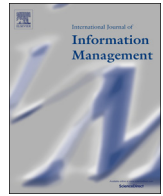




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“Technology enabled Health” – Insights from twitter analytics with a socio-technical perspective

Purva Grover^a, Arpan Kumar Kar^{a,*}, Gareth Davies^b

^a Information Systems area, DMS, Indian Institute of Technology Delhi, India

^b School of Management, Swansea University Bay Campus, UK

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ABSTRACT

Technology had been used in health domain for various purposes such as for storing electronic health records; monitoring; education; communication; and for behavioural tracking. The evident benefits have triggered a huge amount of discussions surrounding health technology in the web 3.0 space and users around the globe are sharing their experiences and perspective on social media platforms. Social media had been used for creating awareness, sharing information and providing emotional support to public in different diseases. This study focuses on exploring the health technology related discussions in Twitter. For this study around 105,489 tweets were collected from Twitter by 15,587 unique users. These tweets were analysed through social media analytics approaches (i.e. CUP framework). The study presents the top technologies in health domain through hashtag analysis and top diseases (acute, chronic, communicable and non-communicable) through word analysis and their association through co-occurrence of words within the tweets. The association depicts technology had been used in treating, identifying and healing of the various diseases. The discussion on social media is skewed towards computing algorithms. The acute and chronic diseases were discussed on social media, and our study indicates that statistically, there is no difference in the discussion of acute and chronic diseases. The communicable and non-communicable diseases are also discussed on social media, and our study indicates no statistically difference in the discussion of communicable and non-communicable diseases which signifies users are referring to Twitter for discussing various type of diseases irrespective of acute, chronic, communicable and non-communicable diseases. Future researchers can use the study as the evidence of extracting insights related to socio-technical perspective from Twitter data. The literature contains lot of evidences where technology had been useful in health domain, but the bigger picture of how the various technologies are being related to health domain is missing, therefore this study tries to contribute to this area by mining tweets.

1. Introduction

Social media had been used for creating awareness related to various diseases (Al-Tae & Abood, 2012; Esposito et al., 2018; Ghanavati, Abawajy, Izadi, & Alelaiwi, 2017; Msayib, Gaydecki, Callaghan, Dale, & Ismail, 2017; Nedungadi, Jayakumar, & Raman, 2018; Triantafyllidis et al., 2017;) for the betterment of the society (Casino, Patsakis, Batista, Borràs, & Martínez-Ballesté, 2017; Platt, Outlay, Sarkar, & Karnes, 2016; De la Torre Díez, García-Zapirain, López-Coronado, Rodrigues, & del Pozo Vegas, 2017). Social media had played a great role in raising warning to diseases such as Swine Flu in 2009 (Kostkova, Szomszor, & St Louis, 2014); Ebola in 2014 (Odlum & Yoon, 2015; Seltzer, Jean, Kramer-Golinkoff, Asch, & Merchant, 2015); and Zika virus in 2016 (Sharma, Yadav, Yadav, & Ferdinand, 2017). The arrival of Zika virus in

America had generated lot of awareness on social media platforms such as Facebook (Sharma et al., 2017).

The health information when shared on social media, the reach of the messages increases for following groups: (a) for the people living in remote areas (Al-Tae & Abood, 2012; Eze, Gleasure, & Heavin, 2016; Manda & Herstad, 2015; Miah, Hasan, Hasan, & Gammack, 2017; Zhang, Thurow, & Stoll, 2015); (b) for individuals with low income and in lower socio-economic communities of the society (Campbell, Caine, Connelly, Doub, & Bragg, 2015; Kim & Zhang, 2015; Thomas & Narayan, 2016); (c) for individuals having little or no access to treatment (Campbell et al., 2015; Kim & Zhang, 2015; Thomas & Narayan, 2016). Social sharing also stimulates social connect among the patients suffering from similar diseases (Barrué, Cortés, Cortés, Tétard, & Gironès, 2017; Owen, Curran, Bantum, & Hanneman, 2016) and e-

* Corresponding author.

E-mail addresses: groverdpurva@gmail.com (P. Grover), arpan_kar@yahoo.co.in (A.K. Kar), g.h.davies@swansea.ac.uk (G. Davies).

Table 1
Use cases of technology used in medical domain.

Use Case	Literature Evidences	Impact
Electronic health records storage	<ul style="list-style-type: none"> ● Lavariega, Garza, Gómez, Lara-Díaz, & Silva-Cavazos, 2016; ● Li et al., 2017 ● Liu, Xia, Yang, & Yang, 2018; ● Lomotey & Deters, 2014; ● Manda & Herstad, 2015 ● Quwaider & Jararweh, 2015; ● Roehrs, da Costa, & da Rosa Righi, 2017 	<ul style="list-style-type: none"> a Access to the health records. b Secure documentation of records for future usage. c Recommendation of medicines, dosage, treatment and prescriptions.
Health Monitoring System: Personalized and commercial	<ul style="list-style-type: none"> ● Al-Tae & Abood, 2012 ● Esposito et al., 2018 ● Ghanavati et al., 2017 ● Msayib et al., 2017 ● Nedungadi et al., 2018 	<ul style="list-style-type: none"> a Better and improve quality of life b Personalized and customized health services.
Medical education and awareness	<ul style="list-style-type: none"> ● Briz-Ponce, Juanes-Méndez, García-Peñalvo, & Pereira, 2016; ● Briz-Ponce, Pereira, Carvalho, Juanes-Méndez, & García-Peñalvo, 2017; ● Fahlman, 2017; ● Al-Tae & Abood, 2012; ● Eze et al., 2016; ● Khalemsky & Schwartz, 2017 ● Manda & Herstad, 2015; ● Miah et al., 2017; ● Schwartz, Bellou, Garcia-Castrillo, Muraro, & Papadopoulos, 2016; ● Zhang et al., 2015; 	<ul style="list-style-type: none"> a Awareness through public health programs b Knowledge sharing new updates in the domains
Communication (a) in remote areas; (b) emergency situations;	<ul style="list-style-type: none"> ● Harari et al., 2017 ● Matthews, Abdullah, Gay, & Choudhury, 2014; ● Matthews et al., 2017; ● Njafa & Engo, 2018 	<ul style="list-style-type: none"> a Treatment for the individuals having low income b Treatment for lower socio-economic communities c Emergency medical response d Life-saving prescription medication
Behavioural trajectories and Disease detection	<ul style="list-style-type: none"> ● Harari et al., 2017 ● Matthews, Abdullah, Gay, & Choudhury, 2014; ● Matthews et al., 2017; ● Njafa & Engo, 2018 	<ul style="list-style-type: none"> a Socio-demographic characteristics of individual b Early warning signal of mood and mental illness

patients seek for information and emotional support on social media platforms (Jiang & Yang, 2017).

A lot of innovative technological solutions have emerged in recent times (like telemedicine, e-health, sensor based devices, electronic health records, etc) to address the health related needs of people. When technology is built into a product that fulfills a particular need, the product becomes a technological solution. Such information technology has also been used in medical domain for monitoring, awareness, education, communication and storage of information (elaborated in Table 1 of literature review section). If the information shared on social media is accurate and credible it can be beneficial but otherwise can mislead the users (Sharma et al., 2017; Matthews et al., 2017). For example, in Zika virus case in America, number of misleading posts were more as compared to accurate posts (Sharma et al., 2017).

This study tries to explore the (a) nature of discussions surrounding the top technologies in the health domain; (b) nature of discussions surrounding top diseases; (c) nature of the association of top technologies with various diseases; and (d) nature of socio-technical network in health domain. Socio-technical networks help us in understanding the human society, nature and technology together. This study tries to address the literature gap of studying the socio-technical system in the health domain with respect to diseases by carrying out a multi-stakeholder analysis of both human and nonhuman interests using actor network theory. To best of our knowledge there is no study in literature which indicates mean discussions surrounding (a) acute and chronic diseases; (b) communicable and non-communicable diseases; on social media platforms. Therefore this study tries to investigate this in the sample.

Actor network theory treats human and non-human artefacts as inseparable. In this case study technology, people and diseases are artefacts, therefore actor network theory had been adopted as a theoretical lens for the socio-technical system. Walsham (1997) had pointed out actor network theory had been used for studying the people and information technology together in the cases such as pilots and computer-controlled planes; computer and people playing games; and

robots in surgery. In this study we had tried to study the technology with respect to human diseases by using the discussions on Twitter on technologies in health domain.

For studying the socio-technical network in health domain inductive, deductive, qualitative and quantitative approaches can be adopted but for this study to have a bigger and generic picture of social-technical system social media analytics was adopted for analysing the technology enabled health discussions. The discussions were extracted from Twitter because following reasons: (a) large number of the users are available on Twitter; (b) the discussions on Twitter contains different meta data information such as geo-tag, time stamp, user profile, network information and many more; and (c) discussions can be extracted from Twitter in cost effective manner (He, Zha, & Li, 2013).

In this manuscript, we focused on how technologies related to health domain are being discussed in social media platform (Twitter) with respect to various diseases. The study had been divided into the eight section such as: first section introduces the pros and cons of sharing the health information on the social media platforms. Second section contains the literature review on usage of technology in health domain, followed by the social media usage in health domain, followed by research gaps and major contributions. The third section introduces the research questions and hypothesis of the study. The fourth section describes the research methodology followed for the study. The fifth section presents the results of analysis. The sixth section discussed the implication of the findings and insights. The seventh section contains the conclusions derived from the study followed by the limitations of the existing study in the last section.

2. Literature review

The literature review had been divided into the three sections: (a) technology usage in health domain; (b) social media usage in health domain, and (c) the research gaps and contribution of the study. The first section, health and technology highlights some of the use cases where technology had been used in medical domain. The second section

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