checks
			19	Reputations
Complementary Industries (CI)	This includes small and medium industries that are present to help the key stakeholders.	Business – Profit	20	Networking
			21	Referrals
			22	Reputations

From Table 1, it can be seen that the CI and AA have a common goal of excelling in their business and earning more profit. Similarly, the users have the basic need of buying, selling or renting their properties and the GR functions to protect the citizens through the imposition of rules and regulation. Further, the end-users or consumers are the people who are at the receiving end of the real estate online technologies and includes customers or consumers who utilize these services to but, sell or rent a property. Their satisfaction is tantamount to the success of the real estate business, therefore, they hold a central position in the hierarchy and all the services revolve around them [7]. Similarly, the AA is the group of business owners and service providers whose aim is to earn profit through business with the end-users or consumers. They play a facilitating role between buyers or renters and sellers and provide their expert services from inspecting the property to listing it online and taking care of the contractual obligations for both parties. In turn, they charge the owners for their services. However, a key concern about the conduct of agents and their abilities to manipulate the situations in favor of the owners especially in case of a dispute remains a concern for the consumers [8]. This is where the third stakeholder i.e. Government and Regulators step in. This

group includes the government bodies and regulatory authorities such as the council and Fairtrade whose main objective is to protect the consumers' rights and make sure that the standards and set of policies related to property deals are followed at all levels. However, the policies are devised in such a way as that are optimal for all parties as the agents and owners are also citizens of the state and they have same rights under the consumer protection laws, so a balance is sought by the GR [9]. In return for these services, the GR taxes all the parties involved in the business and keep their state of affairs in place. The final stakeholders include the complementary industries that are small and medium-sized industries present to provide support and materials to the real estate businesses especially the AA. From marketing to specialized web designs and drafting contracts, these CI usually operate on an outsource basis for the AA or owners. Thus, these have similar obligations as the AA and are bound by the GR laws. These CI builds upon their networking and reputations to get more business.

C. Big 9 Technologies and their utilization in Real estate

The Big9 technologies include Big Data, AI and Robotics, Cloud, SaaS, IoT, Drones, 3D Scanning, Wearable Technologies, and VR and AR. These have been defined in Table 2 along with their uses in the real estate industry as evident from pertinent literature.

Table 2: Big9 Technologies and their uses in Real Estate

Big 9 Technologies	Definitions	Uses in real Estate	
Big Data	The Huge or enormous amount of data that cannot be processed or iterated through traditional tools and techniques.	1.	Building Performance Database
		2.	Property Value Analysis
		3.	Crime Rates
		4.	Walkability and Transit Indexes
		5.	Collaborative BEM
		6.	Value Forecasting
AI and Robotics	Performing complicated, smart and intelligent functions with computers and minimum human involvement.	1.	Automated Renting
		2.	Fraud Detection
		3.	Business Forecasting
		4.	Blockchain Taxation
		5.	Machine Learning
Cloud	Synchronizing data and networking assets over the internet thereby reducing the requirements of placing machinery and computers on site.	1.	Elastic Resource Utilization
		2.	Clients Cross Matching
		3.	Portfolio Management
SaaS	Remotely operatable software enabling the users and agents to bring their business to consumers without the need of bringing in computers.	1.	Order Processing
		2.	Resident Management
		3.	Record Keeping
		4.	Building Maintenance
IoT	Networked collection of physical devices that can sense the physical aspects of the world such as lightning, exposure to heat and others.	1.	Logistic Synchronization
		2.	Intelligent Community
		3.	Entrance Guard System
		4.	Smart Homes
		5.	Temperature Control
		6.	Home Automation
Drones	Unmanned vehicles that can collect accurate and precise data in hard to get around terrains and are operated through remote controls or ground stations.	1.	Aerial Photography
		2.	Volumetric Calculations
		3.	Drone Mappings
		4.	3D Pictures
3D Scanning	Advanced laser-based scanning devices that enable users to replicate and reproduce models of existing structures in the absence of as-built drawings.	1.	3D Modelling
		2.	LIDAR
		3.	3D Images
		4.	Structural Integrity Monitoring
		5.	Point Clouds
Wearable Tech	Gadgets based object detection and communication of electronic devices that are integrated into wearable devices or clothing.	1.	Safety Monitoring
		2.	Object Tracking
		3.	Smart Watches
		4.	Body Mediation and Monitoring
		5.	Smart Bracelets
VR and AR	Creating virtual worlds or enhancing existing features through digital realities and computer simulations.	1.	360 Cameras
		2.	VR Headsets
		3.	4D Advertisements
		4.	3D Object Recognition

Big data, dealing with an enormous amount of data that can not be handled through traditional approaches has disrupted many fields. In the real estate sector, its application exists in property value forecasting, reality development, city management and others [10]. AI and Robotics deal with performing the complicated and intelligent function with minimum human involvement have made their way into the real estate sector through predictive analytics, blockchain taxation, and customer recommendations [11]. Cloud deals with data synchronization and networking over the internet and has applications such as information value for investors' analyses of real estate market, portfolio management and elastic utilization of resources [12]. SaaS deals with remote access to software enabling more business and providing more opportunities to real estate agents. IoT deals with networked assets and physical devices and has applications such as Entrance guard systems or smart homes [1]. Drones and unmanned vehicles are displaying huge potentials in aerial photography and 3D imagery. Recently wall mounted drones are a new entry to residential real estate markets [13]. 3D scanning that deals with point-cloud based scanning and data generation has proven its usefulness in real estate through onsite layout plans generation and structural integrity monitoring.

Similarly, wearable techs such as smartwatches and smart clothes have huge potential in resident's health and safety monitoring and object tracking during construction stages. Lastly, VR and AR dealing with creating new, or augmenting existing physical world have huge potentials in real estate sector and can boost the sales process through immersive visualization and interactive playful content [14].

D. Technology Acceptance Model (TAM) and SISQual Approach

Technology acceptance model (TAM) was introduced by Davis in 1989 [15]. It models how the users come to accept and subsequently adopt a technology. It has been utilized extensively in information systems field however, its utilization in the real estate industry is yet to be seen [2]. The key components of TAM include perceived usefulness, perceived ease of use, behavioral intention to use and accept or actual use or acceptance [15].

In the context of real estate and according to DeLone and McLean Model, three types of qualities referred to as the SISQual are pivotal to the success of any system in terms of user's satisfaction and subsequent acceptance [16]. The SISQual refers to System (S), Information (I) and Service (S) qualities. Thus, controlling the quality of information, the system through which it is disseminated, and the services associated with it can help deliver better quality information to the end-users thereby eliminating their regrets based on information quality [3]. In addition to the above, as stated in the updated versions of TAM i.e. TAM2 and TAM3, other important factors for technology acceptance include self-efficacy, playfulness and usability, and perceived enjoyment [17]. Table XX lists and defines these key constructs that will be subsequently utilized to propose the RESTAM model.

Table 3: Constructs and their adoption models

Constructs	Definitions	Model
Information Quality	Accurate, transparent, novel and reliable information that motivates and encourages a user to use the real estate technology	
Systems Quality	Flexible, customizable, efficient and user-friendly platforms and systems used for presenting and disseminating information to the end-user.	SISQual
Service Quality	Reliable, quick, effective, immersive and more responsive services provided to the end-user.	
Self-Efficacy	The features and services that boost the self-confidence of the end-users in terms of the platform effectiveness to get the desired result.	
Playfulness and Usability	Game-based playful content provided to the end-users to keep them immersed and feel more involved when using the online services.	
Perceived Enjoyment	The feeling of joy and happiness due to ease to use platforms and services.	
Perceived Usefulness	The quality of services and systems utilized by online real estate platforms that incline the users to accept its usefulness and effectiveness for getting the desired result.	TAM
Perceived Ease of Use	The ability of real estate platforms and services motivating the users to feel confident about using the services and encouraging the thoughts of easiness about service utilization.	TAM2
User Satisfaction	The products or services supplied to the suers meeting or exceeding their expectations through which they feel empowered to get their desired results.	TAM3
Behavioural Intention to use	The ability of the online service or platform to satisfy the users and induce a change in behavior for more or repeated utilization of the same service.	
Actual use/ reuse	The tendency of users to reuse or inclination to use a specific service based on their previous experience and satisfaction.	

Table 3 lists 11 key constructs or factors that are adopted in the RESTAM model from the two key theories. These factors are integrated into a holistic framework using the key constructs of TAM to formulate the RESTAM Model. These factors mainly revolve around the information dissemination to the real estate stakeholders especially the end-users through online real estate platforms that are pivotal to the concept of smart real estate management.

IV. METHODOLOGY

The current study follows a rigorous literature review process whereby 213 research articles including 150 journal articles, 48 online reports, and 15 news articles were reviewed to highlight the uses of Big9 technologies in the real estate domain. To search the papers, Google scholar, ASCE library, Scopus, Emerald Insight, Taylor and Francis Online, Elsevier and UNSW library online services were utilized.

The search phrase consisted of keywords such as "Smart Real Estate", "Real Estate Information Management", "Technology Adoption in Real Estate", "Disruptive Technologies in Real Estate" and each of the Big9 technologies as separate keywords within the context of real estate. Based on these keywords, the search filters were reduced to articles published in the last decade i.e. 2009 and onwards and relevant articles were retrieved. A total of more than 350 articles were retrieved which were later reduced to 213 articles. This was achieved after removal of duplications, articles published in other languages than English and editorial notes, and other irrelevant articles. Fig 1 shows the research flowchart for the current study.

Once the articles were retrieved, these were studied under two contexts of "applications of Big9 technologies in smart real estate" and "smart real estate stakeholders and their needs". Thus, stakeholders need assessment was carried out to highlight the key and other needs of smart real estate stakeholders as shown in Table 1. Similarly, the utilisations of Big9 technologies in the real estate sector has been presented in Table 2.
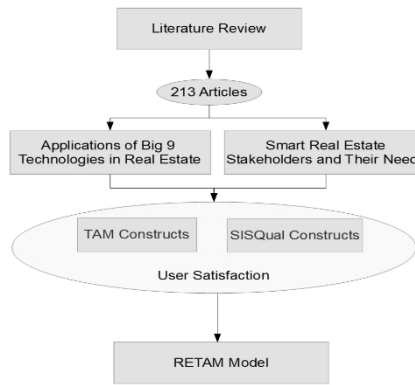
Fig 1: Research Flow chart

After the stakeholders' needs and applications of Big9 technologies in real estate were thoroughly studied and listed, these were linked to the constructs of TAM and SISQual approaches. The focus point central to this merging was user satisfaction. Thus, keeping user satisfaction as pivotal to the adoption and acceptance of Big9 technologies in Smart real estate, a RESTAM model is proposed whereby the key constructs of TAM and SISQual approaches houses the Big9 technologies for their applications in addressing the needs of smart real estate stakeholders.

V. RESULTS AND DISCUSSIONS

As mentioned in the method section, stakeholder needs assessments and analyses were conducted with user satisfaction as the central focus. Different Big9 technologies were investigated for their potential utilization in addressing the needs of the stakeholders. Table 4 shows the Big9 technologies and the stakeholders needs that can be addressed through them. 1,2,3 in the table refers to the serial number of the needs identified in Table 4. From Table 4, it can be seen that the Big9 technologies along with brining the ever so missing innovation into the real estate sector, can be useful for addressing the stakeholders needs as well. Such needs, when addressed through the innovative technologies, will bring the regrets level down to a more manageable level compared to the current poor situation. Thus, the issues of real estate regret especially those related to the lack of information or provision of improper or misleading information can be tackled with ease and will be brought down to a minimum level, if not eliminated completely. Although, it is generally accepted that buyers have a natural tendency of remorse after making an expensive purchase, however, provision of useful and high-quality information will ensure that the buyers make more informed and intelligent decisions due to the presence of more interactive and apprehend able statistical data. Such informed decisions will reduce the current level of regrets and at the same time motivate more users to use the online real estate services thereby creating a win-win situation for all concerned stakeholders.

Table 4: Uses of Big9 Technologies for Addressing Stakeholders needs

Big 9 Technologies	Stakeholder in Focus	Key Need Addressed	Other Needs Addressed
Big Data	AA	Yes – Business & Profit	2,3
	Users	Yes – Buy & Sell or rent	1,2,5
	GR	Yes – Regulations & Protections	1,5,6
	CI	Yes – Business & Profit	1,2
AI and Robotics	AA	Yes – Business & Profit	3
	Users	Yes – Buy & Sell or rent	1,2,4,5,6,7
	GR	Yes – Regulations & Protections	3,5,6
	CI	Yes – Business	1,2,3
Cloud	AA	Yes – Business & Profit	1,2,3,5,6
	Users	Yes – Buy & Sell or rent	2,4, 6,7
	GR	Yes – Regulations & Protections	5,6
	CI	Yes – Business & Profit	1,2,3
SaaS	AA	Yes – Business & Profit	1,2,3,6
	CI	Yes – Business & Profit	1,2,3
IoT	AA	Yes – Business & Profit	1,2,3,5,6
	Users	Yes – Buy & Sell or rent	2,4,5,7
	GR	Yes – Regulations & Protections	1,2,5,6
	CI	Yes – Business & Profit	1
Drones	AA	Yes – Business & Profit	6
	Users	Yes – Buy & Sell or rent	1,6,7
	GR	Yes – Regulations & Protections	5,6
	CI	Yes – Business & Profit	3
3D Scanning	AA	Yes – Business & Profit	6
	Users	Yes – Buy & Sell or rent	7
	GR	Yes – Regulations & Protections	4,5,6
	CI	Yes – Business & Profit	3
Wearable Tech	AA	Yes – Business & Profit	6
	Users	Yes – Buy & Sell or rent	7
	GR	Yes – Regulations & Protections	4,5,6
	CI	Yes – Business & Profit	3
VR and AR	AA	Yes – Business & Profit	5,6
	Users	Yes – Buy & Sell or rent	1,6,7
	GR	Yes – Regulations & Protections	5,6

| CI | Yes – Business & Profit | 3 |

Similarly, the needs are linked to constructs of TAM and SISQual approach as shown in Fig 2. The Figure shows the needs of the smart real estate stakeholders that are linked to the constructs of the TAM and SISQual which subsequently forms the RETAM model. The Figure shows some factors exclusively responsible for information quality such as information about price and costs, mortgages, market awareness, etc. Similarly, some factors are contributing to multiple constructs such as the search tools that contribute to all the six constructs. This corresponds to the importance of the search tools and their optimization for up-gradation of online real estate. These tools not only provide a user the flexibility to search for their dream property with ease but also empowers them to feel more confident about using a specific platform for their dream house search. This, in turn, raises the self-efficacy of the users and thereby motivates them to use the platform again. Such motivation is pivotal to the acceptance and subsequent reuse of the real estate services by the end-users or consumers and plays a huge role in business success.

Similarly, factor such as the reputation of the agents and agencies contribute to most of the constructs and it can be inferred that reputation dictates the usage of a specific real estate platform or agency and their service and vice versa. If the agency or platform has a good reputation, the chances of its utilization and subsequent use are more compared to the one with a bad reputation. Thus, reputation is critical in uplifting real estate services.

Referrals is another key aspect of the online real estate services that are mainly dictated by the networking and good reputation of the agents and agencies involved in the business. These referrals are increased due to better networking skills of the agents and complementary industries however, the role of the system and quality of service cannot be ignored. A good quality system and service motivate the end-users to reutilize the services and platforms for subsequent renting and buying. The role of word of mouth and positive marketing by satisfied customers can drastically increase the referrals to certain businesses.

Similarly, factors and aspects such as the ethical checks, regulation imposition, political advantages and tax returns that concern the government and regulators can be better achieved through a good quality system in place. These will not only provide a competitive advantage to grow as a nation but also gain political advantages over their counterparts through a better-quality system resulting in people liking the system and government.
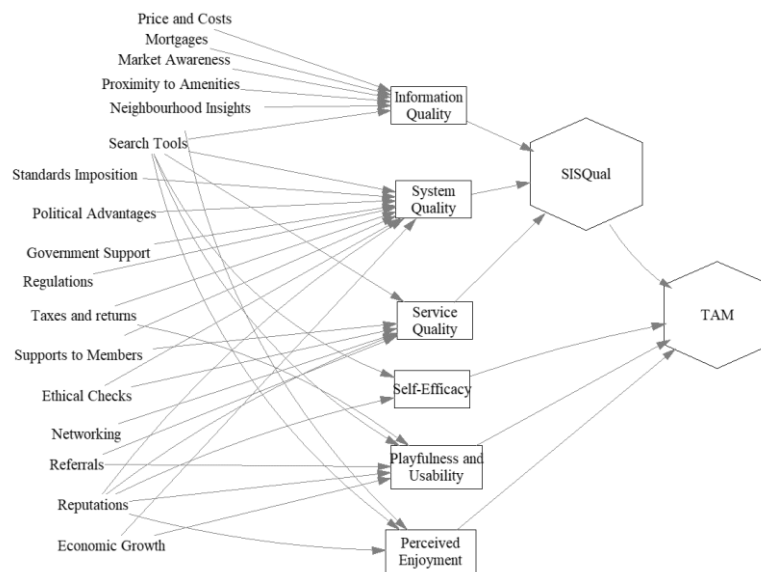

Fig 2: Linking Stakeholders needs to SISQual and TAM constructs

Based on Fig 2 and the linkages established in Table 4 for the needs of stakeholders and the Big9 technologies, Figure 3 provides the RESTAM framework proposed in the current study. The model links the stakeholders needs to the technologies and subsequently to the constructs of TAM and SISQual for proposing a RESTAM framework. The framework paves the way for Big9 Technologies adoption in the real estate sector.
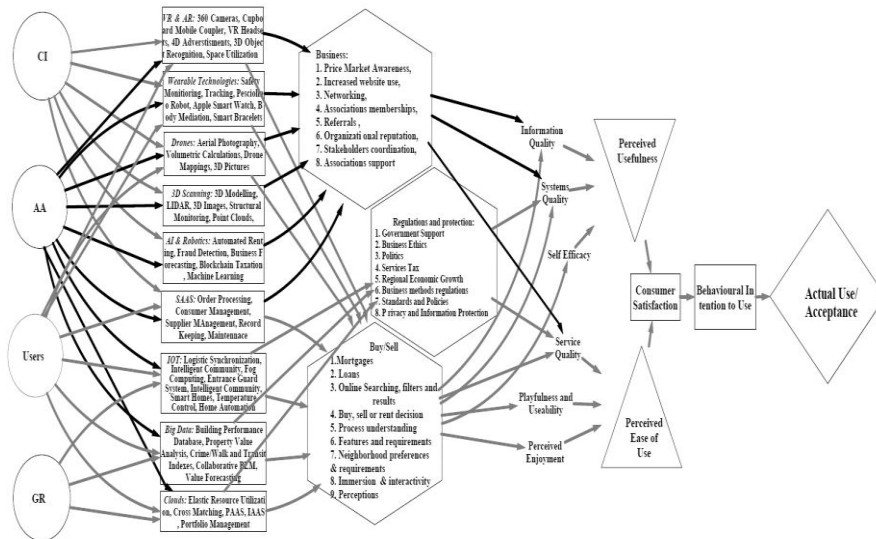
Figure 3: Real Estate Stakeholders Technology Acceptance Model (RESTAM)

The RESTAM model shows the connection between the key real estate stakeholders and their needs that can be addressed through the Big9 technologies. These needs are linked to TAM and SISQual constructs with a focus on consumer satisfaction. The model shows that needs of the government such as the economic growth, the ethical checks, standards and policies implementation, and privacy and information protection can be managed through IoT, Big Data and Clouds. These, in turn, contribute to the systems and services qualities which subsequently influences the perceived ease of use and usefulness aspects. These perceptions increase the users or consumers satisfaction by elevating their trust levels and in turn motivates them to continue using and reuse the online platforms and real estate services in the future.

Similarly, the CI needs of referrals, networking, and reputational enhancements can be addressed through VR & AR, SaaS, 3D scanning, Drones, AI & Robotics and wearable techs. These needs when addressed through the Big9 technologies improves all the SISQual aspects thereby motivating the consumers to adopt or reuse the services provided to them.

Finally, the main beneficiaries of the RESTAM framework are the AA and the consumers which all the Big9 technologies being useful in addressing their needs and requirements. This augments the holistic nature of the framework by validating the statement of creating a win-win situation for both end-users and agents, the two main stakeholders involved directly in the real estate business. The based on the framework, the users can get high-quality information enabling them to make better and informed decisions whereas the agents and agencies can get more business due to more adoption and utilization of the real estate platforms by the end-users.

VI. CONCLUSIONS AND FUTURE DIRECTIONS

The current study presented a conceptual framework for the adoption and acceptance of online real estate platforms by the real estate stakeholders. The resulting RESTAM framework links the real estate stakeholders needs with the key constructs of two key information system theories: TAM and SISQual. Further, the needs of the stakeholders are addressed using the disruptive Big9 technologies and a link is presented with the TAM and SISQual components to pave the way for the acceptance of disruption and innovation in the otherwise rigid and traditional real estate sector.

The RESTAM framework presents a win-win potential for the key real estate stakeholders especially the two main stakeholders: end-users and agents. The former can enjoy more informed and intelligent decision making based on more visualized and interactive data thereby reducing, if not eliminating, their post-purchase or rent regrets whereas the latter can get more business and competitive advantage due to more number of satisfied and happy customers that can act as potential marketers for them.

The model is one of the first steps towards accepting of Big9 technologies in real estate sector, especially for online real estate management. It is expected that it will initiate the much-needed debate for inevitable disruption in the online real estate sector to transform it from traditional to a more "smart" real estate. In future, the work can be expanded upon and online platforms such as real estate websites and cell phone applications can be investigated in detail for their technologies accepting capabilities to pave the way for technology adoption in real estate and property sector.

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