Big data and Internet of Things (IoT) technologies in Omani banks: a case study

1. Introduction

The significance of the IT in banking and financial services may be witnessed by the changing technology landscape over the years. Therefore, banking sector has been harnessing the potential of IT in providing services to the customers. Besides tapping the electronic channel for providing services and improving customer relationship, banks have been invoking social media networking for improving their relationship with the customers (Ozdora-Aksak and Atakan-Duman, 2015). On the one hand, the self-service technologies like the ATM are providing services to the users and generating a large amount of data regarding the transactions, and on the other hand, the utilization of social networking media has been instrumental in the accumulation of data regarding the responses and feedback from the users. Voluminous data is being exchanged during banking transactions internally as well as externally. Besides, Internet of Things (IoT) technologies are useful in channelizing the data collection and processing stages for an organization. The present case study seeks to address this call by proposing the integration of Big Data and IoT technologies in Omani banks by substantiating our argument with a case study of four Omani banks which are deploying self-service technologies and social media (Facebook, for instance) with the objective of providing better customer services. Elsewhere, banks have adopted Big Data analytics for processing the humungous data stored with them about the customers and transactions. For instance, banks in England (Bholat, 2015) and Singapore (Ng, 2012) have integrated Big Data analytics in their operations for providing efficient customer services. Likewise, research has laid emphasis upon invoking IoT technologies for streamlining performance. IoT implies that "individual, man-made or natural, objects and interrelated collections of objects, e.g. in homes and cars, can be made uniquely identifiable by radio tags, sensors and actuators, and thereby become virtually represented in wireless and wired internet structures" (Andersson and Mattsson, 2015: 85). We posit that Omani banks have the potential to harness the Big Data sourced from self-service technologies and their social media platforms and apply sophisticated tools and technologies for providing customer-centric solutions on a real-time basis as well as "nowcast" and "forecast" solutions for unforeseen problems. Further, we emphasize upon the utility of IoT for the banking sector in Oman for ensuring efficiency and effectiveness in services.

The paper is structured as follows: Section 2 shall provide a brief about Big Data; Section 3 shall provide a review of Internet of Things (IoT); Section 4 shall provide a brief about the significance of Big Data and IoT for the banking sector; Section 5 shall discuss about the banking sector in Oman; Section 6 shall provide a case study example of how four banks in Oman are using social media for customer management; Section 7 shall provide a brief about the integration of Big Data analytics and IoT in the four banks and provide an overview of the challenges and prospects which may result by integrating Big Data analytics and IoT in the banking sector in Oman; Section 8 shall provide summary remarks followed by a section on limitations of the study and further research directions

(Section 9) and the paper shall conclude with social and practical implications (Section 10).

2. Big Data

Big Data pertains to the five "Vs" which imply volume, variety, velocity, veracity and value. Volume of data implies that there is a lot of data which needs to processed, variety denotes different formats in which data is made available and stored, velocity indicates the speed with which data is generated on a real-time basis, veracity implies truthfulness and credibility of the data thus collected and finally, value implies the utilitarian aspect of the data. Even in the banks, the data which is generated is of high volume, high velocity and diverse in form (Bholat, 2015).

In the corporate sector, organizations like Amazon, IBM, Hewlett-Packard have been deploying Big Data analytics for processing the humungous data generated by them every moment. Also, other sectors like public sphere, healthcare, education, environment are gradually moving forward to integrate Big Data in their operations. Big Data, provided that are analyzed properly, might be very useful tool for business decision-making. Nevertheless, combining and processing them is not possible using traditional analytical tools and, thus, requires the development of the sophisticated software solutions. As the term "Big Data" generally refers to data sets so large and complex that traditional tools are no longer sufficient to process them, appropriate IT infrastructure and dedicated software are prerequisite to analyze such data properly.

3. IoT: A brief

Internet of Things (IoT) may be defined in simple terms as "(envisaging) a society where all members have access to a full-fledged Internet environment populated by self-configuring, self-managing, smart technology anytime and anywhere" (Nolin and Olson, 2016: 362). "Things" are categorized as a hierarchy of five domains (Sundmaeker et al., 2010). The lowest domain corresponds to domain 1 where there are real world entities or virtual entities which interact with each other as well as with the infrastructure supporting these entities; domain 2 corresponds to the level where the things are imbued with sensors and they are able to interact with the environment; the third level is domain 3 wherein the virtual entities engage in collaboration and networking with other entities; domain 4 is an advanced level wherein the entities are able to exchange communication with the environment and reason out different aspects and domain 5 corresponds to the most sophisticated level wherein things are able to self-replicate themselves besides monitoring, managing or preempting other things.

The term-IoT- was propounded in a crude form in 1999 (Ashton, 2009) and it refers to "information-sensing devices and technologies, such as global positioning system, radio-frequency identification devices (RFIDs), infrared sensors, laser scanners, gas inductors, etc... It is a real-time internet-based network" (Dweekat et al., 2017: 270). Furthermore, IoT helps in linking objects or processes which enable better monitoring and interaction.

There are four layers of IoT architecture: the sensing or perception layer (collects and transmits data with the help of object identification properties and reader tools); the gateway and network layer (connects objects or things and allows them to share and exchange information with the help of a gateway, an internal network or a local area network and an external network or wide area network); the management service layer (in-charge of information analytics, security control, process modeling and device management) and the application layer (collected and transitioned data are reserved, processed through certain techniques to be used for a plan, and objects or things are managed and controlled). IoT technologies are useful in supply chain management, logistics, manufacturing (Zelbst et al., 2012), food chain industry (Grunow and Piramuthu, 2013), healthcare sector (Chong et al., 2015), etc. (For an extensive review of IoT, please refer Mishra et al., 2016).

4. Big Data & IoT for the banking sector

Banks and financial institutions are yet to invoke Big Data in their operations (Bholat, 2015; Frizzo-Barker et al., 2016). There are many ways in which customer relationships are forged via banks. For instance, the most commonplace means of customer relationship management is through the offline banking mode wherein the customer visits the bank or other customer touch point physically. The other popular means of transacting with the customer is via online modes. For instance, electronic banking or virtual banking is invoked wherein internet banking, telephone banking, ATM, WAP-banking and other means are being invoked (Cheng et al., 2006). Likewise, m-banking or mobile banking is utilized to provide customer services over mobile networks and devices (Lee et al., 2015; Yadav, et al., 2015). All these offline and online channels act as potent sources of Big Data for the banks.

Besides, banks indulge in customer relationship management (CRM) activities through their activities on social networking media like Facebook or Twitter. This dimension of banking is known "social banking", wherein banks may "engage the customers and predict their behaviors using insights from social data" (Ghazinoory et al., 2016, in press). Thus, these social banking activities are again a potent source of Big Data in the sense that banks are apprised of the needs and requirements as well as feedback and grievances regarding various issues.

Likewise, with the issuance of plastic cards (credit cards and debit cards) and other customer products where sensing technologies are involved, IoT technologies are being harnessed by the banks for generating customer data and drawing meaningful insights from the same. This is also implicative of the security of confidential data (personal information of the customers) against cyber crimes. IoT technologies generate Big Data in their own turn and they are useful in helping the banks "to understand customer needs, market dynamics, and strategic issues with unmatched precision" (McKinsey Quarterly, 2015). Identification may be made easier and smart phone users (i.e. customers) may benefit from global positioning systems (GPS), sensors and electronics to identify their location. In case of theft or misplace of the plastic currency, the IoT technologies come in

handy to find the lost objects. Finally, IoT technologies are useful in social networking as they help in taking count of the social networking activities of the users.

5. Banking sector in Oman

The Sultanate of Oman borders the Republic of Yemen, the Kingdom of Saudi Arabia and United Arab Emirates. The area of Oman is about 3,09,500 km^2. The population of Oman has been growing over the years and the government is in the process of releasing its latest census figures in 2020 (http://www.omansultanate.com/demographics.htm). Internet usage is on the high in Oman which is attested by 2,584,316 internet users as in December, 2014, which amounts to 78.6% penetration[1]. Until recently, the country was gearing its economy through oil and gas resources. However, with the push on diversification of the economy, the country is envisaging itself into fortifying other sectors like logistics, fisheries, mining, tourism and hospitality (Ninth Five Year Development Plan, 2016-2020).

Banking sector in Oman is progressing at a slow rate (Al-Hajri and Tatnall, 2007; Al-Muharrami, 2016). Banking sector saw its inception in 1948. Broadly, the banking sector remained fragmented until 1970s when the Central Bank of Oman was established. The banking sector witnessed an upswing as a consequence of the banking law of 1974 which allowed entry of foreign banks in Oman. Going by the figures of 2016, there are seven local banks; two specialized banks; two full-fledged Islamic banks and rest are foreign commercial banks. A list of Omani banks is provided in Table 1. The total (gross) assets of banking sector of Oman crossed RO 26 billion at the end of Financial Year 2014 (FY-14) registering a growth rate of 13.5 per cent over FY-13 and both domestic and foreign banks have been contributing to increasing lending growth rates (Central Bank of Oman, 2015). Implicitly, the banks have garnered a large customer base over the years.

Bank	Year of establishment	Website
Local banks		
National Bank of Oman	1973	www.nbo.om
Oman Arab Bank	1973	www.oman-arabbank.com
HSBC Bank Oman	1979	www.hsbc.co.om
Bank Muscat	1981	www.bankmuscat.com
Bank Dhofar	1990	www.bankdhofar.com
Bank Sohar	2006	www.banksohar.com
Ahli Bank	1998	www.ahlibank-oman.com
Foreign Banks		
Oman Arab Bank	1973	www.oman-arabbank.com
Habib Bank	1974	http://globalhbl.com/oman/
Citibank	1975	https://www.citibank.com/tts/global_network/emea/middle_east/oman.html
Bank of Baroda	1976	http://www.bankofbaroda.co.in/oman.asp
Bank of Beirut	2006	www.bankofbeirut.com/Oman

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[1] http://www.internetworldstats.com/middle.htm#om (Accessed on 15 March, 2016)

National Bank of Abu Dhabi	1976	https://www.nbad.com/en-om/personal-banking.html
Qatar National Bank	2007	http://www.qnb.com/cs/Satellite/QNBOman/en_OM/enQNBWelocmemessageOman
Sarasin Alpen LLC	2008	http://www.alpencapital.com/
State Bank of India	2004	http://www.sbioman.com/
Specialized Banks		
Oman Housing Bank	1977	www.ohb.co.om
Oman Development Bank	1977	www.odb.com.om
Islamic Banks		
Bank Nizwa	2012	www.banknizwa.om
Alizz Islamic Bank	2013	www.alizzislamic.om

Table 1: List of banks in Oman (Source: Central Bank of Oman)

In the Organization of Islamic Countries (OIC), the Islamic Banks (IBs) are witnessing an increase in their market share over the years to about 40% in 2014-15 (Sun et al., 2016). Islamic Banks have been contributing towards financial inclusion besides providing avenues for diversification of banking services. As an OIC member, Oman has been witnessing a growth of IBs too. This is attested by the fact that despite being recent entrants in the banking sector, the total customer deposits held with Islamic banks and windows registered a significant increase to RO 1.3 billion in September 2015 from RO 0.4 billion as at the end of September 2014 while the total assets of Islamic banks and windows combined amounted to RO 2 billion as at the end of September 2015 which constituted about 6.5 percent of the banking system asset base (Central Bank of Oman, 2016).

6. **Case study of 4 Omani Bank**

To substantiate our case study's intent, we will take four Omani banks, viz. Sohar Bank, Bank of Beirut (Oman), Oman Housing Bank and Alizz Islamic Bank as a representative of local banks, foreign banks, Specialized Banks and Islamic Banks respectively. The purpose of selecting these banks is twofold. One, each of them is well-acclaimed banks and one of the authors has informal contacts with the management of these banks. Second, these banks have extensive branching network in Oman besides being active on social networking sites. In this section, drawing evidence from their websites, we will capture some information from their Annual/Quarterly Reports and specifically probe into their Facebook pages as well as the viability to utilize voluminous data generated from self-service technologies like electronic banking or internet banking, for instance, to ascertain the voluminous Big Data which is likely to emerge from these sources which would provide a plethora of opportunities to these banks to strategize their products and services using Big Data analytics. Specifically, with focus on Big Data, the sub-section 5.1 shall deal with a case study on the Facebook activities of these banks and the subsequent sub-section shall provide a brief description to underscore how self-service technologies may be better harnessed. Both social media as well as self-serving technologies may be extracted by IoT technologies for yielding valuable insights.

6.1 Alizz Islamic Bank

Alizz Islamic bank (www.alizzislamic.com) started off its operations in 2012 in line with the Royal Decree No. 69/2012 which laid the foundation of Islamic banking in Oman. The bank provides retail and corporate finance products and services in line with Shari'a through its branches, online and mobile devices. The bank is headquartered in Ruwi. Other branches are at Al Khoudh, Nizwa, Salalah, Sohar and Wattaya. As per the latest Annual Report of 2014, the bank holds assets worth OMR 119.6 million and customer accounts and equity of unrestricted investment account holders totaled OMR 15.2 million. The bank's IT department has implemented "Oracle FLEXCUBE Universal" Core Banking System and seeks to provide better services by building upon its IT infrastructure in the coming times. Among the e-banking services are included online banking, mobile banking, interactive teller machine and phone banking. For instance, "alizz Connect" is an online banking portal which helps to check account balances, view and pay card bills, transfer funds locally and internationally, view account statements online, set up, amend or cancel standing orders and create term investment deposits. For ensuring security for online transactions, encryption methods are used. Through mobile banking, customers may avail services like money transfers, view transactions history, view balance and transactions on credit cards, financing or deposits, make online credit card payments, locate bank branches, request cheque books and create beneficiaries from mobile devices. For ensuring security through mobile banking, passwords need to be entered every time a user logs in the account. A multi-layered approach is followed for user registration and authentication. Through alizz Live, an Interactive Teller Machine (ITM), customers may conduct transactions and banking services via a video-based interactive technology which ensures real-time video/audio interaction. However, the alizz Live is only installed at the Muscat Grand Mall (MGM). Through alizz Live, customers may carry out transactions like cardless cash withdrawls of up to OMR 10,000 in any customer denominations, cash deposit to any alizz Islamic bank account, cheque deposit and encashment, opening term deposit, pay-off credit card dues, making local and international transfers and setting up standing instructions. For security purposes, all the transactions are recorded and ID as well as a digital signature are used for authorization and verification purposes. Finally, through phone banking, SMS alerts may be activated to provide details regarding withdrawals and deposits, ATM and internet transactions, salary credits and deposits made through CDM. Through the call centre of the alizz bank, queries, information and grievances may be redressed easily. Lastly, ATM branches are available at various locations to assist the customers to avail multiple banking services.

6.2 Bank of Beirut

The Bank of Beirut is a Lebanon-based bank which has its 4 four branches in Oman (www.bankofbeirut.com/Oman/en/Home) at Muscat, Sohar, Ghubrah (Muscat) and The Wave (Muscat). The first branch was opened in 2006. The Bank of Beirut, Oman, focuses on corporate banking, retail banking, and international banking. The bank provides online banking, internet banking, mobile banking besides customer call centre facility. However, the details are strikingly unavailable at the website. As per the latest Annual Report of the bank, income of the bank has witnessed an increment of 26.11% over the preceding FY. An analysis of customers' deposits reveals that the MENA region, inclusive of Oman, has

witnessed a steep rise by 5.04% between 2013 and 2014. Likewise, the loans made to customers increased by 20.27% over the same period.

6.3 Sohar Bank

Sohar Bank (www.banksohar.com) was established in 2007 as a public joint stock company and is engaged in commercial, investment and Islamic banking through its well-networked branching system at Muscat (10 branches), Al-Batinah (7 branches), Al-Dakhliyah (2 branches) and Al-Sharqiyah (4 branches) and Dhofar (1 branch). The bank's Annual Report, 2014, attests that the bank made a net profit of OMR 29.878 million for the year, which was 11.19% higher than the previous year's net profit of OMR 26.871 million. Further, customer deposits grew 11.49% to OMR 1,552 million during 2014, as compared to OMR 1,392 million in 2013. The bank provides easy access to banking via "e-channels" facility which helps customers to access bank account through ATMs, internet and phones. For personal internet banking, the bank has launched "Al-Mumayaz" which provides customers with real-time access to their bank accounts. For ensuring data privacy and security of customers' transactions, the bank has maintained modern security infrastructure platforms. Thus, customers may avail services related to account balance enquiry, transaction history, transfer of funds, remittances, service requests, interaction with account manager, tracking financial and non-financial activities through new banking and online bill payment for utilities. For corporate customers, the "Al-Mumayaz" platform provides facilities related to real-time account balance enquiry, transfer of funds, trade finance, payroll, bulk files upload, procurement of services of a Corporate Administrator, processing service requests, interaction with Account Management for resolution of queries and net banking. As in the case of non-corporate customers, the bank ensures security and privacy of data through encryption and other tools. Lastly, phone banking through SMS services may be availed by the customers. To ensure safe and secure transactions, the bank's Information Technology & Alternate Channels Division has been gearing towards providing hassle-free services to users.

6.4 Oman Housing Bank

Oman Housing Bank (www.ohb.co.om) was established in 1977 as an Omani stock company in line with the Royal Decree No. 51/77 with a capital of OMR 10 million. Oman Housing Bank is regarded as the successor of Oman National Housing Development Co. which was involved in providing housing finances since 1974. The term of the Bank has been extended under Royal Decree 36/2010 for twenty years commencing from August 2007. The government of Oman is a major shareholder with more than 60% stake. It has branches in Ali Ibrahim Al Raisi (main branch), Sur, Salalah, Sohar, Nizwa, Khasab, Buraimi, Rustaq and Ibra. The bank provides lending services for house construction, purchase of a completed house, purchase and completion of an unfinished house, completion of an unfinished house, expansion of an existing house, repayment of loan arising of (construction/purchase) of a house and maintenance of a house. As per the Annual Report, 2014, the number of approved loans stood at 1887 which amounted to OMR 80 million and the bank earned net profits amounting to OMR

14.5 million in 2013-2014 FY which was an increase by 17.9% over the preceding FY. The Annual Report, 2014, is a testimony of the fact that the bank is not much active in internet banking or other services and not much is being invested in developing the IT infrastructure; however, the bank does make allocations for training of the employees.

6.5 Facebook page activities of 4 Omani Banks: Are the banks tapping social media adequately?

Glancing through the relevant indicators derived from the Facebook pages of these four banks from the period 15th April, 2015 till 15th March, 2016 (Table 2), a lot of vital information is revealed. The selection of the period was in line with our assumption that with increasing social media usage in Oman and growing utility of internet-enabled tools and technologies, Omani banks would have enhanced their activities over time given the competition in banking sector and the growing emphasis upon the economic diversification post oil prices crash after mid-2014. Secondly, Facebook posts for this period were easily available.

Bank	Facebook "page"	"Likes" for the page	Average posts per month	Average "Likes" per month
Oman Housing Bank	www.facebook.com/OmanHousingBank	807	8	10
Bank Sohar	www.facebook.com/excel.banksohar	32503	12	190
Bank of Beirut, Oman	www.facebook.com/BankofBeirut.Oman	54922	9	11107
Alizz Islamic Bank	www.facebook.com/alizzislamicbank	7280	10	240

Table 2: A snapshot of Omani banks' Facebook "pages"

An empirical investigation conducted on 667 e-banking customers regarding their views on their bank's Facebook page revealed how banks may differentiate their products and services based on age-based segmentation (Durkin et al., 2015). Contextualizing this study in the present study would yield useful results for the Omani banks. It would help the Omani banks to chalk out strategies for serving the customers based on their age and occupation. For instance, Bank Sohar and Bank of Beirut, Oman, have been conducting competitive events from time to time. Alizz Islamic Bank and Oman Housing Bank have not picked up the strings. Further, real-time information is missing on all the four banks' "pages". Thus, all the four banks need to work upon this dimension. For instance, for the present, these banks are providing information about various schemes, achievements, motivational thoughts and festival greetings only (Table 3). Mostly, there is repetition of the posts. Although the Bank of Beirut, Oman, is in the forefront in terms of the number of "Likes" per post, the common trend is that these "Likes" vary from post to post and do not show a pattern of increase or decrease.

Bank	Type of post			
	Launch of new branch/scheme	*Achievement*	*Competition*	*Miscellaneous*
Alizz Islamic Bank	Kiosk at MGM	Winning "Business Leadership Excellence" award	-	Celebration of "National Day"
Bank of Beirut	Opening of a new branch	-	Free airline tickets to Beirut	Presence on LikedIn, Twitter and launching of blog (www.blog.bankofbeirut.com); Motivation tips (#BoBTips) like "Spend time with positive people"; Celebration of "National Day"; Greetings for "Id-ul-Fitr"
Bank Sohar	Airing of a radio programme on FM regarding the "Al Mumayaz savings scheme"; Benefits of "Bank Sohar Excel Credit Cards"; To find out on how to convert your transaction to installments, please visit www.banksohar.net/tabid/780/Default.aspx; Opening a new branch at Oman Avenues Mall	Winning "Strategic Website of the Year 2016"	Competition under the "Al Mumayaz savings scheme" (www.banksohar.net/RetailBanking/AccountsDeposits/AlMumayazSavingsScheme/WinnersList.aspx)	Motivation tips for road safety and weather; Greetings for Teachers' Day and Industry Day; Celebration of "National Day"; Celebration of "Quranqasho" for staff members
Oman Housing Bank	Launch of products of the diners	Winning "Banking Executive Award, 2015"	-	Observations of bank representatives on different themes like financial disclosure, diners product, etc.

Table 3: Types of Facebook posts on Banks' "pages"

A study conducted on South African banks underscored the significance of tapping social networking media by the banks (Chikandiwa et al., 2013). This study is pertinent for the present purpose in the sense that besides providing information about the opening of a new branch, all the four banks have not been providing innovative steps in furthering customer experience. Furthermore, visitors post very few comments on the posts. This is attested by the fact that Sohar Bank has got a maximum of 12 comments or Oman Housing Bank gets only one comment for few posts. However, Bank of Beirut got a

maximum of 98 comments on a post pertaining to a general question on shopping behavior. Lack of comments is indicative of decreased interest in the post. For instance, some of maximum "Likes" are witnessed when the "cover photo" or "profile picture" is changed. In the period covered, Bank of Beirut changed its "profile picture" once getting 29 "Likes" while it changed its "cover photo" six times getting an average of 39 "Likes". Likewise, Bank Sohar changed its "cover photo" twice in the period and got an average of 36 "Likes" which is sometimes more than the "Likes" per post. These examples are testimony of the fact that besides keeping a dedicated staff for looking after the social media updates, banks need to strategize their posts and provide more of "real-time" and "updated" information with regular follow-up. Further, traditional media like phone calls or branch visits should be integrated with the social media such that banking becomes a hassle-free experience for customers with updated information in their hands.

In another study based in Turkey, it was found that Facebook and Twitter were being harnessed by the banks for improving upon their CRM activities (Ozdora-Aksak and Atakan-Duman, 2015). The study has potent implications for Omani banks as well. For instance, as may be understood from the aforesaid, Omani banks are yet to make a mature presence on social media. It's time when Omani banks gauged the potential of social media and used it for customers' benefits as well as for its own growth in terms of market share. Likewise, none of the Omani banks are active on Facebook on a daily basis. Providing "real-time" information does not imply that the page be flooded with "posts" every moment, but categories should be made for "interest rates", "repayment period" or "grievances", for instance. For bank's achievements and competitions, separate webpages should be designed. As a customer for whom the "posts" are being created, only those "posts" should be created which are of utility for her. In this way, the "casual" attitude of the "posts" would be transformed to that of a focused and precise approach. Furthermore, Omani banks must learn how to bridge the gulf between what they "post" on social media with what their websites are displaying. Customers should perceive the sense of "relationship" and "ease" of usage and understanding while accessing the website as while being active on the Facebook page. The last finding of the study by Ozdora-Aksak and Atakan-Duman (2015) is very relevant to Omani banks. Oman Housing Bank is a laggard in terms of its Facebook activities while Bank of Beirut, Oman, has been quite active through its Facebook "page". We argue that state-owned as well as private Omani banks must gear towards "knowing" and "understanding" their customers while using social media.

6.6 Self-service technologies in the four banks

The role of self-service technologies is appreciated in banking sector (Chang and Wildt, 1994). Thus, self-serving technologies are instrumental in strengthening customer relationship management besides securing their retention and attracting new customers. Utilization of self-service technologies by the four Omani banks under study reveals interesting insights. For instance, Sohar Bank has been quite active in providing services through its "E-channels" indicator. Bank of Beirut has an "online banking" platform at the top panel of its opening webpage. Alizz Islamic bank provides e-banking options at the left side of the panel. Oman Housing Bank needs to upgrade its webpages, though.

Furthermore, since the website features have an important role in attracting and retaining customers (Luedi, 1997; Selz and Schubert, 1997; Zeithaml et al., 2002), it is important that the websites be designed in user-friendly manner and there should be personalization of services which would help in building the trust of the customers as well (Al-Hawari, 2011; Herington and Weaven, 2007).

7. Integration of Big Data analytics and IoT in Omani banks

Big Data is generated on a real-time basis owing to the sheer volume and velocity of transactions in the service sector. IoT connects "billions of objects-"things" like sensors, monitors and radio-frequency identification (RFID) devices-to the Internet" (Dutton, 2014: 2) and it facilitates service innovations (Andersson and Mattsson, 2015). This section will underscore how Big Data analytics and IoT technologies may complement each other for a more robust framework in banking services. IoT technologies- such as sensors and network technologies- are useful for changing organizational processes and customer interactions and even entire business models. Therefore, banks may tap IoT technologies and improve upon the customer relationship management. For customers' complaints regarding theft and misplace of their plastic cards, IoT technologies may be tapped. Likewise, repeat occurrences from various customers might give a more wholesome picture about the trends in plastic currency misplacement or theft and this may be a potent source for Big Data analytics. Given the Big Data generated by customer transactions alongside other banking services, data generated via IoT technologies' application may also be tapped by banking sector in Oman for ensuring efficiency and effectiveness in services. Both Big Data and IoT technologies run on a real time basis and therefore, prediction and sentiment analysis may be further developed. IoT facilitates in data sharing and banking sector in Oman is slated for a remarkable growth with inferential judgments about data sharing and analysis to predict customer behavior. Likewise, "forecasting" (prediction of trends about the future) and "nowcasting" (prediction of current trends) (Koop and Onorante, 2013) may be enabled using Big Data analytics and IoT technologies which may enhance banks' efficiency and build customer trust. Likewise, tracking devices may be used to generate Big Data and the same may be processed to yield vital information about the customers. This would usher "smart banking" in an appropriate manner.

However, there are challenges associated with Big Data and IoT technologies adoption in Oman's banking sector. For instance, the Annual Reports of these four banks are a testimony of the fact that banks are not making much allowance for reforming their IT infrastructure. IoT technologies are in a nascent stage and there are barriers to their acceptance. For instance, there are hindrances like "institutional barriers (regulations and standards, trust/security) and existing network structures and processes (barriers to reconfigure existing business networks, develop new business models)" (Andersson and Mattsson, 2015: 89). Therefore, banks must institutionalize their R&D and IT infrastructure and engage well-trained and well-equipped personnel to handle the needs and requirements of the customers by invoking Big Data analytics and IoT technologies. For instance, security requirements should be met while instituting these technologies (Li et al., 2016). Besides, it is important that the privacy of the customers be ensured at all

times (Stamoulis et al., 2002) and for this, the IT infrastructure should be well in place. Awareness needs to be built in the users about Big Data analytics and IoT technologies. Omani banks also need to change their business model to accommodate these technologies (Gerpott and May, 2016). For instance, the design of plastic cards (credit and debit cards) needs to accommodate IoT and Big Data components for the accurate processing of data generated by the use of these plastic cards. Furthermore, banking sector needs to invest time and resources to enable collaboration among relevant stakeholders –external and internal- like business, academia and government (Dutton, 2014). There are technical challenges associated with tapping these technologies like spectrum management or roaming and connectivity issues (Forge, 2016) and these challenges are linked with government policy on telecommunications and infrastructure. Finally, self-service technologies should be further improvised for generating more valuable and real-time data so as to integrate Big Data analytics and IoT technologies.

8. Concluding remarks

To conclude, it may be pointed out that Big Data analytics and IoT technologies may help the banks in improvising upon their services and maintaining better customer relationships. The case study sought to underscore the implications for integrating Big Data analytics and IoT technologies in the banking sector of Oman. With a brief description about Omani banks in general, we took a brief study of four Omani banks which were representative of local banks, foreign banks, specialized banks and Islamic banks. We discussed about the activities of the four banks with particular emphasis on their self-service technologies and assessed the standing of these banks with their latest Annual Reports. We studied the Facebook "pages" of these banks and underscored that Omani banks are lagging behind in terms of the quality and quantity of Facebook "posts". Overall, we posit that there are five lessons for Omani banks:
a. Strengthening of R&D infrastructure in banks;
b. Strengthening of social media activities and self-service technologies;
c. Integration of data from diverse sources (social media, self-service technologies, open data) for Big Data analytics and IoT technologies' applications;
d. Ensuring privacy and security of customers' information;
e. Forging ties with private companies and public authorities for co-integration of Big Data and IoT technologies.

9. Limitations and directions for further research

10. Social and practical implications

Our research has left social and practical implications. While the utility of Big Data analytics and IoT technologies is amply acknowledged, it should also be borne in mind that privacy, equality, trust and individual choice are being protected (Dutton, 2014). Likewise, these technologies may lead to innumerable changes in the socio-economic landscape and these societal changes may change the perceptions of the banking customers, for instance. For instance, cyber crimes may rise and hacking may have a number of adverse consequences. However, these challenges may shake the trust of the

customers in banking services. For countering these hindrances, policy and legal mechanisms are necessary so that any counter-activity is checked and pre-empted. Practitioners and policy analysts should take note of the implications of invoking technologies in the banking sector and other services which have a direct and indirect bearing on the common man.

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