



Disruptive technological change within knowledge-driven economies: The future of the Internet of Things (IoT)



The boundaries of innovation management have considerably evolved over the last thirty years, especially with the advent of the Internet of Things (IoT) which engages and leverages intelligent management processes and business-related activities for productivity as drivers of revitalization, technological forecasting and reengineering initiatives.

The IoT is considered a disruptive technological paradigm increasingly influencing the daily life, the business world and even the global economy. In a nutshell, the IoT can be considered a family of technologies whose purpose is to transform any type of object, even without originally a digital “nature”, into a device connected to the Internet, likely to take advantage of all the features owned by the objects born to use the network, like the functionality for monitoring and control as well as adaptation and potentially even self-organization. In this context, monitoring means that the objects can behave as sensors, likely to produce information about themselves or the surrounding environment and sharing knowledge with and among the users (Arora and Gambardella, 1994; Sundmaeker et al., 2010; Van den Bergh et al., 2014) whereas control, means that the objects can be controlled remotely without particular technologies but simply through the Internet. In this manner, modern enterprises become progressively more “intelligent” and ambience-sensing as the components of the production lines grow more interconnected, thus opening the way to new forms of business (Cooper and Schendel, 1976; Del Giudice, 2016). The development of IoT, likely to generate higher economic value and achieve higher levels of operating efficiency, goes actually through different types of opportunities: digital transformation processes and new business models and services (Carayannis et al., 2014a, 2014b, 2017) based on information gleaned from IoT home appliances. The IoT-enabled functionality and the related socio-economic, socio-technical and socio-political applications and their implications (privacy, safety and even quality of democracy considerations), are receiving great attention by consumers and end users, and they span a broad spectrum including the monitoring of personal health, fitness devices or automation in navigation or other operations (Lopez-Nicolas and Soto-Acosta, 2010, Del Giudice and Straub, 2011a, 2011b). Likewise, it is reasonable to expect that all kinds of industry globally will benefit as well as be disrupted whether in the manufacture, distribution, infrastructure management and resources (see again Industry 4.0 and Digital Transformation references).

Most recent innovative strategies and practices increasingly postulate novel IT-based and technological opportunities to revise and re-define modern business models and emphasizing new disruptive paradigms requiring original tools and dynamic capabilities including the acquisition and incorporation of knowledge and technology from

outside the organization (Alavi and Leidner, 2001; Carayannis et al., 2018; Cegarra-Navarro et al., 2016; Vermesan, 2009).

Nevertheless we still know very little about how the IoT is influencing global ecosystems as well as the social change (Gawer and Cusumano, 2014). The disruptive technology “halo effect” of the IoT has the potential to revolutionize the way businesses gather data and, within this process, transform many aspects of management, accounting and auditing as well as how we live and function as individuals and citizens of democracies. Although the IoT is growing in importance, it has yet to reach critical mass. Therefore, the aim of this special volume has been to investigate the impact and the role of the IoT on various managerial processes as well as their effect on the social change within global ecosystems, in terms of the promotion of knowledge flow, innovation and competitiveness (Alavi and Leidner, 2001). Furthermore, as the IoT is going to change the sources of transactional data flowing into enterprise resource planning, billing and accounting systems, it will alter the way audits of these transactions are carried out: this special issue aims to focus on these issues as well.

Following those premises, this special issue was motivated by the following question: **“how are IoT technologies changing the nature and dynamics of the ways and means of competing for business?”**.

Conscious of many underexplored phenomena that should be scientifically and practically addressed, this special issue strives to address empirical and practical applications of best practices, comparative analyses, cross-studies, network analyses and synthesize the prior theoretical literature into an emerging grounded theory framework. Hence, this volume comprises both theoretical and empirical research papers.

The selected papers reflect research collaborations between scholars from different nations and they encompass contributions and discuss empirical findings across multiple levels of analysis from a wide range of organizational archetypes. The research methodologies used for gathering empirical data vary from quantitative surveys to exploratory case studies based on qualitative data. Several rounds of blind peer reviews resulted in the final form of this volume for publication with the TFSC. We aimed at selecting papers reporting on the application of innovative methods addressing real world problems. We were looking for studies containing both some form of novel innovation as well as an empirically validated application. Readers of this special issue should be technically savvy, scientifically demanding, and drawn to practically relevant phenomena.

This volume opens with a quantitative research by Martinez-Caro Eva, Juan-Gabriel Cegarra-Navarro, Alexeis Garcia-Perez, and Monica Fait titled **“Healthcare Service Evolution Towards The Internet Of Things: An End-User Perspective”**. This study provides evidence that

contributes to acknowledge the impact of IoT for the well-being and social care. Particularly dynamic industries such as the healthcare service sector have just begun to understand the benefits of the IoT for the provision of a new, more advanced type of services. However, whilst the healthcare service industry is yet to fully grasp the benefits of information systems for its practitioners and managers, and for patients and families, there is a need for a better understanding of the challenges and opportunities associated to IoT-based healthcare systems as another disruptive wave of technologies. In particular, research on the relevance of users' skills for adoption of IoT-based healthcare services has been limited. Using the current Internet-based healthcare service landscape as a platform for the formulation and testing of its hypotheses, this paper explores the relationship between patients' capabilities for effective use of information and communication technologies and the success of IoT-based healthcare services. The resulting theoretical model for effective use of information and communication technologies and the success of IoT-based healthcare services was then validated. The validation was based on data collected from a randomly selected sample of 256 users of Internet-based healthcare services provided by the public healthcare system of the Region of Murcia in Spain. The findings of this research inform future strategies for the implementation of new generations of health and well-being services based on IoT technologies.

The second article, entitled **“Intertwining The Internet Of Things And Consumers' Behaviour Science: Future Promises For Businesses”**, is written by Francesco Caputo, Veronica Scuotto, Elias G. Carayannis, and Valentina Cillo. The aim of this research is to explore how inter-networked smart devices or machine-learning algorithms transfer information and knowledge on digital consumers by small sensors and computing processors. Disruptive changes and breakthrough innovations are embraced in the development of the Internet of Things. Companies thus track consumers' behaviour and offer personalised products and services. However, consumers are still sceptical in using these devices due to privacy risks and a dearth of awareness about the technologies' perceived value. Therefore, to overcome these barriers, the research seeks to measure the relationships among the elements that affect customers' willingness and decisions to use IoT-based products. On the basis of motivation theories, two categories of motivational factors have been identified: extrinsic factors such as entertainment and social interaction and intrinsic factors such as information acquisition, privacy risk, and technology readiness level. They are analysed using a sample of 782 early-adopter customers in Italy. The aim has been to offer an explorative, quantitative study on the IoT to enhance the existing knowledge and support business in the process of engaging more users and creating new personalised products. In line with this, the study's implications, limits, and recommendations for further research are presented.

“Internet Of Things: A Systematic Review Of The Business Literature From The User And Organisational Perspectives” is the third selected article joining this special issue, written by Yang Lu, Savvas Papagiannidis, and Eleftherios Alamanos. This study addresses a deep literature review of IoT by assuming a user-driven perspective. The Internet of Things is a new technological paradigm that aims to connect anything and anyone at any time and any place, giving rise to innovative new applications and services. In doing so, it offers a number of opportunities and challenges that users and organisations need to tackle. In this paper the authors systematically review the business literature related to the Internet of Things and provide a critical account of the latest state of play. After outlining the methodological approach adopted, the authors considered the definitions of the Internet of Things. Then, in turn, they discussed the relevant business literature from each perspective. The paper concludes with a synthesis of the emerging themes and potential avenues for future research.

The fourth article in this volume is authored by Concetta Metallo, Rocco Agrifoglio, Francesco Schiavone, and Jens Mueller and it is titled **“Understanding Business Model In The Internet Of Things**

Industry”. This research presents the results of an exploratory study of how organisations operating in the Internet of Things (IoT) industry are building and innovating their business model (BM). Using an exploratory sequential approach through the multiple-case study method, the authors applied the “Canvas BM” framework to explore the BM of three companies operating in IoT industry, namely Intel, Solair, and Apio. The paper finds the most important building blocks - key activities, key resources, and value proposition - and most critical related factors enabling IoT-oriented organisations to create and capture value. Furthermore, the main results also suggest that the main difference in the processes of BM building and innovation depend on the different capabilities and competencies possessed by organisations. This study therefore advances the theoretical understanding of the critical factors for the value creation process in the IoT industry's organisations and offers interesting implications for management theory and practice.

“The Internet Of Things, Dynamic Data And Information Processing Capabilities, And Operational Agility” is the fifth paper selected for the special issue authored by Pervaiz Akhtar, Zaheer Khan, Shlomo Tarba, and Uchitha Jayawickramad. This study provides managerial implications for contemporary data and information driven managers who adopt evidence-based decision making for better operational outcomes. Whilst there are promising links between the Internet of Things (IoT), dynamic data and information processing capabilities (DDIPCs), and operational agility, scholars have not conducted enough empirical studies that offer convincing evidence for the use of the IoTs and relevant linkages. The results obtained from structural equation modelling indicate that the use of the IoTs is the key determinant for operational agility and also plays a vital role in establishing DDIPCs that further reinforce it. Additionally, DDIPCs mediate the relationship between the use of the IoT and operational agility. By persuasively building these links based on theoretical arguments and testing them by using a unique dataset, this study contributes to the deeper understanding of the mechanisms by which the use of the IoT and DDIPCs strengthen operational agility.

The research perspective completely changes with the sixth article based on engineering and technology industry. An Italian research team composed by Lorenzo Ardito, Diego D'Adda, and Antonio Messeni Petruzzelli have authored a case study research and it is titled **“Mapping Innovation Dynamics In The Internet Of Things Domain: Evidence From Patent Analysis”**. This research aims at exploring the Internet of Things as emerging paradigm in the ICT sector and at the centre of many current political and economic circuits. Scholars, executives, and policymakers are becoming increasingly interested in understanding how to turn the IoT into reality, since various technological constraints (e.g., standardization and interoperability) limit the possibility of realizing an inclusive IoT information network. These constraints are exacerbated by the lack of a clear picture of the innovation dynamics and technology evolution of the IoT. This paper seeks to address this gap by mapping the development of IoT technologies. In particular, the authors have collected 61,972 IoT patents filed under the Patent Cooperation Treaty in the period 2000–2012. They analysed temporal trends, cross-country dynamics and identity of the applicants. Moreover, they provided insights about the development of the most relevant IoT technologies by looking at triadic patent families.

“The Management Of Organizational Ambidexterity Through Alliances In A New Context Of Analysis: Internet Of Things (IoT) And Smart Cities Projects” is the seventh quantitative article accepted for the special issue and it is co-authored by Stefano Bresciani, Alberto Ferraris, and Manlio Del Giudice. They have been able to emphasize a different perspective by focusing the attention on how multinational enterprises (MNEs) are engaged in Smart Cities project through IoT innovations. In the last decade, the Internet of Things (IoT) has affected the approach of organisations to innovation and how they create and capture value in everyday business activities. This is compounded in the so-called Smart Cities, where the objective of the IoT is to exploit information and communication technologies (ICTs) to support added-

value services for citizens, giving companies more opportunities to innovate through the use of the latest technologies. In this context, MNEs are building alliances, starting several projects with public and private city stakeholders aimed at exploring new technologies for cities but also at exploiting new IoT-based devices and services in order to profit from them. This implies that companies need to manage and integrate different types of knowledge to efficiently and effectively support the simultaneous pressure of exploration and exploitation, at a project portfolio level. Using structural equations model with data collected from 43 IoT smart city project alliances in Italy, this paper tests and finds evidence that MNEs need to develop knowledge management (KM) capabilities combined with ICT capabilities if they want to obtain greater ambidexterity performance at the project portfolio level. More specifically, the authors highlighted that KM capabilities enhance alliance ambidexterity indirectly through firms' ICT capabilities, suggesting that MNE managers should design KM tools and develop new ICT skills.

The following article is entitled “**Adoption Of Internet Of Things In India: A Test Of Competing Models Using A Structured Equation Modeling Approach**” and it is co-authored by Monika Mital, Victor Chang, Praveen Choudhary, Armando Papa, and Ashis K. Pani. They recognized the usefulness of IOT's adoption as a key factor for economic and social development of developing countries, by testing for the first time a multiple approach useful for both academicians and practitioners as well. Internet of Things based applications for smart homes, wearable health devices, and smart cities are in the evolutionary stage in India. Adoption of Internet of Things is still limited to a few application areas. Currently, there are still very few studies that explore the adoption of Internet of Things from a multiple theory perspective, namely, The Theory of Reasoned Action (TRA), The Theory of Planned Behaviour (TPB) and The Technology Acceptance Model (TAM). This research aims to satisfy a clear gap in the main field of research by proposing a Structured Equation Modelling (SEM) approach to test three competing models in the context of Internet of Things in India. With respect to previous literature, this research sets the stage for extensive research in a broad domain of application areas for the Internet of Things, like healthcare, elderly well-being and support, smart cities and smart supply chains etc.

The ninth article, “**The Internet Of Things: Building A Knowledge Management System For Open Innovation And Knowledge Management Capacity**” written by Gabriele Santoro, Demetris Vrontis, Alkis Thrassou, and Luca Dezi examines how new disruptive technologies in the context of the Internet of Things (IoT) are changing the manner in which knowledge is managed within organisations. This pattern, calling for a new and inventive knowledge management system and an open approach, expectedly should also enhance the development of internal knowledge management capacity, which in turn is a prerequisite of firm's innovativeness. In this context, the main goal of this research is to investigate the relationship among knowledge management system, open innovation, knowledge management capacity and innovation capacity. To reach this goal, the research employs structural equation modelling on a sample of 298 Italian firms from different sectors. The findings indicate that knowledge management system facilitates the creation of open and collaborative ecosystems, and the exploitation of internal and external flows of knowledge, through the development of internal knowledge management capacity, which in turn increases innovation capacity.

In conclusion, the last article titled “**An Investigation Of The Effect Of Electronic Business On Financial Performance Of Spanish Manufacturing Smes**” developed by Simona Popa, Pedro Soto-Acosta, and Daniel Perez-Gonzalez aims to fill research gaps in the existing literature on the effect of electronic business on financial firm

performance within the specific context of manufacturing Small and Medium Enterprises (SMEs). More specifically, this research analyses not only the direct effects of e-business on firm performance but also the mediating effect of organizational innovation the relationship. Building on the knowledge and resource-based views, the proposed research model and its associated hypotheses are tested by using partial least squares (PLS) structural equation modelling on a dataset of Spanish manufacturing SMEs. Results suggest that electronic business has a direct effect on financial performance and is positively associated to organizational innovation. In addition, results show that the relationship between electronic business and financial performance is mediated by organizational innovation.

As a conclusion, this special issue would not be successfully completed without the great contribution from the reviewers. A special acknowledgement is also extended to the Editor in Chief of Technological Forecasting and Social Change, Professor Fred Phillips, for his insightful support and patient guidance: this issue would never see the light without his guidance, support and interest in the research topics we proposed.

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