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Discovering the Internet of Things (IoT) within the business process management: a literature review on technological revitalization

The evolutionary change of the IoT and the business process management: an introduction

The growing relevance of the "Internet of Things" (IoT) arises from the possibility to connect people, goods and operations through a global network. The IoT allows for an increasing competitiveness of the global corporations by sharing specific knowledge and social value in the long term, thus influencing the company performance and the customer relationship management. On one side, in many sectors such as agri-food, natural environment, smart cities, insurances, safety security, the IoT utility is changing the way of interpreting the business process management inside and outside the firms as well as innovation processes connected to products and services. On the other side, the competitiveness of markets needs of intelligent equipment, expert systems and technology (Al Mashari et al., 2003; Gubbi et al., 2013).

The phenomenon of the Internet of Things (IoT) is based on smart infrastructures revolution, connecting companies, machineries, transports and so on under a unique system characterized by logistic mechanisms, energy resources and means of communication. In this direction, some traders predict that 100 billion devices will be connected to the Internet by 2030.

A new technology management scenario is therefore emerging where products consisting of electrical and mechanical parts become intelligent systems that combine hardware, software, control sensors, data storage and connectivity in infinite ways. In this regards, the IoT permits to share big data flow among modern companies, by increasing productivity and reducing marginal costs. At the same time, it becomes vital for businesses to understand the potential of the IoT in order to manage business process management, technology strategy, technology forecasting, technology roadmap, technology management portfolio. We still know very little about how the IoT are changing the way of interpreting the business process management inside and outside the firms and this topic is progressively becoming very hot in the leading managerial literature (Al Mashari & Zairi, 2000). Then, management scholars are aiming at investigating the impact and the role of the IoT on the business process management in terms of promotion of knowledge flow, innovation and competitiveness. Likewise, management researchers aim at understanding how IoT foster innovation inside organizations and which implication this phenomenon can have on business process management and competitiveness of the firms (Al Mashari & Zairi, 1999).

A review about technological revitalization under the IoT vision

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In the IoT scenario, both physical and virtual ”things” have identities, physical attributes and virtual personalities, use intelligent interfaces and are seamlessly integrated into the information network (Atzori et al. 2012; Atzori et al. 2010; Berman & Kesterson-Townes, 2012). The ontology of the IoT is, therefore, essentially structured into three layers, inhabited by three kinds of “things” in a symbiotic interaction with each other, through an overarching unified infrastructure: the physical, the digital and the virtual entities (Abi Research 2013; Ali et al. 2014). Physical “things” have digital counterparts and virtual representations. In this threefold cosmology, actors, meaning human beings, relate to their environment just like any other entity, through their multiple digital counterparts and virtual representations. The uniform set of characteristics attributed to all the three kinds of entities, such as identity, personality and intelligence, converge into one single attribute: being smart. Moreover, “smart things/objects” are also provided with agency as they are “expected to actively participate in business, information and social processes” (Weber, 2010; Weyrich et al., 2014; Yan et al., 2014). Then, maintaining the economic and the social stability of life, by supporting hyper-complex systems, in a regime of resource scarcity and in a globally competitive market, is likely to become more and more challenging: even more taking into account that the welfare is still essentially associated with indefinite consumption growth (Vermesan & Friess, 2014; Wang et al., 2013). Firms then (continue to) face the paradox of *sustaining* a steady increase in our global resource consumption within a closed, finite system, with limited stocks and bio-geo-chemical resilience (Swan, 2012). The post-normal scenario of uncertain facts, disputed values, high stakes and urgent decisions is, now more than ever, intrinsic in a way of proceeding through technology manipulation (National Intelligence Council 2008; Nitti et al. 2012; O’Really, 2005; Roman et al. 2013; Sanchez Lopez et al. 2012; Smith, 2012). Nonetheless, the dominant discourse about a way out of organizations’ dilemma is still inherently embedded in the modern ideal of science as “The Endless Frontier”, despite the ever more evident contradictions and drawbacks of technologies designed to provide everything at the cost of nothing. Innovation can be considered as the decisive step along a path-dependent transition from normal, curiosity-oriented science creating common knowledge, to a big, industrial, goal-oriented techno-science, producing corporate knowledge (Soto-Acosta et al., 2010). The promises of innovation are articulated along a two-fold set of arguments. As the first line of reasoning reads, in a paradoxical situation, organizations need to take into account an essential hidden variable, which Malthus first proverbially overlooked. Natural supplies might be limited, but human creativity is *unlimited*, and so is human power to decouple growth from scarcity, improving efficiency in the use of natural resources and ultimately substituting them altogether, with equivalent technological optimized artefacts. Techno-scientific

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innovation allows then for a "sustainable growth", through the optimization and the substitution of our means, and through the deployment of suitable silver-bullets, protecting us from the socio-ecological problems as they arise (Al Mashari et al., 2001). Secondly, techno-scientific innovation is taken as the mainstream solution in order to keep expanding our economies in spite of market saturation, by opening up new pathways of competitiveness and consumption, to be filled with new, constantly upgraded, products and services. In this overall framework, the Information and Communication Technologies (ICT) in general and the Internet of Things in particular, play a significant role, replying to both lines of arguments (Zairi, 1998; Fleisch, 2010; Gartner, 2013; Glasser et al., 2007; Heller Baird & Parasnis, 2011; Höller et al., 2014; ITU, 2005). First, we can extensively improve our efficiency in the use of resources by allowing ICT, and more specifically the IoT, to manage both *for* firms and *through* firms, as well, the complexity of the socio- technical systems firms rely on to survive (Soto-Acosta, et al., 2015; Palacios-Marqués et al., 2015; Palacios-Marqués, Merigó & Soto-Acosta (2015). The implicit assumption here is that this complexity can be decomposed and translated into structured binary information, by technologically enhancing, monitoring and processing power. In this way, firms can allegedly optimize not only production system and services, but also decision-making processes (Iglesias et al. 2013; Curtin et al., 2007; Del Giudice & Straub, 2011; Del Giudice et al. 2012; Nielsen, 2006). Implementing the IoT scenario entails the introduction of a plethora of new products, services and business models, thus ensuring new routes to revitalize technology solutions (Jankowski, 2014; Jara et al., 2014a; Jara et al., 2014b; Kotler et al., 2010; Li et al., 2014; Li et al., 2012; Luckett, 2004; Luo et al., 2014; Prahalad & Ramaswamy, 2004; Del Giudice & Maggioni, 2014). The IoT scenario, therefore, implies a sort of "reverse" of technological strategy. By using IoT applications, incumbent companies develop innovation to extend the lifetime of old technology-based products by networking them with the new technology.

Discussion about technological revitalization, innovativeness and business performance

A new approach to accommodate management propensity to the innovation is technological revitalization (Schiavone, 2013) by which established firms create completely new technological products, but without making significant changes to the technical features of old products. Technological revitalization is an innovative approach used often in old technology-based industries. This section discuss the main implications and effects of this approach for innovativeness and the achievement of performance in mature industries.

Technological revitalization is a market-driven technological strategy as customers are the

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starting point for the strategy formulation. According to Day (1999), various elements shape this type of strategies; market orientation, by leveraging distinctive capabilities, create value for customers, achievement of superior performance. All these elements are critical for an effective implementation of technological revitalization.

Market orientation refers to the continuous analysis and understanding of customers' needs (Straub & Del Giudice, 2012; Campanella et al., 2013).

This is a key precondition of this approach here discussed. Indeed, just an in depth analysis of the practices and habits of old technology users may allow companies to understand if this approach might be worthy of value creation. Referring to organizational capabilities, revitalization attracts the commitment of incumbent companies, which, prior to technological change, were specialized in the development of old technology-based products for the mass market. Technological revitalization leads to a survival of core competences and capabilities of incumbent firms. Managers have to face more strategic, operational and organizational issues typical of a "participation strategy" (Cooper and Smith, 1992). In terms of R&D management, the integration of different technologies is compulsory capability for technological revitalization. These capabilities are essential to create value for customers. To this end, market analysis should be integrated with the activity of organizational cross-functional teams able to identify the best ways to merge old and new technology. Finally, the matching between organizational capabilities and value creation is critical to achieve superior performances (and a competitive advantage) in these old technology-based market niches.

Also at marketing level, managers of the corporate units devoted to old technology and new technology should collaborate closely. Therefore, the organizational separation between these units should not be high. This innovation approach is likely to be very valuable when new technology is in phase of introduction or development. Indeed, the partial resistance of users towards new technology will become full adoption over time. Such change minimizes the utility of an adoption of technological revitalization, for instance, in the maturity phase of new technology.

The main result of this market-driven approach should be a sustainable performance for firms in those niches of users resisting to technological substitution. This approach should be coupled with a general repositioning of the corporate brands and products or even work out as a stand-alone strategic behavior within the general innovations' portfolio of firms. Technological revitalization can be an approach fitting properly into the broader innovation strategy of incumbent firms facing industry technological change. Such approach is just one strategic option for incumbent companies and its implementation is not in conflict with other innovation approaches, supporting or not old technology. Albeit companies can implement sailing ship effect and technological revitalization at

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the same time, technological synergies between the two innovation approaches are difficult due to their different technological bases (old technology for sailing ship effect, new technology for technological revitalization). This consideration suggests, in general, it is critical for companies to balance effectively organizational resources between the various innovation approaches (revitalizing or not old declining products) they implement. Such balancing of the innovations portfolio should be oriented by the general innovation strategy of the firm. In this scenario, the IoT applications are likely to play a key role for stimulating technological revitalizations within industrial firms.

Conclusions

The IoT researches and applications are developing the industry sector as well as other economic sectors all over the world by creating value for both consumers and providers on the market. Examples of technological revitalization stemming from the use of IoT applications are coming from various domains like optimizing business process flows based on the analysis if big data, optimizing processes based on smart tags and smart objects, as well as the implementation of ad-hoc predictive maintenance applications. On one hand, technologies revitalized thanks to the IoT applications provide more and more efficient services solutions acquired by different clients; on the other hand, intelligent revitalized applications enhance the efficient companies systems starting from the production perspective. In this context, a relevant change is connected to the governance model applied by contemporary firm based on IoT applications. Particularly, in the new knowledge economy, innovations included in new revitalized products and processes are likely to become the driving factors and the source of future financial and competitive advantages for each firm. The investigation of IoT applications together with other immaterial assets owned by the firms allows for the interpretation of the synergies generated by dimensions of intellectual capital and retrieved in human capital, relational capital and structural capital.

Today, several megatrends are relevant for the business process management within the modern factories: the globalization, the progressing technological evolution, the dynamism of product life cycles, and the shortage of resources. Likewise, other relevant key factors seem to be the acceleration of innovation cycles and the increasing customer demand for individualized mass-productions with highest quality expectations. Within those industrial contexts, IoT projects and applications are developing in manufacturing, supply chain, supervision and servicing. In addiction to the revitalizations of the technologies, a major question, which arises in all those projects, concerns the value and the benefit such application can bring to the user and to the entrepreneur. The value question is extremely relevant in the manufacturing industry, as well as it is pertinent in

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industrial applications. It is the value that such IoT based applications brings which will determine their adoption, acceptance and wide use. However, this value is very difficult to quantify since it relies on several features, which are heavily application area dependent. Therefore, the IoT adoption drives the future research towards many challenges in the international production systems and for market demand and supply by creating value in the long term. So many examples nowadays clearly show that the main mechanism to create value from IoT technology is to generate actual and refined information from real world, thus optimizing the technological and business process management based on it. Managing data and handling them, as well as extracting relevant information and correlating IoT data with other factory information and processes, will define the achievement of business process-oriented results for the IoT industrial applications. The rising number of technical contributions using IoT shows that technologies are evolving and there is a learning and application process supported by standardization efforts. Easy installation, standardization, stoutness, configuration and servicing are essential to keep IoT systems operational and hence offering value for the business process management within every industry. Value creation from the application of IoT to technological revitalization is likely to be pivotal from a business process management point of view. It is going to affect the use of IoT technologies in the industry, on a progressively higher scale, in the coming years. However, this is another history.

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Biography

Manlio Del Giudice is an Associate Professor of Management at the University of Rome "Link Campus", where he serves as Associate Dean of the Faculty of International Business Management. He is also Associate Research Professor of Management at the Paris Business School (Paris, France) and Professor of Management of Biotech Firms at the "Federico II" University of Naples. He holds a PhD in Management from the University of Milano Bicocca and he has taught in a number of universities worldwide. Professor Del Giudice has about 80 publications in mainstream journals and publishers, such as Elsevier and Springer; furthermore, he has active research collaboration programs with more than 40 universities across the globe, including affiliations with celebrated universities and research centres, from New Zealand to United Arab Emirates. Professor Del Giudice serves on the editorial boards of prestigious peer reviewed academic journals; at the same time he has promoted and managed several academic spin-off green biotechnology companies and technology transfer activities. His research interests focus on knowledge management, cross-cultural management, family business management, and entrepreneurship.

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