



# Theory and Practice of Social Innovation to Support Open ICT Ecosystems for Improved User Experience: The Case of UDRC

Kaveh Bazargan<sup>(✉)</sup>, Ali Rezaeian, and Mohammad Taheri

Shahid Beheshti (National) University (of Iran), Tehran, Iran  
{k\_bazargan, a-rezaeian}@sbu.ac.ir,  
m23taheri@gmail.com

**Abstract.** The dominant rhetoric of smart cities is mainly grounded in the large scale adoption and implementation of cutting-edge technological innovation by local governments and cities all over the world. Responsible context sensitive and social innovations are key complementary drivers to reduce digital divide within and between cities and promote dividends and human value such as dignity, inclusion, urban upgrading, participation and better user experience. This research reports on the continuous efforts performed at the Iranian Urban Development and Revitalization Corporation (UDRC), from February to August 2017, to implement social innovation for urban upgrading by redesigning its website as open ICT ecosystems for improved user experience. The CUBI UX model is applied and continuous remote user research is conducted for three months to measure and understand the user experience of the old website. Then, after redesigning the old version of the website into a new one, interactive prototyping and implementation, user experience is being measured during the next three months. Finally, comparative analysis of user experience measures between the old and the new version of the website are presented and discussed.

**Keywords:** Social innovation · Open ICT ecosystems · User research  
User experience · Web analytics

## 1 Introduction

The key concept of “innovation” and more specifically the importance of leveraging “social innovations” together with the informed usage of emergent “information and communication technologies” for creating “better living environments for all” have been highlighted more than 30 times in the New Urban Agenda adopted at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III) in Quito, Ecuador, on 20 October 2016 and endorsed by the United Nations General Assembly on 23 December 2016. Adopting a lifelong learning approach and the wise application of the human computer interaction body of knowledge, including user experience research and user experience design, can be a great theoretical and practical enabler for professionals involved in the creation of more citizen/human/user-centric digital policies, strategies, ecosystems, platforms, services and tools. More specifically, professionals should learn how to address the challenges stated in the New Urban

Agenda by setting measurable user experience target levels, goals, appropriating and implementing research-based user experience heuristics in the field of digital public sector systems design and digital innovations. This research illustrates how social innovation via user experience research and user experience design can support open ICT ecosystems towards continuously measuring and improving digital user experience by studying the domain specific case of the Iranian Urban Development and Revitalization Corporation (UDRC) website.

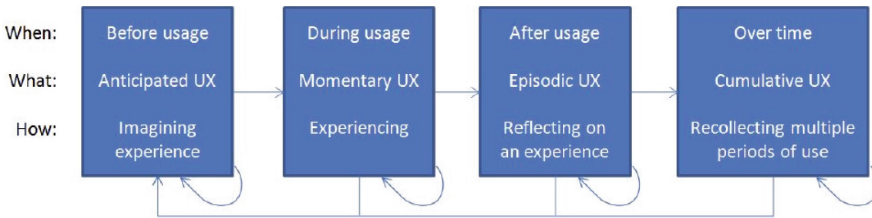


Fig. 1. Time span of UX based on key experience factors [2]

## 2 Review of Literature

### 2.1 Defining and Measuring the User Experience

The ISO [1] definition of User Experience (UX) states that: *UX is the person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service. UX includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and accomplishments that occur before, during and after use.*

Methods and tools used to measure UX should be selected based on the specific time spans in which the UX is actually being shaped. To this end, Roto et al. (2011) have classified UX in four distinct categories displayed in Fig. 1 [2]. Anticipated UX relates to the period before the first use of the system, or any of the three other time spans of UX, since a person may imagine a specific moment during interaction, a usage episode, or life after taking a system into use. UX can also refer to a specific change of feeling during interaction (momentary UX), appraisal of a specific usage episode (episodic UX), or views on a system as a whole, after having used it for a while (cumulative UX).

In this research we consider the definition of UX in the second time span (i.e. Momentary UX) that can be measured by relevant indicators linked to the online usage of the system. This definition is consistent with our past research studies on UX strategy maturity of Spatial Web-based Projects [3].

### 2.2 Open ICT Ecosystems and Socio-Technical Approach to Smart Cities

The Roadmap for Open ICT Ecosystems has been published by the Open ePolicy Group (2005) as user-friendly guide for policymakers and technologists offerings tools

for understanding, creating, and sustaining open information and communication technologies ecosystems [4]. Some of the guiding principles of Open ICT Ecosystems are as follows:

**Interoperable** – allowing, through open standards, the exchange, reuse, interchangeability and interpretation of data across diverse architectures and platforms;

**User-Centric** – prioritizing services fulfilling and addressing user needs and requirements over perceived hardware or software constraints;

**Collaborative** – permitting governments, industry, and other stakeholders to create, grow and reform communities of interested parties that can leverage strengths, solve common problems, innovate and build upon existing efforts made by others;

Jha et al. (2016) have built eKutir, a social business in India that leverages an information and communication technology (ICT) platform to progressively build a self-sustaining ecosystem to address multiple facets of smallholder farmer poverty [5]. The evolution displays a distinct pattern where the five elements of the ecosystem progressively evolve and reinforce each other to create a system that is economically sustainable, scalable, and can accelerate transformative change.

Smart cities, by definition, refer to the data economy, stimulation from ICTs and improved urban management from software algorithms integrated within the urban fabric. As highlighted by Han and Hawken (2017), a purely technocratic and techno-engineering focus on smart cities will not deliver the outcomes that are necessary to create more livable cities that innovate across all areas of society, from the environmental to social and economic areas [6]. According to the authors, future smart cities will rely on their distinctive informational ecosystems and multiple identities to address challenging and ever growing economic, social and environmental needs.

The Indian Housing and Land Rights Network (HLRN, 2017) has undertaken a comprehensive human factors review of the process and the guidelines of India's Smart Cities Mission as well as of the 60 selected smart city proposals [7]. The report recommends smart cities policies, programs and projects to adopt a more coherent and equitable socio-technical vision driven by Indian cities' realistic challenges, concerns, needs in order to holistically understand and address people's demands and concerns.

### 2.3 Social Innovation and Urban Upgrading Policies

Wehn and Evers (2015) have studied how advanced ICT-enabled citizen observatories can enable a two-way communication paradigm between citizens and decision makers, potentially resulting in profound changes to local environmental management processes and, as such, in social innovation processes and outcomes [8]. The specific case study discussed by the authors aims at illustrating how social innovation can result in increased eParticipation in local flood risk management.

Van der Have and Rubalcaba (2016) have performed a systematic analysis of available literature and identified that social innovation field is grounded in four distinct intellectual communities: (1) community psychology; (2) creativity research; (3) social and societal challenges; (4) local development [9]. Our research is mainly focused on the third community which aims at addressing social and societal challenges.

The I.R. of Iran Ministry of Roads and Urban Development has adopted the National Strategy Document for Revitalizing, Rehabilitation, Renovation and Enabling Deteriorated and Underserviced Urban Fabrics in 2014 [10]. The Iranian Urban Development and Revitalization Corporation (UDRC) key national mandate is to improve the cities' livability and citizens's quality of life by applying urban regeneration policy and the national strategy [11]. The eight key strategies adopted by this national strategy document are as follows [10]:

**Strategy 1:** A coordinated urban development policy framework giving priority to 'Endogenous Development';

**Strategy 2:** Real estate and capital market to correspond to demand by low-income urban strata;

**Strategy 3:** Improve quality of life and strengthen and nurture the identity of target urban areas and neighborhoods;

**Strategy 4:** Participation of residents;

**Strategy 5:** Facilitating investment and creating appropriate incentive structures aimed at the private sector;

**Strategy 6:** Improving economic, social, and environmental conditions for residents;

**Strategy 7:** Leveraging the physical, social, economic and environmental capacities;

**Strategy 8:** An appropriate financial system.

The Iranian UDRC has also signed more than 20 strategic alliance partnerships and collaborations agreements with national administrations, institutions and associations to facilitate the implementation of the national strategy.

The Regional Urban Upgrading Working Group (RUUWG) permanent secretariat is currently being hosted by the Iranian UDRC in the context of the Asia Pacific Ministerial Conference on Housing & Urban Development (APMCHUD) [10].

One of the key medium of communication and interaction between all stakeholders at different local, provincial and national scales is UDRC's main website which acts as an open Information and Communications Technology (ITC) platform that integrates online materials and is enriched with dedicated content for two way communications.

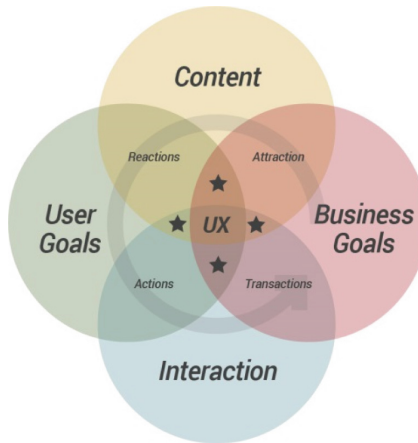
### 3 Research Methods

#### 3.1 CUBI User Experience Model

Stern has proposed the CUBI User Experience Model to analysis interactive systems provided by businesses for user that includes four key components and four key process steps [12]. Figure 1 displays how each component intersects with others and how the four key processes are being shaped in each step.

As illustrated in Fig. 2, the intersection between business goals and content is called Attraction. Every experience will have initial touchpoints to engage users. Users will processes the signals they receive, react to these communications and quickly decide if it's something useful to them. Then, the reaction can motivate users to take action to complete a given goal or perform a given task. This could be prompted from a call to action, trigger and task list or by other relevant means. Finally, user actions then

translate into business transactions. The types of transactions may include purchases, providing ratings on products or services, or other direct interactions with the business.



**Fig. 2.** CUBI User Experience Model and action cycle (Stern [12])

### 3.2 Remote User Research Tools

In order to fully understand and analyze UDRC website online user behavior, actions and reactions we used and integrated a combination of specialized remote user research tools such as Web Analytics, Web Optimization and Behavioral Analytics software packages including Google Analytics, Optimizely and Kissmetrics. Each relevant JavaScript tracking codes were automatically generated and embedded in all webpages with the assistance of UDRC web administrator and ACM SICHI Iran Chapter [13]. UDRC.IR website usage data and other relevant key metrics that are described in the next section were collected and analyzed during 6 months. The first time period for data collection started on the 16<sup>th</sup> February 2017 and ended on the 19<sup>th</sup> May 2017. The second time period for data collection ranged from the 20<sup>th</sup> May 2017 to the 20<sup>th</sup> August 2017.

### 3.3 Selecting Web Analytics Metrics and Dimensions

Selecting relevant web analytics metrics and dimensions is a key factor of success in using remote user research data to discover and formulate practical solutions to user experience challenges. Metrics represent quantitative measurements of different aspects of users' behavior, like the time period they spend viewing a webpage or the frequency at which users viewed a webpage. Dimensions qualify various attributes of users, their hardware, their internet browser, how they got to the website, or specific sections of the website that users visit, which can be used to divide website users into different user segments. Table 1 defines the list of selected web analytics metrics and dimensions used in this research.

**Table 1.** List of web analytics metrics, dimensions and measurement units

Metrics and dimensions	Measurement units
Unique visitors	Numeral count
New visitors	Numeral count
Returning visitors	Numeral count
Geographical location: city	City names
Visitor source (source)	Searches, direct, links, advertising, media searches, social media
Page views	Numeral count
Downloads	Numeral count
Outbound links	URL address
Average actions	Numeral count
Average time per visit	Seconds
Bounce rate	Percentage
Target goals (goals)	Numeral count

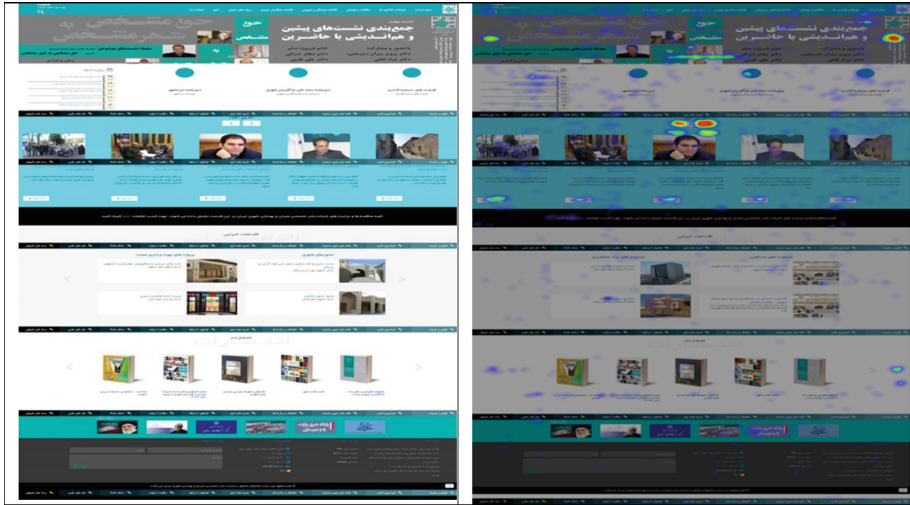
One the relevant JavaScript tracking codes are embedded into the website code, online specialized software packages such as Google Analytics, Optimizely and Kissmetrics provide an automated and systematic access to most of the metrics and dimensions listed in Table 4 based on collected and analyzed website log files. One exception are goals that must to be identified based on manual analysis of individual webpage content and usage frequency. Then, goals have to be manually added in order to get relevant measurements accordingly.

## 4 Results

### 4.1 Analyzing UDRC Old Website Users, Goals and Selection of Target Goals

We first explored all the data collected by the web analytics software packages during three months in a time span ranging from the 16.02.2017 to the 19.05.2017 in order to get some initial insights about visitors behavior and top geographical origins. The visitors originating cities were also of great importance due to specific target cities listed as top priority cities in ongoing urban regeneration programs and projects. Figure 3 (a) and (b) displays the UDRC old website homepage and associated heatmaps.

Table 2 presents UDRC old website visitor segmentation by top origin city for the time period ranging from the 16.02.2017 to the 19.05.2017. Visitors originated from Tehran for 51.1% of visits followed by Isfahan with 9.3%, Hamadan with 3.6%, Tarbriz with 3.3% and all others.



**Fig. 3.** (a) UDRC old website homepage and (b) heatmaps (16.02.2017–19.05.2017)

**Table 2.** UDRC old website visitor segmentation by top origin city (16.02.2017–19.05.2017)

City	Visitors ▼	Avg actions	Avg time	Total time	Bounce
★  Tehran, Iran	2,006 51.1%	3.1	5m 41s	7d 22h	17%
★  Isfahan, Iran	366 9.3%	3.3	6m 14s	1d 14h	9%
★  Hamadan, Iran	143 3.6%	2.4	3m 37s	8h 37m	23%
★  Tabriz, Iran	128 3.3%	3.5	4m 4s	8h 41m	12%
★  Karaj, Iran	115 2.9%	2.6	4m 15s	8h 9m	11%
★  Mashhad, Iran	95 2.4%	3.7	8m	12h 40m	5%
★  Yazd, Iran	95 2.4%	3.6	1m 43s	2h 43m	6%

## 4.2 Measuring UDRC Old Website UX and Target Goals Completion

We analyzed visitor statistics and key indicators such as pages visit statistics, entrance pages, exit pages, downloads and other relevant factors to understand user goals. Then, we requested UDRC board members to provide us with a list of top target goals that would expect website visitors to complete in each session. Then, target goals were manually coded into the web analytics software packages.

Figure 4 displays the UDRC old website visitor map by geographical location at national scale.



Fig. 4. Geographical locations of UDRC old website visitors at national scale

As shown in Table 3, more than half of the visitors originate from search engines with 56.2% followed by 33.3% of direct visits and 7.7% of visitors are redirected via links. The remaining rows display analytics for other relevant visitor sources.

Table 3. UDRC old website visitor segmentation by traffic source (16.02.2017–19.05.2017)

Source	Visitors ▼	Avg actions	Avg time	Total time	Bounce	Goals
<a href="#">Searches</a>	9,240 56.2%	3.2	5m 45s	36d 21h	15%	<a href="#">4622</a>
<a href="#">Direct</a>	5,465 33.3%	7.8	23m 52s	90d 13h	23%	<a href="#">1709</a>
<a href="#">Links</a>	1,266 7.7%	2.8	5m 8s	4d 12h	20%	<a href="#">702</a>
<a href="#">Advertising</a>	415 2.5%	2.9	4m 37s	1d 7h	13%	<a href="#">189</a>
<a href="#">Media searches</a>	19 0.1%	5.3	10m 50s	3h 26m	15%	<a href="#">7</a>
<a href="#">Social media</a>	19 0.1%	1.2	1m 29s	28m 11s	20%	<a href="#">3</a>
<a href="#">Syndication</a>	7	6.0	9m 15s	1h 5m	0%	<a href="#">1</a>
<b>Total</b>	<b>16,431</b>					7233

The last column in Table 4 displays the total number of target goal completion by origin city. Other UX metrics such as average actions, average visit time, total visit time and bounce rate are also presented.



**Table 4.** UDRC old website visitor segmentation by top origin city and target goal completion (16.02.2017–19.05.2017)

City	Visitors ▼	Avg actions	Avg time	Total time	Bounce	Goals
★  Tehran, Iran	2,006 51.1%	3.1	5m 41s	7d 22h	17%	951 47.4%
★  Isfahan, Iran	366 9.3%	3.3	6m 14s	1d 14h	9%	236 64.5%
★  Hamadan, Iran	143 3.6%	2.4	3m 37s	8h 37m	23%	68 47.6%
★  Tabriz, Iran	128 3.3%	3.5	4m 4s	8h 41m	12%	96 75%
★  Karaj, Iran	115 2.9%	2.6	4m 15s	8h 9m	11%	80 69.6%
★  Mashhad, Iran	95 2.4%	3.7	8m	12h 40m	5%	68 71.6%
★  Yazd, Iran	95 2.4%	3.6	1m 43s	2h 43m	6%	76 80%

### 4.3 Imbedding Social Innovation into UDRC Proposed Website Prototype

Figure 5 shows the wireframe, components, user interface elements of the high fidelity interactive prototype made for the new UDRC website. This interactive prototype is the result of ongoing user research, usability testing sessions with actual users and joint meetings with key UDRC internal and external stakeholders and UDRC web editors and webmasters.

**Fig. 5.** UDRC new website interactive prototype

While designing the interactive prototype, we tried to redesign the original UDRC website home page, information architecture, navigation, content organization and interactions in a way that imbeds social innovations by following a localized version of the 75 GoodUI design patterns [14] and a localized adaptation of UX UK Awards innovation criteria and best public sector UX criteria localized with the support of

ACM SIGCHI Iran Chapter [3]. The original main UX UK Awards best public sector criteria are best innovation criteria are explained below [15]:

***Best public sector criteria:***

- ***Engagement with the public*** - how were members of the public (as well as public sector workers) engaged in the development of the product? User testing, interviews, persona development, workshops? Trials?;
- ***Service to the public*** - provides a valuable public service, possibly a new service or possibly improving on an existing service (that may have been offline previously);
- ***Value to the public*** - clearly brings value to users (members of the public) - not a wasting of public funds in its production; ideally able to demonstrate savings to the public purse as a result of developing the site/service/app, or able to demonstrate how the investment made is likely to benefit the public interest in years to come.

***Best innovation criteria:***

- ***Novelty*** - Some element of the design of the site/app/service is new; something we've not seen before, or very rarely seen it before.
- ***Value*** - Is it worthwhile innovation? Does it solve a problem, or does it bring real value, or is it just frivolous or "innovation for the sake of it"? This innovation should be good.
- ***Pioneering*** - Is this the future? Do we believe this innovation is clearly a game-changer, that in light of this site/app/service, others will follow and adopt what's novel here? Should others repeat and do as this? Sets the bar for where things will/should go in the future.

Figure 6 displays the user interface of UDRC new website homepage that results for implementing the interactive prototype described earlier in this section.

#### 4.4 Measuring UDRC New Website UX and Target Goals Completion

As displayed in Table 5, all UX metrics apart from the total visit time and average time per visit have undergone a positive change rate. These changes are consistent with the expected outputs and outcomes of putting the users at the center of the website redesign process and embedding social innovations into the new UDRC website.

The UX improvements resulting from visitors interactions with the new UDRC website in terms of additional new visitors, more returning visitors, better engagement rates, more average visitor actions, lower bounce rate and more target goals completion are shown in Table 6. Segmentation based-on top origin cities is also presented.

As shown in Table 7, interacting with UDRC new website has also resulted in improved UX and target goal completion rates and lower bounce rates for all visitors across all sources during the selected time period ranging from the 20<sup>th</sup> May 2017 to the 20<sup>th</sup> August 2017.

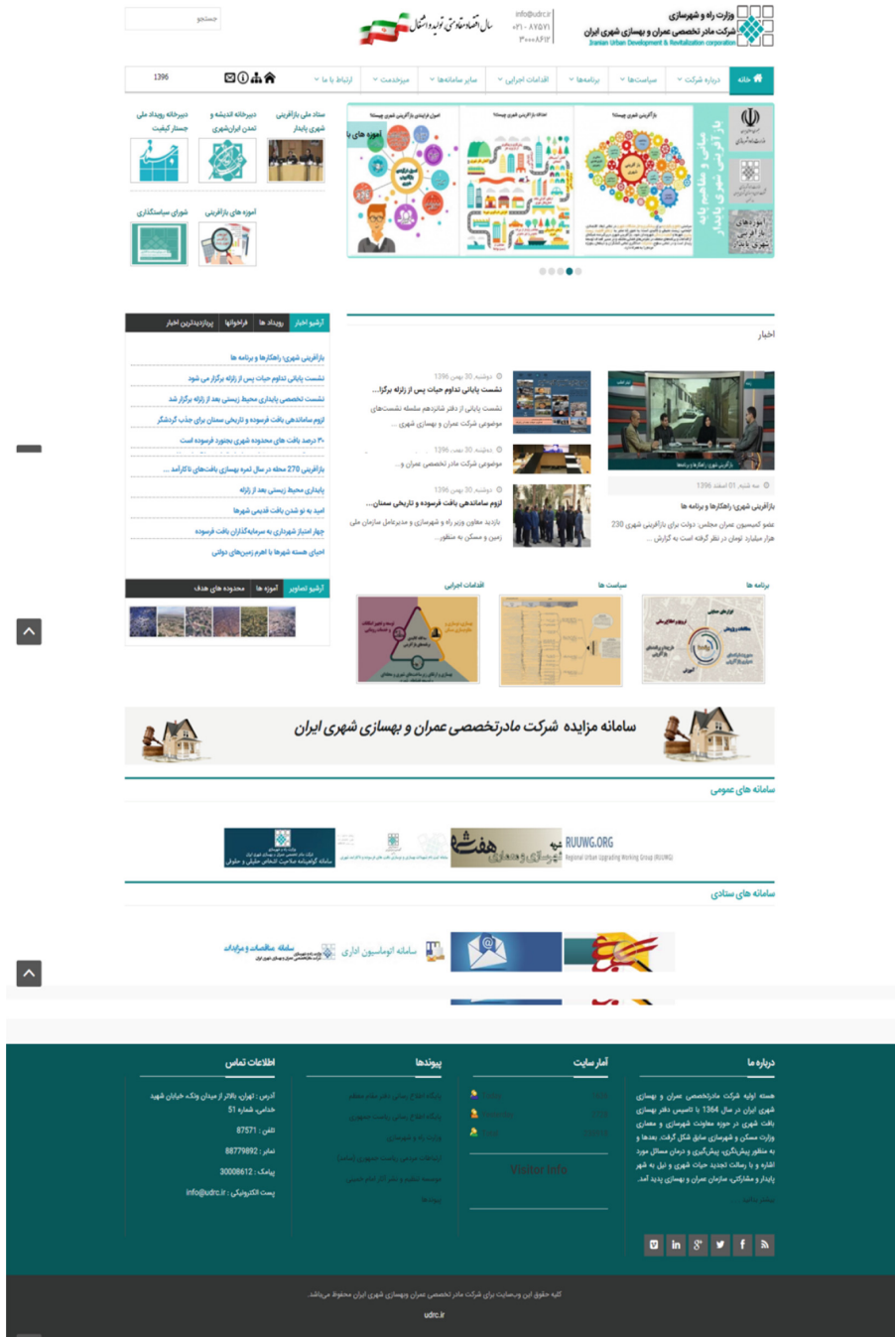


Fig. 6. UDRC new website home page

**Table 5.** UDRC new website visitor data (20.05.2017–20.08.2017) compared to previous period

Visitors	19,325	+18%
Unique visitors	14,486	+16%
New visitors	7,330	+16%
Returning visitors	7,156	+15%
Actions	98,253	+51%
Page views	92,185	+54%
Downloads	2,945	+8%
Outbound links	3,123	+17%
Average actions	5.1	+28%
Total time	90d 11h	-7%
Average time per visit	6m 47s	-21%
Bounce rate	19%	-6%
Goals	8,456	+17%

**Table 6.** UDRC new website visitor segmentation by top origin city (20.05.2017–20.08.2017)

City	Visitors ▼	Avg actions	Avg time	Total time	Bounce	Goals
Tehran, Iran	2,298 53.2%	3.2	5m 47s	9d 5h	13%	1266 55.1% +15%
Isfahan, Iran	363 8.4%	2.9	5m 43s	1d 10h	16%	219 60.3% -1%
Tabriz, Iran	153 3.5%	3.5	6m 26s	16h 24m	16%	100 65.4% +20%
Mashhad, Iran	142 3.3%	2.5	7m 48s	18h 28m	14%	62 43.7% +49%
Zanjan, Iran	121 2.8%	4.5	4m 8s	8h 20m	11%	47 38.8% +116%
Yazd, Iran	108 2.5%	3.3	3m 51s	6h 56m	23%	49 45.4% +14%
Karaj, Iran	97 2.2%	3.1	4m 42s	7h 36m	6%	34 35.1% -16%
Hamadan, Iran	84 1.9%	3.6	5m 41s	7h 57m	17%	30 35.7% -41%
Shiraz, Iran	69 1.6%	1.7	3m 2s	3h 29m	35%	20 29% +23%

**Table 7.** UDRC new website visitor segmentation by traffic source (20.05.2017–20.08.2017)

Source	Visitors ▼	Avg actions	Avg time	Total time	Bounce	Goals			
🔍 Searches	10,067	52.1%	3.4	5m 53s	41d 3h	15%	5343	53.1%	+9%
👤 Direct	7,396	38.3%	4.3	6m 30s	33d 9h	24%	2116	28.6%	+35%
🔗 Links	1,359	7%	3.2	6m 15s	5d 21h	19%	835	61.4%	+7%
📢 Advertising	471	2.4%	3.6	5m 6s	1d 16h	24%	157	33.3%	+13%
📺 Media searches	23	0.1%	1.2	2m 9s	49m 27s	34%	5	21.7%	+21%
📱 Social media	9		1.0	17s	2m 33s	67%			-53%
Total	19,325						8456	43.8%	

## 5 Conclusion

This research aimed at understanding the theory and practice of social innovation for supporting open ICT ecosystems towards improving digital user experience. The case of the Iranian Urban Development and Revitalization Corporation (UDRC) website was selected in this study. First, remote user research was performed on old version of UDRC website for three months, from February to May 2017, in order to discover users profiles, what user goals are and define what expected target goals should be. Then, the UX and target goals completion rate for the old UDRC website were measured and selected. In the next phase, social innovation were embedded into the UDRC new website prototype and implemented accordingly. Finally, continuous remote user research was realized, from May 2017 to August 2017, in order to measure UX improvements and target goal completion rate for new UDRC website.

## 6 Limitations

The operational definition of UX adopted in this research is limited to *Momentary UX* which relates to the live usage of the UDRC website as explained in Sect. 1.1. It would therefore be of interest to consider other relevant types of UX and measure the evolution of relevant UX measures within different time spans in the context of additional longitudinal studies. In terms of the total time span for the data collection, this study is limited to six months. Extending the total time period for the user research from time six to twelve months would provide us richer data sets that shall be transformed into better user research insights and findings. Finally, the established concept of UX in a digital environment should be extended to more emerging concepts of city experience and urban experience in a mixed physical and digital smart city environment. In this respect, UNSECO learning cities [16] can provide relevant scenarios for future research studies blending build urban environments and digital environments.

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