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RESEARCH PAPER

Key Challenges in Big Data Startups: An Exploratory Study in Iran

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Abstract

Due to the explosion of data in recent years and the increase in its commercial application, big data and its analytics have attracted the attention of governments, academics, and practitioners, especially that of the startups. At the same time, regarding the recent nature of the phenomenon, entrepreneurship literature lacks a thorough understanding of the contextual challenges experienced by big data startups. Therefore, this study aims to contribute to the literature of big data entrepreneurship by identifying the environmental challenges of big data startups and exploring the priority of these challenges in the context of Iran, a developing IT market country. For this purpose, our research method is comprised of two phases: identifying the challenges of big data startups' using in-depth interviews and questionnaire, and prioritizing such challenges based on experts' assessments using a fuzzy analytic hierarchy process. Our findings revealed that lack of particular laws and policies for big data, lack of transparency, data mismanagement, financial challenges, technological and educational weaknesses, unawareness of big data advantages, and lack of willingness for utilizing it are the most significant challenges of big data startups in a developing context. The paper concludes with some policy and managerial recommendations for creating a supportive environment for startups.

Keywords: Big data, Fuzzy analytic hierarchy process (AHP), Key challenges, Startup

Introduction

Startups are rapidly growing (Kim et al., 2018) and playing a significant role in improving societies (Salamzadeh & Kesim, 2017). While the whole startup economy is growing, deep tech sub-sectors (Startup Genume, 2019) including big data are growing faster since data is going to be the most prominent trading commodity in the future (Xiao et al., 2014). Therefore, governments, academics, and business communities are becoming increasingly interested in big data analytics and its related businesses (Chen et al., 2012).

While startups are recognized as one of the leading developers and diffusers of big data technology (Davenport & Dyché. 2013), they face several challenges that are different from other enterprises and are heavily dependent on the political, legal, and economic ecosystem in

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which they act (Salamzadeh & Kawamorita, 2015; Wagner & Sternberg, 2004). Thus, every ecosystem proposes unique challenges for big data startups that raise the demand for appropriate policy tools to shape a good startup ecosystem.

Adopting appropriate policy tools and targeting big data startups in each ecosystem are the output of an in-depth understanding of the specific challenges that they face in that ecosystem. Therefore, there is a need for studies that address big data startups' challenges. Despite the necessity of such studies, the literature lacks research that addresses big data startups challenges, particularly in developing countries like Iran.

Iranian policymakers desire to move from a resource-based economy to a knowledge-based economy by investing in emerging technologies (Kanani & Goodarzi, 2017). Meanwhile, information technology (IT) startups including big data startups are one of the primary groups that received considerable attention, but the actual level of activity in these fields is still lower than the real potential of the sector. Therefore, investigating big data startup challenges in the entrepreneurship ecosystem of Iran is vital, as Iran can be considered a good playground among developing countries.

As there is a need to identify challenges facing Iranian startups (Global Entrepreneurship Monitor, 2018) that are mainly working in high tech areas, the most crucial goal of this research is to identify the challenges of Iranian startups that are working in the field of big data. This paper identifies big data startup challenges by using semi-structured interviews and questionnaires and prioritizing them with the fuzzy AHP model.

The rest of this paper is structured as follows: Section 2 provides a literature review on startups' and big data startups' challenges, Section 3 provides the research methodology, Section 4 outlines data analysis and findings, Section 5 provides results and discussion, and Section 6 concludes the paper.

Literature Review

Startups and Their Challenges

The term "startup" has gained a lot of popularity these days. However, there is no precise definition of this concept (Cockayne, 2019). It is defined as "a human institution designed to create a new product or service under conditions of extreme uncertainty" (McGowan, 2018) or "a new organization, venture or a company in the early stages of its operation" (Nurcahyo et al., 2018; Salamzadeh, 2015). Yun (2017) defines a startup as a new business that entrepreneurs initiate by combining business ideas and resources, and Rise (2011) defines it as an institution designed to create a new product or service under conditions of extreme uncertainty (Del Vecchio et al., 2020).

Despite the difference in the appearance of definitions, most authors agree upon converting a new idea to real business as the core of the startup concept. More than that, startups have common characteristics such as being a significant source of new jobs and entrepreneurship (Decker et al., 2014), having a spillover to firms with geographic proximity to them (Gilbert et al., 2004), not being very experienced in the potential market they might enter (Gans & Stern, 2003), being fragile (Salamzadeh, 2015), having a high rate of failure (Patel, 2015), being younger than ten years, having innovative technologies or business models (Kollmann et al., 2015) and lacking tangible and intangible resources (Spender et al., 2017; Wymer & Regan, 2005).

In sum, it is evident that "A startup is neither a smaller version of a large company" (Blank, 2010) nor an SME. Therefore, they may experience different challenges.

In general, startups struggle with significant challenges (macro and micro challenges) that are addressed in some research. Table 1 presents some critical challenges faced by new entrepreneurs and startups in the literature.

Table 1. Summary of the Addressed Critical Challenges Faced by New Entrepreneurs and Startup in the Literature

Challenge / Resource	Legal issues	Lack of appropriate mentors	Competition with large companies	Market place and marketing	Lack of a strategic and business plan	Lack of experience and talent	Economic and funding obstacles	Government policies
Dawson & Henley, 2012								✓
Rosenberg & Marron, 2015								✓
Wagner & Sternberg, 2004								✓
Kanchana et al., 2013						✓	✓	
Malagihal & Hazarika, 2018							✓	
Salamzadeh & Kawamorita, 2015						✓	✓	
Simón-Moya, et al., 2014							✓	
Kurode, et al., 2019			✓	✓		✓	✓	
Mor, 2015			✓			✓		
Pandey & Pattnaik, 2017					✓			
Cutler, 2014			✓					
Sopjani, 2019								✓
KPMG, 2016		✓				✓	✓	✓
Wang, et al., 2016	✓			✓	✓	✓	✓	
Salamzadeh & Kesim, 2017						✓	✓	✓

Big Data Startups' Challenges

In addition to general challenges, startups may face some challenges that arise from the professional context in which they work. Based on our research in scientific databases, a few studies have addressed the entrepreneurs' challenges in the big data context.

Bachlechner and Leimbach (2016) mentioned some of the professional challenges such as lack of technical knowledge, weaknesses in big data solutions, inter-organizational cooperation, hiring competent experts, establishing trust, and legal issues as challenges of big data startups. Vaghela (2018) introduced handling a large amount of data, data complexity, data security, and shortage of skilled people as the main challenges of big data startups. According to Mann (2019), three main data challenges faced by big data startups are lack of data, over-reliance on quantitative data, and limited resources for data management and infrastructures. In addition, skills and capabilities, social and cultural attitudes toward technology, and institutions are the recognized influential factors on this technology usage (Buente & Robbin, 2008; DiMaggio et al., 2001; Hilbert, 2014).

As it is visible, despite the fact that big data is being recognized as a significant technological trend and a growing industry, few studies have investigated the challenges faced by big data startups.

Iran's Startup Ecosystem

Iran, with $463 billion[1] GDP[2] (2020), is the third-largest economy in the Middle East. As a developing country, Iran is looking for incremental programs for startups, with vast entrepreneurship potentials. The TEA index[3] of Iran is 11%, and the average entrepreneurs in Iran are male and young (Global Entrepreneurship Monitor, 2018).

Before the 2000s, there was limited evidence of the emergence of new ventures in Iran. Afterward, the Iranian government played a significant role in improving the entrepreneurship and startup ecosystem (Global Entrepreneurship Monitor, 2018). Since 2012, the "startup ecosystem" has started to flourish especially in the main cities of Iran (Salamzadeh et al;, 2017) where they benefited from the establishment of supporting programs, events, and exhibitions as well as a vast increase in the number of incubators, accelerators, technology transfer offices, angel investors, and venture capitals.

Meanwhile, several challenges are addressed as major disincentive factors of Iran startups ecosystem growth including sanctions (Tavakol, 2020), inappropriate tax system, lengthy process of company registration, limited access to local financing (Cheraghi & Yaghmaei, 2017), weak policy-making, lack of knowledge, legal issues (Salamzadeh & Kawamorita Kesim, 2017), entrepreneurs thinking locally, talent exit, and low R&D investment rates (Jozi, 2015).

Recent sanctions have also created many challenges as well as opportunities for Iran's business environment and startup ecosystem.

As it was mentioned before, bright future and high value-added nature of big data – as one of the core developing fields of the global economy – have attracted decision-makers to subsequently design and implement supportive policies for fostering its growth (UNCTAD, 2016). Iran's startup ecosystem, as an excellent developing playground that is moving toward a knowledge-based economy, faces several shortcomings and challenges in the big data field that have not been addressed by other scholars and need to be identified.

With this paper, we aim to address these shortcomings and challenges by investigating the startups' challenges in the Iranian big data context.

Research Methodology

This research is considered a pure exploratory study as it goes through the data with no pre-existent hypothesis, but has an objective (Blaikie & Priest, 2019; Merriam & Grenier, 2019) that is to identify and prioritize the contextual challenges of Iranian big data startups. Regarding the nature of exploratory studies, a deep understanding of the phenomena should be produced by asking "why" and "how" questions through engaging in conversations with research participants (Creswell, 2009).

To find proper research participants, the sampling method of this research is purposeful as it tried to reach all Iranian big data startups in the big data supply chain with less than three-year experience. This range includes big data providers, transfer service providers, storage service providers, analysis service providers, visualization service providers, and consultancy service providers. To this end, all the universities, science parks, startups under venture capitals and angels supporting programs, and websites have been searched. As big data is an emerging technology, this extensive-range definition and inquiry has led to the identification of 26 big data startups.

1. Estimated by 2019/20
2. Gross Domestic Product
3. Total early stage Entrepreneurial Activity

By finding 26 Iranian big data startups as our sample, our research is comprised of two parts: the first part examines the way to determine big data startups' contextual challenges in Iran, and the second part the way to prioritize these challenges based on their "importance" for big data startups, and their "ubiquity" in Iran as a regional context. Figure 1 demonstrates a brief sketch of the research process structure.

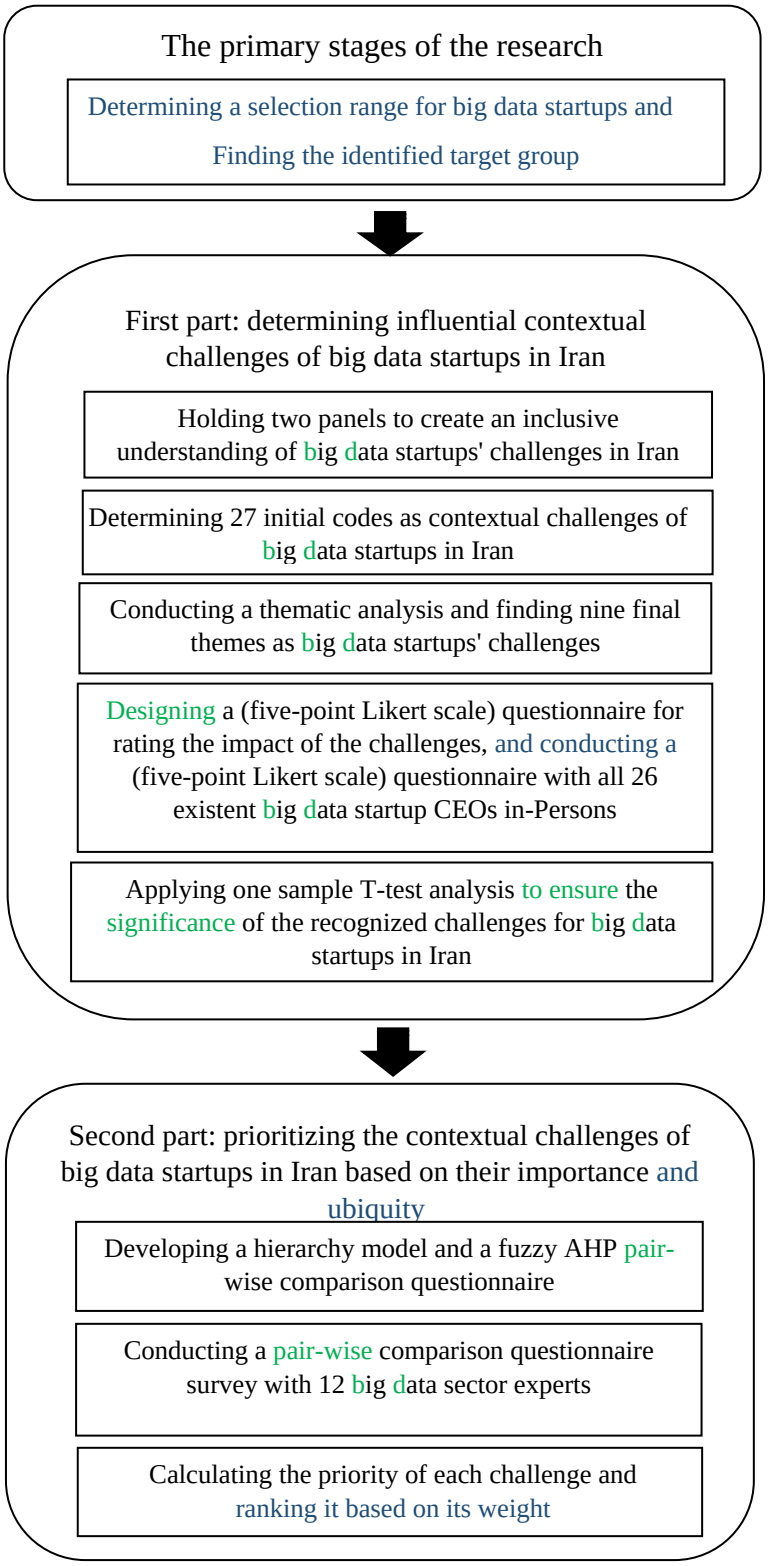

Figure 1. The Research Process Structure

Identifying Startup Challenges

To identify startups' challenges in the context of Iran and the big data industry, firstly 15 main challenges including startups' general challenges and big data startups' specific challenges that were addressed by researchers were extracted from the literature. This set consisted mainly of legal and economic issues, government policies, lack of technical knowledge, weaknesses in big data solutions, inter-organizational cooperation, data complexity, data security, shortage of skilled people, social and cultural attitudes toward technology, institutions, lack of data, over-reliance on quantitative data, and limited resources for data management and infrastructures, that are previously mentioned in the literature review section. Then, two panels, consisting of some recognized startups' CEOs with at least two years of startup management experience, were held for debating about the extracted challenges and identifying new challenges that are specifically related to Iran's regional context and big data. The panels started with a set of open-ended questions, designated for identifying big data startups' contextual challenges, regarding the exploratory nature of the research. The panelists' comments were analyzed and codified after each panel. The panelists also were asked to point out if any other challenge remained after each panel. For reducing researcher bias, both panels' transcripts were given to another independent researcher to have a more objective and probably a different stance to the obtained evidence. After undertaking the panels, the collected data were saturated. As a result of analyzing and codifying panelists' responses, 27 initial codes were identified as big data startups' challenges (based on the panelists' comments).

Regarding the qualitative aspect of this part and the overlap between some obtained challenges, a thematic analysis was conducted to obtain both inclusive and distinct challenges. Based on the thematic analysis, nine inclusive challenges were identified from the codes. To be ensured of the impact of these nine challenges on big data startups' outcomes in Iran, a five-point Likert scale questionnaire, that was designed and pretested by a small group, was sent in-person to all big data startup CEOs who had attended the ELECOMP 2018 exhibition (the most prominent IT exhibition in Iran, in which almost all the distinguished big data startups were present), and the startups who were working at university science parks. Then, the obtained results of this survey were analyzed by t-test. For maintaining the quality of the responses, the participants were not obliged to answer all the questions in case they were not sure about the concepts included in any of the questions. By analyzing the obtained responses, six challenges were recognized as big data startups' main challenges in Iran.

Prioritizing the Challenges

In the second part of the research, the six obtained challenges from the last phase of the study were prioritized using fuzzy AHP method.

Developing a hierarchical model and pair-wise comparison questionnaire, which must be distributed among a panel of experts, is pre-required for fuzzy AHP analyses. Therefore, a hierarchical structure for prioritizing Iranian big data startups challenges, based on their "importance" and "ubiquity," was developed. As can be seen, Figure 2 demonstrates a 3-level AHP model of these challenges' prioritization. The first level is dedicated to the goal of the study, which is prioritizing Iranian big data startups' challenges. The second level expresses the prioritizing dimensions, namely the "importance of the challenges" and the "challenges ubiquity"; and the third level presents the recognized big data startups contextual challenges.

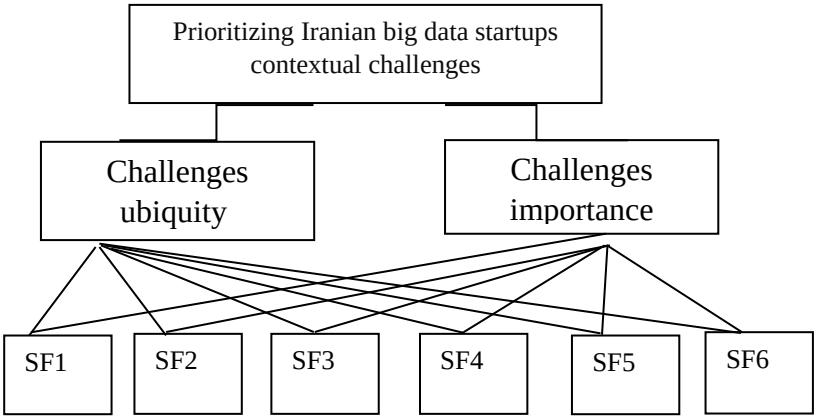

Figure 2. The Hierarchical Structure of the Contextual Challenges' Prioritization

After that, a panel of experts was needed to fill the pair-wise comparison questionnaire. The panel size must be large enough to cover different viewpoints and small enough to be manageable (Ahmed & kilic, 2019). Therefore, a 12-member panel of experts, who were working on big data policy-making projects in telecommunications and information technology research institutes, was selected.

The pair-wise comparison questionnaire was presented to the expert panel. They were asked to compare each of the two elements with each other and judge the priority degree of the components with respect to the upper level. Table 2 indicates the quantitative preference scale that the panelists were asked to consider for their judgments.

Table 2. The Preference Scale of the Comparison Matrix

Value	Preference degree
9	Extremely preferred
7	Very strongly preferred
5	Strongly preferred
3	Moderately preferred
1	Equally preferred

After that, the pair-wise comparison questionnaire results were collected and converted to a fuzzy triangular matrix by calculating the geometric mean of all experts' judgments about every two challenges, as below:

$$a_{ij} = (a_{ij}^1 \otimes a_{ij}^2 \otimes \ldots \otimes a_{ij}^m)^{1/m} \quad (1)$$

where a_{ij}^k, denotes the subjective judgment of k^{th} expert about the "importance" or "ubiquity" of the challenges i and j. Therefore, a fuzzy comparison matrix with fuzzy triangular numbers (TFN) is as below:

$$\tilde{A} = (\tilde{a}_{i,j})_{n\times n} = \begin{bmatrix} (1,1,1) & (l_{12},m_{12},u_{12}) & \ldots & (l_{1n},m_{1n},u_{1n}) \\ (l_{21},m_{21},u_{21}) & (1,1,1) & \ldots & (l_{2n},m_{2n},u_{2n}) \\ \vdots & \vdots & & \vdots \\ (l_{n1},m_{n1},u_{n1}) & (l_{n2},m_{n2},u_{n2}) & \ldots & (1,1,1) \end{bmatrix} \quad (2)$$

where each set (*l, m, u*) is an indication of TFN in which parameters "*m*", "*l*" and "*u*" are the most promising value, the lower limit bound, and the upper limit bound of the possible evaluations.

Different methods have been introduced and used for handling a fuzzy comparison matrix (Wang et al., 2008).I In this paper, the extent fuzzy method (Chang, 1996) has been applied to experts pair-wise comparison matrix and evaluation model where

$$\tilde{a}_{i,j} = (l_{ij}, m_{ij}, u_{ij}) = \tilde{a}_{ij}^{-1} = (1/u_{ji}, 1/m_{ji}, 1/l_{ji}) \quad \text{for} \quad i, j = 1, \ldots, n; j \neq i \tag{3}$$

To calculate the priority vector of the triangular fuzzy comparison matrix above, the extent analysis method is used as follows.

First, the fuzzy sum-up of each row of the fuzzy comparison matrix is as calculated as

$$RS_i = \sum_{j=1}^{n} \tilde{a}_{ij} = (\sum_{j=1}^{n} l_{ij}, \sum_{j=1}^{n} m_{ij}, \sum_{j=1}^{n} u_{ij}), \quad i = 1, \ldots, n \tag{4}$$

Second, normalizing it is done as

$$\tilde{S}_i = \frac{RS_i}{\sum_{j=1}^{n} RS_j} = \left(\frac{\sum_{j=1}^{n} l_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} u_{kj}}, \frac{\sum_{j=1}^{n} m_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} m_{kj}}, \frac{\sum_{j=1}^{n} u_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} l_{kj}} \right) \quad i = 1, \ldots, n \tag{5}$$

Third, the degree of possibility of $\tilde{S}_i \text{ "} \tilde{S}_j$ calculation is carried out as

$$V(S_i \text{ "} S_j) = \begin{cases} 1, & \text{if } m_i \text{ "} m_j \\ \dfrac{u_i - l_j}{(u_i - m_i) - (m_j - l_j)}, & \text{if } l_j \text{ "} u_i \quad i, j = 1, \ldots, n; j \neq i \\ 0, & \text{others} \end{cases} \tag{6}$$

Where $S_i = (l_i, m_i, u_i)$ and $S_j = (l_i, m_j, u_j)$

Fourth, the degree of $\tilde{S}_i$ possibility over all the other (n-1) fuzzy numbers' calculation is as

$$V(S_i \text{ "} S_j \; j = 1, \ldots, n; j \neq i) = \min_{j \in \{1,..,n\},\ j \neq i} V(S_i \text{ "} S_j), \quad i = 1, \ldots, n \tag{7}$$

Fifth, defining the priority vector $w = (w_1, \ldots, w_n)^T$ of the fuzzy comparison matrix is as

$$w = \frac{V(S_i \text{ "} S_j | j = 1, \ldots, n; j \neq i)}{\sum_{k=1}^{n} V(S_k \text{ "} S_j | j = 1, \ldots, n; j \neq k)}, \quad i = 1, \ldots, n \tag{8}$$

And finally, correcting the normalization formula is done as follows

$$\tilde{S}_i = \frac{RS_i}{\sum_{j=1}^{n} RS_j} = \left(\frac{\sum_{j=1}^{n} l_{ij}}{\sum_{j=1}^{n} l_{ij} + \sum_{k=1, k\neq i}^{n}\sum_{j=1}^{n} u_{kj}}, \frac{\sum_{j=1}^{n} m_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} m_{kj}}, \frac{\sum_{j=1}^{n} u_{ij}}{\sum_{j=1}^{n} u_{ij} + \sum_{k=1, k\neq i}^{n}\sum_{j=1}^{n} l_{kj}} \right) \quad i = 1, \ldots, n \tag{9}$$

Data Analysis

Identifying the Challenges

By scrutinizing the transcripts of the panelists' comments, undertaken by two of the authors independently, 27 initial codes were identified.

Regarding the information provided in Table 4, unawareness of big data advantages in different sectors, lack of accelerators and financial supporter's awareness of big data technology and its potential added value, inaccessibility of expert human capital, and lack of big data professional training are the most repeated codes that mainly arise from the emerging nature of this technology, particularly in a developing regional context like Iran. Meanwhile, other codes refer to other challenges of the startups in a more scattered way. Therefore, by reviewing the obtained codes, nine themes were identified as final challenges, and these themes were presented to an expert panel, constituted of ten panelists. The panelists were asked to express their ideas regarding whether the themes were suitable or not. The panel agreed on all nine themes as big data startups' challenges in Iran. Table 4 demonstrates the themes and the codes assigned to each of them.

Table 3. Identified the Initial Big Data Startup's Challenges' Codes

Number	Challenges initial codes	Frequency
1	Lack of accelerators' and financial supporter's awareness of big data technology and its potential added value	5
2	Big data business risk value	2
3	Big data monitoring weakness	1
4	Big data analytics and visualization weakness	3
5	Big data R&D weakness	3
6	Big data transferring problems	2
7	Unawareness of big data advantages in different sectors	6
8	Lack of data digitalization in some data generation resources and failing to aggregate them	2
9	Decision-makers' unwillingness to utilize big data in organizations	3
10	Security systems weaknesses	1
11	Lack of technical context for developing open data	1
12	Lack of market for big data supply and demand	1
13	Lack of big data products and services assessment labs	1
14	Uncompetitive market	2
15	Lack of evaluation system for big data	1
16	Lack of legal obligations	1
17	Inaccessibility to expert human capital	5
18	Financial insecurity	4
19	Lack of data transparency	4
20	Intangible assets unsupportive laws	3
21	Lack of international relations in the big data context	1
22	Mismanagement of data provided by big data sources deployment	2
23	Lack of knowledge about big data improvement potentials in government services	2
24	Not considering data as an asset, capital, and business subject by the country's economic law system	2
25	Unsupportive policies for big data development	2
26	Lack of tax incentives	3
27	Lack of big data professional training	5

Table 4. The Thematic Analysis of Initial Iranian Big Data Startups Challenges

Codes	Frequencies	Themes
Big data business risk value	2	Financial and economic challenges
Lack of tax incentives	3	
Financial insecurity	4	
Lack of data transparency	4	Lack of transparency and accountability
Mismanagement of data provided by big data sources deployment	2	Data mismanagement
Lack of accelerators' and financial supporters' awareness of big data technology and its potential added value	5	Unawareness of big data advantages and unwillingness to utilize it
Unawareness of big data advantages in different sectors	6	
Decision-makers' unwillingness to utilize big data in organizations	3	
Lack of knowledge about big data improvement potentials in government services	2	
Inaccessibility to expert human capital	5	Technical and educational weakness
Big data transferring problems	2	
Big data analytics and visualization weakness	3	
Lack of big data professional training	5	
Lack of data digitalization in some data generation resources and failing to aggregate them	2	
Security systems' weaknesses	1	
Lack of technical context for developing open data	1	
Lack of market for big data supply and demand	1	Uncompetitive local market
Uncompetitive market	2	
Big data monitoring weakness	1	Lack of assessments and evaluation systems
Lack of assessment labs for big data products and services	1	
Lack of evaluation system for big data	1	
Lack of legal obligations	1	Lack of particular laws and policies for big data
Intangible assets' unsupportive laws	3	
Not considering data as an asset, capital and business subject by country economic law system	2	
Unsupportive policies for big data sector development	2	
Lack of international relations in the big data context	1	Lack of international relations in the big data context

Table 4 proposes financial and economic challenges, lack of transparency and accountability, data mismanagement, unawareness of big data advantages and unwillingness to utilize it, technical and educational weakness, uncompetitive local market, lack of assessments and evaluation systems, lack of particular laws and policies for big data, and lack of international relations in the big data context as the startups' most frequent challenges that should be prioritized.

Thus, the obtained challenges were presented to all 26 big data startup CEOs via setting short meetings in a questionnaire format in which themes were presented as positive predicates, and respondents were asked to prioritize each of the nine challenges based on their impact on startups' output on a five-point Likert scale ranging from 1 to 5. To maintain the quality of the responses, the participants were not obliged to answer all the questions if they were not sure about the concepts involved. Because all the 26 distributed questionnaires were presented in-person and were thoroughly explained to the respondents, the response rate was 100% with no invalid inquiries.

The survey results indicate that the mean scores of the challenges impact range from 2 to 4.4 with the standard deviations of less than 0.9. The results also suggest that three of the challenges with means less than three, including "lack of assessments and evaluation systems", "lack of international relationship in the big data field", and "uncompetitive local market" are considered challenges with low impact on big data startups output in Iran by the startups CEOs mind, at the 5% level of significance. Table 5 demonstrates the statistical analysis of one sample T-test for the recognized challenges.

Table 5. Statistical Analysis of One Sample T-Test of the Recognized Challenges

Challenges	Test Value= 3			
	Mean	**Mean difference**	**Std. deviation**	**T-test statistic**
Unawareness of big data advantages and unwillingness to utilize it	4.3200	1.32000	0.50	7.117
Data mismanagement	4.2600	1.26000	0.73	24.711
Technical and educational weakness	4.2000	1.20000	0.59	18.974
Lack of transparency and accountability	4.1000	1.10000	0.76	34.785
Financial and economic challenges	3.7000	.70000	0.81	7.379
Lack of laws and policies for big data	3.6000	.60000	0.76	3.162
Lack of assessments and evaluation systems	2.4000	-.60000	0.51	-6.325
Lack of international relations in the big data context	2.2000	-.80000	0.85	-12.649
Uncompetitive local market	2.1200	-.88000	0.69	-11.000

Since negative T-test statistics means that the mean of the variable is significantly less than the test value, the challenges with negative T-test statistic value including "lack of assessments and evaluation systems", "lack of international relations in the big data context" and "uncompetitive local market" are considered unimportant. Moreover, all challenges with means more than three and positive T-test value, including "unawareness of big data advantages and unwillingness to utilize it", "data mismanagement", "technical and educational weakness", "lack of transparency and accountability", "financial and economic challenges," and "lack of special laws and policies for big data," are considered the main contextual challenges faced by Iranian big data startups that will be explained briefly in the next subsections using secondary data resources as well as the experts' opinions.

Prioritizing Challenges

As it was mentioned in the methodology, a pair-wise comparison matrix is one of the requirements of fuzzy AHP method. In this study, the pair-wise comparison questionnaire was filled by 12 experts as below.

Table 6. The Pair-Wise Comparison Matrix of Challenges Importance Concerning the Goal

	SF1	SF2	SF3	SF4	SF5	SF6
SF1	(1, 1, 1)	(1/9,1/7 ,1/5)	(1/5, 1/3, 1)	(3, 5,7)	(3, 5,7)	(1/7, 1/5, 1/3)
SF2	(5, 7,9)	(1, 1, 1)	(1/7, 1/5, 1/3)	(3, 5,7)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)
SF3	(1, 3, 5)	(3, 5, 7)	(1, 1, 1)	(3, 5, 7)	(1, 3, 5)	(1, 3, 5)
SF4	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)	(1, 1, 1)	(1/7, 1/5, 1/3)	(1/7, 1/5, 1/3)
SF5	(1/7, 1/5, 1/3)	(3, 5, 7)	(1/5, 1/3, 1	(3, 5, 7)	(1, 1, 1)	(1, 3,5)
SF6	(3, 5, 7)	(3, 5, 7)	(1/5, 1/3,1)	(3, 5, 7)	(1/5, 1/3, 1)	(1, 1, 1)

The pair-wise comparison questionnaire results were collected and converted to a fuzzy triangular matrix. This amount was first calculated repeatedly for determining the local priority weights at each level. Secondly, the global priority weight for each element was calculated by multiplying its local weight with its corresponding weight along the hierarchy. Table 7 demonstrates the local and global weights percentages of the challenges along with displaying the prioritization result of all challenges based on their global weights. A short glance at Table 7 reveals that based on the respondents' points of view, challenges' "importance" is more critical than challenges' "ubiquity" in prioritizing big data startups' challenges. Therefore, at level 2, "lack of special laws and policies for big data" is in priority for receiving policymakers' focus, followed by "lack of transparency and accountability", "data mismanagement", "financial and economic challenges", and "technical and educational weakness", while "unawareness of big data advantages and unwillingness to utilize it" must be the last priority of policymakers.

Table 7. Challenges Priority Based on Their Weights

Priorities	Challenges	Evaluation Criteria		Global Weight%
		Importance Weight% (67.6)	Ubiquity Weight% (32.4)	
		Local Weight%	Local Weight%	
1	Lack of particular laws and policies for big data	28.2	30.5	28.9
2	Lack of transparency and accountability	29.6	26.7	28.7
3	Data mismanagement	13.4	15.2	14
4	Financial and economic challenges	14.4	12.6	13.9
5	Technical and educational weakness	10	8.7	9.6
6	Unawareness of big data advantages and unwillingness to utilize it	4.3	6.4	5

Findings

Applying the extended fuzzy AHP model to determine the weights of all challenges provides useful insights into the problems that must be addressed by policymakers regarding their priorities to foster big data startups and generally big data industry development.

Our findings reveal that "lack of appropriate laws and policies for big data", "lack of transparency and accountability", "data mismanagement", "financial and economic challenges", "technical and educational weakness", and "unawareness of big data advantages and unwillingness to utitlize it" are the main challenges of Iranian big data startups respectively. These challenges are explained briefly using secondary data resources and the experts' opinions:

- Lack of Appropriate Laws and Policies for Big Data

Any technology should be developed within the framework of the law; otherwise, it will cause losses. The information economy becomes increasingly prominent and promises to provide many opportunities but it could also generate some potential drawbacks. Internationally compatible data protection regimes are desirable as a way to create a trustworthy environment that is more predictable for all stakeholders involved in a data-driven economy (UNCTAD, 2016). In Iran, the laws have not yet been modified in alignment with the development of big data technology, and this is one of the most critical challenges for business owners and startups.

- Lack of Transparency and Accountability

Transparency in big data context refers to knowing who holds the governance of data (Mantelero, 2014), the clarity of data ownership, the possibility of tracking the data, etc. This is one of the main challenges of data-driven businesses in non-transparent societies.

- Data Mismanagement

Management is a group of activities related to the planning, development, implementation, and administration of systems for the acquisition, storage, security, retrieval, dissemination, archiving, and disposal of data. Proper data management requires a full life cycle management of datasets.

- Financial and Economic Challenges

Compared to Asia and the world, the entrepreneurial finance factor in Iran is fragile (Global Entrepreneurship Monitor, 2018). In such regions, starting up activities in knowledge edge, such as big data, is riskier and more likely to impose more financial challenges. Big data business risk value, lack of tax incentives, and economic insecurity can be considered subcategories of this factor.

- Technical and Educational Weakness

Most of big data problems require a minimum of four roles (Usher, 2015). For big data system success, accessibility to the experts required for these roles is vital. Inaccessibility to expert human capital, education weakness in the field of big data, and weakness or even absence of big data security technologies are examples of this challenge.

- Unawareness of Big Data Advantages and Unwillingness to Utilize It

The community awareness of the advantages of big data in developing countries like Iran is low, and the public fails to know even the basics. Therefore, persuading managers to accept it is very difficult. Without a clear understanding, a big data adoption project has a high risk of failure. Besides, there is a threat that the managers may waste a lot of time and resources on things they do not even know how to use. A survey is conducted in association with big data challenges also confirmed this.

Discussion

Based on our findings, the biggest challenge of Iranian big data startups is the lack of appropriate laws and policies for the big data sector. This challenge was also addressed in other studies, e.g. (Dawson & Henley, 2012; Rosenberg & Marron, 2015; Wagner & Sternberg, 2004) for all the startups as a global challenge. It seems that lack of appropriate

policy-making studies for startups based on their industrial context in both academic and practical schemes is the cause of this significant challenge. Therefore, conducting in-depth contextual studies on startups and then designing and implementing appropriate policies that address this and other aforementioned challenges would help big data startups operate in a better environment with fewer challenges (Pugna et al., 2019).

Data is a fuel of the big data value chain. Lack of transparency, accountability, and data mismanagement has led to the restriction of big data businesses, especially startups in this domain, and the limitation of the utilization of big data benefits by society. In other words, data mismanagement harms both the supply and the demand side in the industry (Bachlechner & Leimbach, 2016; Buente & Robbin, 2008; Kshetri, 2014). As the addressed studies on big data challenges have been conducted in the context of developed countries, no stress has been found on transparency as a challenge, while transparency is recognized as one of the main challenges of big data startups in this study, which reveals the role of regional context in shaping high-tech businesses' challenges. The non-transparent context of developing countries like Iran is a challenge for big data startups. This is also the challenge of the society and has caused vast institutional inefficiencies and misuses. More transparent systems – particularly in health-care and commercial areas, which can lead to free data flow in the society – could be considered as an initial but decisive action for any developing country to foster its data-driven businesses. The challenge in the fourth priority is financial and economic shortcomings. This challenge is the challenge of all Iranian companies, especially newcomers and startups, and it is generally addressed as the common challenge of startups by several researchers and authors (Salamzadeh, 2015; Zhang & Zhang, 2014). It can be perceived that startups located in developing countries are under more pressure. As big data is an emerging high-tech field, technical and educational weakness, especially in countries that are not the origins of this technology, is a challenge that makes it difficult for developing countries to enter this area. Lack of human resource and difficulty in hiring competent experts (Bachlechner & Leimbach, 2016) that are mentioned as big data challenges by the past researchers can be a proof of this claim. Therefore, addressing this issue by investing in the required technical and educational infrastructures as well as shaping collaborative networks between science parks, universities, and startups could help the country to mitigate this barrier. Countries' unawareness of big data advantages and unwillingness to utilize it is another challenge that is in the last priority according to experts' opinions. Addressing this challenge could increase the demand and the technology acceptance rate for big data solutions in developing countries; that will facilitate finding customers for big data startups, as finding initial customers is generally one of the prominent common challenges of startups.

Among the six main recognized contextual challenges of big data startups, four challenges are specifically related to the big data field; hence constituting this paper’s contribution, as they have not been addressed in other studies explicitly. The two other challenges are associated with the regional context and are also discussed by other researchers. Therefore it could be concluded that while part of our findings supports previous studies, the other part contributes to the literature by introducing specific challenges arising from the big data field in Iran that are not addressed in other studies.

As Iran is a good testing ground, the results can be generalized to other developing countries with high bureaucratic institutions and non-transparent systems. To our knowledge, no previous study examined the multidimensional contextual challenges of startups; therefore, this is the first study that has analyzed the challenges faced by startups in a developing regional context.

Conclusion

Startups face different challenges during their evolutionary path. In this paper, we extracted the startup challenges of previous studies and investigated key challenges that big data startups have to deal with in Iran. Our survey provided a snapshot of Iranian big data startups' challenges, and prioritized them based on interviewees' comments.

Our findings revealed two significant classes of challenges for big data startups in Iran; the first category contains challenges that are general for all the startups, including "lack of appropriate laws and policies" and "financial and economic challenges." The second category contains challenges like "data mismanagement," "technical and educational weakness," and "unawareness of big data advantages and unwillingness to utilize it," which are highly dependent on the industrial and regional context of startups.

Based on our findings, big data startups deal with some challenges that arise specifically from the field in which they act in a developing country. In other words, this paper contributes to the existing literature by introducing the specific challenges that big data startups face in Iran and can be generalized to other developing regions.

Moreover, this paper can be a trigger to initiate action, as it raises the awareness of policymakers about big data, big data startups, their potentials, and more importantly, their challenges. In other words, findings of this paper could be applied by policymakers to design and implement policies for big data startups as one of the leading developers and diffusers of this cutting-edge technology.

Limitations

Despite our effort to cover all the existing big data startups in Iran, the sampling of this research is partly based on available samples obtained by searching on the Internet and ELECOMP 2018 exhibition. Therefore, as there is no database in Iran that contains information about startups and the field that they are operating in, there might be a number of big data startups, particularly in early stages that have not been identified in this research. More than that, the results of this study are mainly based on big data startup CEOs' and big data experts' point of view; thus any bias in their understanding of Iran's big data startup challenges may lead to the bias of the results of this research. However, we tried to reduce this bias by comparing the results of this research with multiple resources including previous researches in this field.

Finally, since Iran has been studied as the only regional context of big data startups in this research, caution should be exercised in generalizing the results of this research to other developing countries with different characteristics from Iran that can benefit from more internationalized startup ecosystems.

Suggestions for Further Research

This study can be extended in several ways. It could be replicated using a multi-case study method, conducting it in several regional contexts with different specifications, and comparing the results. More than that, future studies can investigate startups' challenges in the field of other emerging technologies such as cloud computing, Internet of Things (IoT) and artificial intelligence. In addition, the sample size, which includes big data startups, can be diversified in different ways. It can cover the whole value chain of big data that will bring a huge contribution to the literature, or it can include other IT startups for making the results more generalizable in the Information Technology industry.

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