Human-Machine Interaction and AI for Competitive Business in the Digital Era*

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Abstract

Digital innovation prompts reflection on the rationalization of business processes. Businesses are less restricted to organizational boundaries and increasingly linked to the technological evolution and the global economic and social context. Intelligent transformation supported by technological development requires a redefinition of business models and the roles assigned to artificial and human intelligence. The competitiveness of companies is the result of sustainable strategies and policies, striking the right balance between human and artificial intelligence. The study of human-machine interaction in decision-making processes appears to be crucial to the future of economic organizations, and thus should be extended beyond the bounds of techno-centric approaches. Mechanical thinking is left to the machines, while the human must be given the space and time to ensure creativity capable of creating value.

Keywords: Industry 4.0; Artificial Intelligence; Human-Centric Approach; Decision Making; Business model; Organization

1. Introduction

Digital innovation (Industry 4.0., ecommerce, networks, digital platforms, etc.) is changing businesses to such an extent that they have become much more interdependent and obliged to consider the competitive advantage as part of a hitherto unknown organization complexity both in time and space (Brondoni, 2002; Brondoni & Zaninotto, 2018).

Business models have thus ended up being more complex, interdependent and characterized by new drivers of value creation. The synergistic interaction of new

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intangible assets (Big Data, Internet of Things, Artificial Intelligence (AI), Blockchain, Fintech applications, etc.) fuels product and process innovations and creates interconnected portfolios revolving around Internet-based digital platforms (Brondoni & Boccardelli, 2019).

The crisis of Fordism is nothing more than the crisis of those tools aimed at managing the external environment's complexity. As a matter of fact, the primary goal was to remove complexity back in the day; however, today's economic system business cannot refrain from tackling it on the grounds that competition has reached a global scale.

In this context, knowledge-based companies have acknowledged the crucial role of scientific breakthroughs, knowledge, intellectual capital, and all other intangible assets by investing in them as drivers of value creation for both the firm and its stakeholders (Freeman et al., 2018). Such resources give a boost to growth by increasing the chances of earning extra income and by building a market-dominating position, which would be rather difficult to achieve by relying mainly on traditional production factors.

Innovation models are thus based on integrated investment strategies in tangible and intangible assets. Also, such shifting and ever-evolving frameworks represent qualitative, discontinuous and interactive processes where the interaction is no longer primarily related to the internal processes of companies and positive feedbacks they produce, but rather to relationships with other companies, customers, suppliers, financial structures, research centers, competitors, and their territorial context (Civera & Freeman, 2019).

The integration of new technologies together with their features and people who use them requires a carefully considered plan. In order for information technologies to improve business results, they must consider merging with organizational and coordination skills. Managers are actors-builders of the intersection of local and global relationships where the problems raised by global competition are tackled and eventually solved. Additionally, they are responsible for the planning of such an integration. It follows that managers do not restrict themselves to being mere executors; quite the opposite, they are bearers of the Barnardian morality that supports systemic action and ensures its success, so that the purpose of producing goods and services will match up with the purpose of other organizations (Barnard 1938).

2. Human-Machine Interaction in Industry 4.0's "Intelligent Transformation"

Globalization unlocks the potential of territories and leads to increased immaterial competition (Brondoni, 2002). From the point of view of business administration, the crucial contextual factor is soft technology, that is, information and knowledge processed and managed by means of lightweight technologies, such as those found in electronics, information technology, and telecommunications. Advanced technologies such as artificial intelligence, especially in combination with new knowledge and scientific discoveries, are key to extracting value from a growing

amount of data and information as well as overcoming the limits of rationality imposed by business decision makers.

Most companies today are focused on the three-dimensional specialization and customization of products to satisfy customers' volatile demand. What they do is separate out tasks in order to adapt them to new processes and technologies. Put simply, they diversify activities by concentrating on few distinctive skills.

Industry 4.0 has triggered off a real industrial revolution by providing much more advanced automation systems than ever before. Additionally, the introduction of an ever-growing integration of scientific knowledge on production processes entails a kind of blending of real world and virtual world. However, the element that sets 4.0 Industry apart is the interconnection between physical and digital systems, which occurs through constant adaptation and use of smart machines. The ever-increasing pace of technical innovation pushes to delegate more and more tasks, functions and even decisions to machines. As a matter of fact, the cognitive processes of the hybrid human-computer approach is deeply affected by such a delegation.

Since the effects of technology on human psychology are based on circular causality, it follows that human evolution must be sought as part of complex interactions between biological evolution (Darwin), socio-cultural evolution (Lamarck) and technological development or evolution. In light of this, we can speak of human-machine co-evolution (Longo, 2012).

Decision making is the process of gathering all relevant information and evaluating on alternatives. On the one hand, the increase in the amount of available information improves the rationality of a decision; on the other hand, it is the reason behind information overload, unequal attention allocation and greater ease of falling into cognitive traps (Kahneman, 2001; Kahneman & Tversky, 2000).

Technology and, more specifically, artificial intelligence techniques can help decision makers in making more thoughtful decisions by organizing all the relevant information. Systems based on neural networks and/or genetic algorithms prove particularly effective in filtering information, as their inferential mechanisms rely on the ability to weigh scattered information (Langdon & McPhee, 2008). In this way, the decision maker's task is assisted by the technical tool, which also plays the role of selector of relevant information. Also, it provides the decision maker with clarity of action. The role of AI-based tools is even more crucial if we consider the limits of rational choices due to cognitive constraints in terms of synthesis, organization and use of information. In light of the above, it follows that the most influential technological changes are, inter alia, those related to storage capacity, computational speed and programming skills.

One reason the connection between the physical world and the ever-changing digital world enabled by Industry 4.0 is not easy to define is that humans must quickly find suitable processes and methods in order to keep up and interact with it. Some of the significant and numerous differences that exist between machines and human brain play a functional role. In order for the latter to perform tasks, it needs sub-cognitive abilities through which individuals associate ideas, process emotional aspects of terms, understand linguistic ambiguities, and so on. In other words, it can be said that human intelligence in the strict sense is strongly influenced by both the

culture in which individuals live and the experiences they have in life (Searle 1984). In this way, it seems quite unlikely that artificial intelligence is capable of perceiving and experiencing in the same way as humans.

In addition to the above, machines lack of social intelligence, which is important for creativity. It can be described as the ability to bring into existence something new that does not involve repetitive physical movements, such as those performed by stimulus-response devices.

Finally, another limitation lies in the fact that artificial intelligence is not endowed with human-like self-awareness. Conversely, human beings consciously experience their own individuality and the surrounding reality. They are capable of thoughts and actions (Di Bernardo, 2021a).

The creation of artificial intelligence or intelligent devices to suit corporate decision makers entails the understanding of and the interaction with natural features. Life, cognition and economic organization are adaptive and complex emergent phenomena that urge us to overcome the methods used in classical mechanics, in order to focus on a philosophical and ethical reasoning where to deal with the coincidence between hardware and software.

Life, mind and socio-economic or administrative organization are historical processes in which hardware turns into software and vice versa. This can only happen in the case of embodied entities and through the use of complex autopoietic models that are more suitable for the intelligibility of their process of embodiment (Di Bernardo, 2021b).

The increase in computational speed, the storage capacity and the improvement of programming skills lay the groundwork for brand-new tools and applications to become part of the decision-making processes in an even more pervasive way, where human decision makers play the role of overseers. This trend containing both important opportunities and serious risks has already been observed in highly-automated conditions. For these reasons, the study of human-machine interaction in decision-making processes appears to be crucial to the future of economic organizations, and thus should be extended beyond the bounds of techno-centric approaches.

New technology does not necessarily develop new knowledge (Foss, 2005). Once again, it is necessary to appeal to the soft rationality of decision-making processes as well as to resort to Barnard's creative and moral leadership to cope with the development of competitiveness. In the following section, we discuss the decision-making processes by proposing an interdisciplinary perspective that incorporates the concepts of unpredictability and probability. We also refer to the seminal work of Herbert Simon that represented, for management and organizational studies, the beginning of a new path towards modernity.

3. Decision-Making Processes in Comparison with Neuroplasticity and Embodied Cognition

The concepts of decision and decision making have always been a subject of heated debate. Both the general organizational literature and the specific literature on decision-making processes offer a wide variety of conceptual alternatives. When Simon began to ponder the behavior of economic organizations even before the rationality of individuals, social sciences were dominated by the "pure" rational choice theory, according to which the decision is nothing more than a response based on one's own background knowledge, including its possible changes (Von Neuman & Morgenstern, 1944). Albeit accurately representing sophisticated phenomena, the classical model together with its secondary models shows rather serious limitations as regards the representation of individual and organizational decision-making processes (Simon, 1947; March & Simon, 1958).

In such an ever-changing scenario with fluid preferences and scattered, incomplete information, other theories with a lower level of abstraction ought to be preferred to the rational choice theory. Herbert Simon's goal was to replace the pure theory of rationality with the bounded rationality of human beings, namely, people who struggle with insurmountable cognitive and information constraints. Far from maximizing their utility function, they find themselves forced to settle for satisfactory solutions.

Simon brought the end of an era by undermining the idea of a logical and rational human mind and introducing the concept of unpredictability alongside the concept of probability. The objective limits of knowledge, the impossibility of dealing with too many variables at the same time, the uncertainty in each hierarchy of preferences, the mental disposition, the cultural beliefs, and the social conditioning ensure that decisions are made, in most cases, on the basis of sufficiency and minimal satisfaction. According to Simon, human beings are therefore no longer guided by perfect rationality; they are actually driven by a limited rationality.

Simon's remarkable legacy and contributions foregrounded the unbreakable bond between cognitive science and economics due to epistemological change in the latter and some evolutionary reasons, namely, the bi-directional link between brain and social world, or rather, the integration between genetic factors, social environment and biological basis. In other words, Simon foresaw that the brain is a flexible, seamlessly integrated interface within the environment, whose physical interaction shapes and influences the very same cognitive activity. In order to emphasize the brain plasticity, that is, the interpretive paradigm in current neuroscience, it is necessary to leave behind the outdated perspective of a rigid, centralizing brain. As stated by Edelman, the concept of plasticity owes its most appropriate meaning to modulation. Much of the brain development is stochastic and epigenetic (Jablonka & Lamb, 2005), whereas the organization of the nervous system is connectional (Edelman, 1995).

Cognitivism described the mind capable of thinking and making decisions as "disembodied" from the body and "detached" from the environment in which it interacts. In this regard, Simon's adaptive approach to cognition anticipates the new

perspective introduced by the theory of embodied cognition, which rather speaks to us of an embodied and grounded cognition that involves acting with a physical body on an environment with which the body interacts. This does not only refer to the study of the central nervous system, but also to the role of all the other body parts (Caruana & Borghi, 2013).

From this perspective, there is no dualism between mind and body. There are no vertical hierarchies between high and low, between cortical-cognitive and subcortical-emotional brain systems. Perceptual, cognitive and motor processes are well intertwined and integrated. We can speak of "circularity" and mixture, inasmuch as action influences both perception and thought, and vice versa.

The research that led to the discovery of mirror neurons at the University of Parma supports the interpretation of human cognition that shifts the center of gravity of brain's rational activity and its computational abilities to the brain-body-environment interaction. Such studies reveal the close relationship between perceptual, cognitive and motor processes and their mutual influence, according to which acting is thinking and action is the basis of learning. No more symbolic or sub-symbolic paradigms, no more manipulations, but a process of creation of meaning that occurs spontaneously as a result of the structure of living beings and their relationship with the world (Varela et al., 1991).

Mirror neurons are considered by scientists as the neurophysiological basis of "empathetic mirroring", that is, a useful decision-making tool in socio-economic domains that allows decision makers to relate to others and understand their world from the inside (Gallese, 2018). The mirror mechanism allows us to pre-reflexively comprehend the emotional state of others by integrating the visceral and emotional elements, that would otherwise be left out in understanding, with top-down cognitive functions. Therefore, the sensorimotor aspect of corporeity, posited first in French phenomenology (Merleau-Ponty, 1945) and then in Enactivism, is experiencing ever greater acknowledgement in cognitive research related to decision-making processes. Thus far, we have assumed that our body structure and sensory motor skills serve as the basis for understanding others.

Thus, what happens to the *homo oeconomicus* when cognitivism and neuroplasticity appear? They build organizations as open, adaptive, dynamic cognitive systems, also providing strategic coordination, that is, a variable ecosystem made up of discovery-oriented agents. In this respect, they address bounded rationality with more solid and open decision-making processes and use (modern) technologies to face increasing uncertainty, unpredictability and opportunism. There are different levels of technology integration in decision-making processes, which range from simple information support to AI decision making. All these levels require the development of specific organizational competences to integrate effectively technology within the strategic development processes of the organizations.

4. Concluding Remarks. Profiling the Business Organization of Our Time

Understanding the change is the task of all human beings. Digital transformation and interactions, robotics in manufacturing production, new ways of working, and fast social innovation processes are part of this transformation. In both academia and business contexts interdisciplinary approaches are required to predict what is happening and what is going to happen in the future and to support economy and society in addressing the increasing complexity.

The fourth industrial revolution, one of the most significant steps in human evolution, has led to a global economic and social revolution. The birth of modern computing in 1970s marked the beginning of the digital age, which in turn caused automation to significantly increase over time. In consequence, production and information sharing have gradually shifted to favor a bottom-up approach in ways never seen before.

Ever since the capitalist business model was introduced, the relationship between man and production technology has sparked off a vivid and multidisciplinary debate. As stated by Simon (1985), technology is the tool that increases the "procedural rationality of economic agents" without replacing it and improves, albeit "not perfectly" the economic performance of complex organizations. The more the environmental uncertainty and competitive pressures are, the more the quantity and quality of information needed to make decisions increase (Galbraith, 1973). Therefore, the special attention being paid to complex technologies, such as those found in artificial intelligence, information technology and telecommunications, lies in their capability to support new industrial processes and needs. However, managing (or processing) information does not coincide with the creation of knowledge, which, by contrast, is information combined with experience, context and interpretation. As above, technology works only in combination with contextualization and interpretation capacities that only humans are endowed with.

Not only does digital transition enable growth opportunities in many manufacturing and service sectors – weakened by obsolete and inefficient production models – but also demonstrates potential for growth and value in areas such as public administration, education and training. There is no doubt that more sustainable technologies can help build a more efficient industrial model, reduce the costs of raw materials and create new jobs. This is nothing but the foundation for Industry 4.0.

That being said, the so-called "technological voluntarism" looms large (Casson, 2000). This refers to the tendency to believe that artificial intelligence prevails over human intelligence when it comes to creating value. Here, the risk is to go back to the centrality of the (virtual) machine and its intangible know-how and forget the instrumental role of technology. Concurrently, the relentless "production" of technology, or rather, the race between large companies and whole economic systems to stockpile important natural resources for the tech sector inevitably creates inequality and exploitation. The technological development creates spillovers on the economic system as much as it creates the conditions for mistreatment and unethical behaviors.

In conclusion, modern capitalism is shaped by new technologies that tends to develop innovation by combining self-generated knowledge with external stimuli and cues. This process is called collaborative innovation (Gassmann et al., 2010). This kind of innovation requires flexible and adaptive organizational structures, inter-organizational collaborative relationships, virtual coordination and soft skills. The structure of modern companies combines hierarchical fiats with relational or hybrid governance mechanisms to build agile organizations able to adapt to different and changing environmental conditions.

Different business models coexist in the economic system. They have been handed down through the decades, while others have sprung up recently. Business models mainly devoted to efficiency - similar to Fordism corporations – coexist with rather flexible and adaptive organizations, similar to the learning organizations (Garvin, 1993). Companies strongly grounded in a specific geographical context coexist with born-global firms (i.e., business organizations that opt to go international from inception). However, such a pluralism in terms of organizational size and governance entails a shared need for solidarity, equity and sustainability (Porter & Kramer, 2006). Aside from the moral imperative, the reason behind this is self-preservation, which businesses naturally seek as their first priority once they get started.

The cornerstones to ensure businesses' development are the same factors masterfully outlined by traditional organizational theorists in the early years of modern capitalism (Cafferata, 2022). They need order, rules, collaboration and a leadership capable of combining creativity and morality (Barnard, 1938). Finally, they need socio-economic environments that reward responsible behavior and help foster creation of "beauty". After all, music and art together with science are the greatest achievements of the human spirit. Businesses draw on beauty to generate ideas, innovation and healthy progress.

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