Empowering service systems through Intelligence Augmentation (IA) in digital society

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Abstract. The paper explores the interpretative significance of relevance in the systemic qualification of "intelligence," particularly in the context of Intelligence Augmentation (IA). Using the Viable System Approach (VSA) matrix, it delves into Informational Variety and Systemic Relevance to understand the incremental impact of AI in complex decision-making. The study reveals that, methodologically, the relevance of the viable system explains the synergistic collaboration between humans and machines, considering technology not just as an influential resource but also possessing structural criticality. "Intelligent" service systems, based on AI, transform into "wise" systems when components cooperate with technological resources. This interaction, rather than amplifying human capabilities, leads to cognitive enhancement, streamlining decision-making. The abstract emphasizes the incompleteness of current support systems, which focus solely on the quantitative aspect of information, suggesting that greater efficiency necessitates integrating human experiences, knowledge, and emotions. It underscores that the role of technology lies in how humans interact with it, and as technology becomes increasingly critical, algorithms will progressively shape AI decision-making processes. In summary, AI facilitates the transition of the business system from an intelligent to a wise configuration, integrating the rational component of AI with the emotional aspect of human intelligence.

Key words: Intelligence Augmentation (IA), Information Variety Model (IVM), Viable Systems Approach (VSA)

1 Introduction

It is now established that the fundamental focus of research and management has shifted from the intelligence of organizations - as a structural endowment of technology - to the ability of decision-makers to implement and utilize intelligent algorithms capable of supporting decision-making processes and enhancing the performance of organizational systems - as a system contribution of technology [1, 3, 4]

The concept of Intelligence Augmentation (IA) that we adopt emphasizes the idea of a synergistic collaboration between humans and machines, rather than a replacement or a simple amplification of human capabilities. This perspective falls within the system outlook, which views intelligence as an integrated system that emerges from the interaction between human and technological components. In the context of requalifying the concept of intelligence from a system perspective, it is presumed that IA goes beyond mere amplification of human cognitive abilities. Instead, it is a collaborative integration process in which the synergy between humans and machines generates added value. This implies that intelligence

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is no longer seen as an isolated characteristic of the individual but as a dynamic system in which human and technological resources combine in a complementary manner. This perspective could have significant implications, for example, in the development of technologies that enhance human cognitive abilities through interaction with intelligent systems. It could be applied in sectors such as education, medicine, industry, and many others, enabling closer collaboration between humans and artificial intelligence to address complex challenges. In essence, IA represents a paradigm shift that emphasizes collaboration and integration between humans and machines, surpassing the traditional approach of viewing AI solely as a substitute or enhancement of human capabilities.

These observations reflect a significant shift in the perceptions and behaviors of new generations towards technology, particularly artificial intelligence (AI). The rapid spread and integration of technology into everyday life have contributed to changing how people develop their intellectual and emotional capabilities, including:

- Naturalness of Technology: the widespread adoption of technology, including AI, has made this component an integral part of daily life. For today's youth, using smart devices, virtual assistants, and other AI-based applications may seem so natural and pervasive that it is almost considered an extension of themselves.
- Essentiality of Technology: technology is often seen as essential to fulfilling social, educational, work, and entertainment needs. AI, in particular, may be perceived as a tool that enhances efficiency, access to information, and the ability to solve complex problems.
- Inseparability from Technology: dependency on technology has increased, and many young people find it challenging to imagine life without continuous access to the internet, applications, and intelligent features. This "inseparability" can manifest both practically, in the daily use of technological devices, and emotionally, with a deeper connection between individuals and the technologies they use.

This shift in perspective can have significant impacts on how people learn, work, communicate, and interact with the world. However, it is also important to consider associated challenges, such as technological dependence and the need to develop a balanced equilibrium between the digital and the real world. The logical implication of such a change in perspective lies in the fact that the role of technologies in itself is not important, as commonly stated and accepted, but rather how humans interact with them. Consistent with this assumption, studies on Information Variety Model and Systemic Relevance (Barile et al., 2020) allow for supporting such an interpretation and, at the same time, creating conditions for a new understanding of human-machine interaction, both in ontological and epistemological terms. This interpretative evolution of the structure and process of human thought resulting from interaction with machines forms the basis for the contribution to the enhancement of cognitive processes by artificial intelligence (AI). This highlights the identity of so-called wise organizational systems, predominantly oriented towards the overall efficiency of the system, rather than that of intelligent systems, primarily aimed at the effectiveness of the system regardless of the "costs or sacrifices" borne by its participative components.

In this sense, aligning the adopted perspective with the theoretical framework of service systems in Service Science (Spohrer and Maglio, 2008) qualifies the concept of a wise service system. In relation to this, the knowledge-amplifying processes induced by AI are more consistent with the concept of Intelligence Augmentation (IA): a resonance effect in the interaction between human intelligence - rational and emotional - and machine intelligence - rational and computational – [6, 7, 8]. A fundamental implication of this hypothesis is the renewed centrality of humans in the complex decision-making context of the enterprise. Even as there is undoubtedly an increasing presence of artificial components and high- performing algorithms, the fact that decision-makers resort to artificial tools does not necessarily and fortunately imply what is often and mistakenly feared as the replacement of humans by machines.

To understand the mechanisms and dynamics of the human-machine effect, namely Intelligence Augmentation (IA), it is useful to refer to the concept of systemic relevance. This is understood as the capacity of an external system to influence the choices and survival perspectives of a certain viable system [15]. From a managerial perspective, if we consider that the influence of a supra- system is oriented towards the overall efficiency of the interacting system rather than maximizing effectiveness by leveraging positions of power, then we could argue that IA appropriately belongs to wise systemic configurations rather than intelligent ones. Therefore, this leads to the belief that the relevance of the wise supra-system, oriented toward the well-being and survival of the complex and overall system, can explain, on the one hand, the synergistic and non- substitutive effect between humans and machines and, on the other hand, interpret the conceptual transition of technology from an influential resource in decision-making processes to a critical resource capable of conditioning the action context.

In this sense, this contribution focuses on the concept of IA, which, according to existing literature, is defined as the ability to approach a solution by integrating the current knowledge base [2, 4]. From this perspective, we will seek to clarify the innovative interpretation of knowledge derived from the Viable Systems Approach (VSA), namely the Information Variety Model (IVM). The objective of the work, therefore, is to analyse the interpretative contribution of relevance to the management of the complexity of the decision-making process, specifically in the context of IA.

If it can be acknowledged that individuals, in general, and business decision-makers, in particular, are increasingly inclined to follow protocols, it becomes relevant to attempt to provide some answers to a fundamental question regarding the effects of human-machine interaction in terms of IA: "whether" and "how" future algorithmic dependence will be respectful or harmful to human intelligence in the next future?

2 The value contribution of Intelligence Augmentation (IA) in complex decision- making processes

Historically, managerial studies on decision support systems have been based on the model developed in 1971 by Gorry and Scott Morton (1989). Using Anthony's (1965) categories of managerial activities and Simon's (1979) taxonomy on types of decisions, these scholars provided a substantial advancement in explaining and applying intelligent systems, particularly in the context of complex decision-making processes.

While this modelling progression remains valid, it necessitates an interpretation through a process of conceptual and functional updating. The explanation lies primarily in the disruptive and inevitable technological evolution, as well as the increasing complexity of systems and organizational dynamics.

The adoption of technological tools and algorithms suggests some reflections. In particular, transitioning from Artificial Intelligence (AI) to Intelligence Augmentation (IA) means, as mentioned in the introduction, recognizing a shift from intelligent systems to wise systems. In this context, the "composition" between artificial intelligence and human cognitive structure results in a productive and problem-solving enrichment. It simultaneously emphasizes the highly relevant and adaptable component of the human factor in complex socio-technical systems [12].

In this regard, it is useful to recall the difference in the literature between the terms "intelligence" and "wisdom" [4; 6]. In the first sense, intelligence is the ability of an organism or system to survive with its own autonomous identity in a context and to produce economic value and social well-being within it. In this perspective, intelligence constitutes potential for the viability of systems - a necessary but not sufficient condition to ensure coordinated harmony within the spatio-temporal dimension where technology evolves.

Wisdom (Phroneris) is a characteristic of entities or systems capable of living through change by creating conditions of high resonance in the reference context and supporting, over time and space, processes that generate widespread and shared value. This implies that wisdom presupposes collective intelligence capable of balancing, through co- finalization, the pursuit of individual interests with overall systemic interests. Consistent with this assumption, Intelligence Augmentation (IA) does not refer to a process of mere problem resolution but rather to a better contextualization of the problem. Intelligence emerges in the qualification phase of a problem, and in a sense, it allows for addressing relevant questions such as:

- *Why resort to IA?*
- *What is its contribution to problem identification?*
- *How useful is it in managing problems more effectively?*

Intuitively, intelligence is termed "Enhanced" because it enables the exploration of the analysis space, not necessarily to find more solutions, but certainly to identify the better ones. It is, therefore, an intellectual differentiator that leads to a collaborative intelligence optimization process. Consistent with the methodological framework of the Viable Systems Approach (VSA) and the Information Variety Model [13] that qualifies it, Intelligence Augmentation (IA) is the ability to approach a solution by being able to modify one's knowledge base, which includes value categories, interpretative schemes, and information units. According to this assumption, "being intelligent" means acting not only based on objective data but also, and especially, based on patterns through which these informational units translate into subjective information and consolidate due to the prevailing values that characterize the essence of the individual/system. The process of internalizing knowledge feeds and differentiates the intelligent mechanism in the act of making the best decision in specific circumstances [1]. Consequently, the optimization of new collective interpretative patterns follows, where the effect of applying AI in problem-solving processes configures the gradient of Intelligence Augmentation (IA) that accompanies the evolution and viability of the wise system. In summary, the optimizing approach to solving a complex problem leads us to consider that:

- the choice depends on the ability to internalize/understand, which comes from interpretative patterns.
- a new idea/solution is considered strongly influenced by the rootedness of certain value categories.

In other words, the choice made among various possible solutions depends on the level of harmony achieved in terms of cognitive alignment, that is, following one's rational and emotional nature [14]. This is characterized by elements or objects (information units observed in the context of viability) that are "assumed/filtered" into informational components through the translation and influence of specific interpretative patterns and the prevailing value system that defines the identity of the system to which they belong.

The implication of this assumption is that "individuals/systems should develop more emotional and social intelligence and less rational intelligence - which comes out from the composition with artificial intelligence - to achieve the conditions for the growth and consolidation of a wise decision-making system based on a virtuous combination of machines and humans" [3]. In this regard, we believe that the concept and impact of Intelligence Augmentation (IA) represent an undoubtable asset in understanding and implementing complex decision-making processes.

3 The Viable System Approach (VSA) and the concept of system relevance: IA implications in complex decision-making processes

Managerial decision-making processes are influenced by the relevance of supra- system, i.e., entities that project expectations, constraints, and rules onto the related system [16]. This consideration, which is also reflected in the postulate of the Viable Systems Approach (VSA), implies that the system government - interpreted in the manager/decision-maker - leverages its rational intelligence in decision-making processes, even though its human characterization also interferes by employing the emotional sphere, often in an instinctive manner. This interference can be more or less pronounced depending on the degree of involvement and/or apprehensive tension that varies over time and space, especially due to pressures received from more influential supra-systems.

According to the principles of the VSA, systemic relevance strongly influences the viability of the system and is assumed as a condition and degree of pressure/influence that supra-system s exert on business decision-making processes. This means that the system governance is induced to assess the gradient of relevance of interacting supra-system s in order to adopt behavioural and/or structural modifications – respectively resorting to organizational elasticity and flexibility - suitable for maintaining and/or restoring systemic homeostasis. It is, therefore, a latent and immanent variable that is constantly monitored through the criticality matrix of resource/relationship criticality and the influence exerted/exertable by the context supra- system [16, 17].

In the VSA perspective, the degree of conditioning exerted by supra-system s on a specific considered vital system is expressed by the degree of relevance. The determination of the degree of relevance is the result of a value judgment made by the decision-maker regarding the capabilities and probabilities of a supra-system to be indispensable, necessary (in terms of released resources), and to influence, thus conditioning, the decision-making processes of governance.

The correct interpretation by the decision-maker of the interactional potentials resulting from the relationship with supra-system s ensures two favourable conditions for the viability of the business system:

- *contextualization:* the system's ability to maintain homeostatic balance in inter-systemic relationships.
- *viability*: its ability over time and space to "live" change proactively.

These conditions are crucial for the business system's viability, and the degree of relevance serves as a metric for assessing the impact and influence of supra-system on decision-making processes within the enterprise. Both conditions are sources of value creation, competitive advantage, and, therefore, improvement in the efficiency and effectiveness of the viable system. The determination of the "attraction capacity" of each supra-system is a fundamental aspect influencing the definition of choices to be adopted to improve the probabilities of survival in a specific context. The following Figure 1 illustrates the dynamics of selection by the decision- maker of the relevant supra-system s in the reference context.

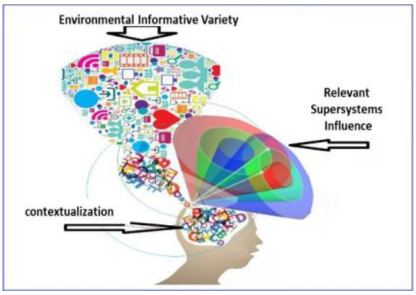

Fig. 1. The selection of a reference context by the decision maker.

The understanding of relevance as a subjective and contextual concept, shaped by the decision-maker's perception process, opens the door to an innovative interpretation in the realm of human-machine interaction (IA). In addition to the conventional measurement defined by the Viable System Approach (VSA)—which considers relevance in terms of resource criticality and the degree of influence exerted by supra-systems—two nuanced dimensions emerge:

a) Relevance from Influence (Systemic): This pertains to components originating within the system that hold influence over specific processes or actions, contributing to a nuanced systemic impact.
b) Relevance from Criticality (Structural): This refers to components deemed structurally critical, indispensable for performing processes, such as the crucial role of a hand in tennis or writing.

This disruptive interpretation carries significant managerial implications. The viability of a system depends not only on strategy and objective adequacy but also on the manager's capability to align decisions across various levels. Failure in achieving this alignment can pathologically affect the system over time.

Stating that relevance poses an obstacle to change is justified, and its variation hinges on the speed of change, defined as "consonance" in the Viable Systems Approach (VSA). The more consonance grows, the more relevance changes, indicating a dependence inertia. While influential relevance is observed in a specific time and space, critical relevance is widespread at the same time and space. However, if influence persists over time, it transforms into structural criticality, becoming recurrent and necessary.

From a managerial standpoint, consonance is linked to the system's ability to align itself, taking on emotional connotations. The increasing consonance of technological systems over time makes technology, as an influential supra-system, progressively critical. This is because the algorithms it defines permeate and condition socio-technical systems and contextual communities.

In line with VSA, relevance not only signifies the capacity for pressure but also the ability to attract the supra- system. It can be both influential and critical; if a service system is conditioned by a critical supra-system, it loses decision-making autonomy, and influence becomes laden with the nuance of criticality.

In the context of AI and IA, technology doesn't inherently emerge as critical or structurally relevant but can gradually become so through increasing consonance with business processes. An example illustrates this premise:

Imagine a musician using an advanced AI-based application with a fast 5G connection, accessing a vast music database. During performance, the musician taps into the database, integrating new harmonies and styles in real-time. This example showcases how technology, through AI, doesn't replace human creativity but acts as a catalyst, enhancing cognitive variety.

In social contexts, the "sensitivity" of new generations to technologies integrates quickly into their consciousness and operational autonomy, consolidating and rooting over time. As technology, especially through AI, increasingly becomes indispensable, decisions in complex contexts are more influenced by algorithms than the technological substrate.

In summary, IA, while enhancing human cognitive processes, elevates the relevance of the technological supra- system from an influential resource to a critical one.

4 Implications and Future Directions for research

In light of the previous sections, the decision-making process within business is undeniably influenced by the technological supra-system. As technology becomes increasingly pervasive in both social and economic spheres, it evolves into a supra-system of high criticality.

The growth of this criticality, observed in the interaction between human- machine, human cognitive structure, and machine algorithms, prompts further exploration - specifically regarding the concept of the "owner." The owner, as an individual exposed to a broader and more advanced informational variety, can enhance consonance with the process algorithm and, in this context, manage the decision-making moment as a "owner". In this sense, IA solidifies within the configuration of wise systems rather than intelligent ones.

The key observation here is that it is not technology itself, but rather the algorithms derived from its application to mechanical systems, that significantly shape the being and becoming of both atomic viable systems (individuals) and complex organized systems. This dependency on the integration of human-machine interactions is increasingly prevalent. Especially in complex environments and with the growing influence of new technological applications, decisions are supported by the incremental knowledge gradient resulting from human-machine interactions. At this juncture, it is legitimate to ponder: *What are the future scenarios for IA? Will the application of AI have positive or negative externalities as the indispensability of the technological substrate continues to assert itself?* As technological integration becomes more entrenched, the future of IA may unfold in various ways, and the externalities will likely depend on how responsibly and ethically this integration is managed. A thoughtful and multidimensional approach is necessary to navigate the evolving landscape of Intelligence Augmentation.

Understanding IA and its implications in complex decision-making processes is just the beginning of a vast field of inquiry. Some relevant implications and future research directions include:

- **Practical Implications**: The widespread adoption of IA in decision-making contexts requires an in-depth exploration of practical implications. This may include the development of ethical and regulatory guidelines to ensure responsible use of IA, as well as the design of systems that maximize collaborative benefits between human and artificial intelligence.
- **Role of the Decision Maker**: Further exploring the role of the decision maker in an environment where IA is extensively integrated. How does decision-making dynamics change? What skills are essential for decision- makers in an environment heavily influenced by IA? These questions can guide research on the development of necessary human capabilities.
- **Social and Economic Impact**: Analysing the implications of IA on society and the economy is crucial. This includes assessing impacts on employment, social inequality, and professional training. Exploring how IA can contribute to solving social and economic challenges is an important direction.
- **Security and Privacy**: Data security and privacy are fundamental issues in the era of IA. Delving into how to ensure the security of sensitive information and safeguard individuals' privacy becomes essential, especially considering the access and processing of large amounts of data.
- **Continuous Technological Development**: IA is closely tied to technological developments. Exploring the next frontiers of technology, such as the integration of advanced artificial intelligence, machine learning, and collective intelligence, can provide insight into future directions of IA.

So, IA represents a milestone in complex decision-making processes, and its impact requires an in-depth understanding and ongoing exploration of its multiple facets. Future research should aim for interdisciplinary depth, considering technological, social, and ethical aspects to shape a future where IA is a powerful and responsible ally for enhancing human capabilities.

The future scenarios for Intelligence Augmentation (IA) can be diverse, and their impact will largely depend on how this technology is developed, implemented, and regulated. A series of possibilities and challenges emerge: <u>Positive Future Scenarios</u>:

- **Enhancement of Human Abilities**: IA could continue to enhance human capabilities in various sectors, including medicine, education, manufacturing, and scientific research. For example, virtual assistants or virtual twin could become valuable tools in solving complex problems.
- **Deeper Human-Machine Collaboration**: Successful implementation of IA could lead to closer and more synergistic collaboration between humans and artificial intelligence,

helping overcome global challenges.
- **Development of Creative Solutions**: IA could stimulate human innovation and creativity, enabling the resolution of problems in new and unconventional ways.

These positive scenarios highlight the potential benefits of IA in elevating human capabilities and fostering fruitful collaboration between humans and machines.
However, it is important to also consider future scenarios that may pose challenges and negative impacts.

Negative Future Scenarios:
- **Digital Inequalities**: If access to IA is not evenly distributed, digital inequalities may emerge, with some individuals benefiting significantly while others are excluded from such opportunities.
- **Dependency and Loss of Skills**: Increasing indispensability of IA could lead to dependency and the loss of human skills, as some individuals might prefer to overly rely on technology instead of developing manual or cognitive abilities.
- **Privacy and Security Risks**: Widespread use of AI technologies could pose risks to privacy and security, especially if adequate controls and regulations are not implemented.
- **Job Loss**: Advanced automation could result in a significant loss of jobs in some sectors, with IA replacing certain human tasks.

These negative scenarios highlight the importance of addressing issues such as equitable access, skill development, privacy, security, and the potential impact on employment as IA becomes more integral to various aspects of society.
To mitigate negative scenarios, an ethical and regulatory approach is essential to guide the development and implementation of IA. Society must address issues related to equity, security, professional training, and transparency to ensure that IA brings general benefits and remains sustainable in the long term. The social, economic, and professional lives of new generations are and will increasingly be permeated by the critical weight of technology. This means that the process algorithms implemented with technology will “accompany” and “enhance” decision-making and operational capabilities both in social and professional contexts.

It is generally known that those managing technology typically provide an algorithm rather than programming its effects. For instance, the algorithm might be based on neural network data mining, which learns from human interaction and adapts symbiotically. The consequence of this is that individuals will likely find themselves “unable to decide independently” without the incremental contribution of the algorithm operating in resonance. This implies that individuals will consciously be more inclined to invoke the algorithm rather than making decisions autonomously.

Furthermore, some scholars argue that Decision Support Systems (DSS) may have unintentional negative consequences on the organization, risking value destruction rather than creation. Such destruction of value by the intelligent system can occur due to “misunderstandings” that arise with the decision-maker, without whom the support system would have no reason to exist. Therefore, it has long been believed that support systems could limit individual decision processes since the decision-maker, instead of independently evaluating other possibilities or critically assessing the choice suggested by the system, ends up accepting it directly.

5 Conclusions

In navigating the intricacies of business systems, decisions often rely on variables that resist algorithmic processing. Existing support systems, albeit enhanced by algorithms, provide a formalization of the environment through mathematical models, primarily leveraging quantitative information. Yet, for optimal efficiency, these models must integrate human experiences, knowledge, and emotions that elude algorithmic capture.

Even when enriched by algorithms, support systems facilitate preliminary decisions. The decision-maker, drawing on a blend of qualitative information, personal experiences, and model- suggested solutions, achieves a level of efficiency in decision-making. In scenarios where data is reliable but not exhaustive, or when unforeseen changes occur, the expert might outperform the machine, especially in conditions not yet integrated into the algorithm—highlighting the need for IA.

In essence, the redefined concept of IA, characterized as collaborative and integrated intelligence, propels the business system from mere intelligence to wisdom. This evolution incorporates the emotional component unique to human intelligence, seamlessly integrated with the rational component governed by AI.

Moreover, IA sets the stage for continuous and progressive optimization of computational models, emphasizing the central role of the human decision- maker and acknowledging the growing criticality of technology in decision- making processes. This notion aligns with an ethics-centered and human- focused approach to the evolution of Artificial Intelligence (AI).

Key motivations supporting the vision of IA include:

- Centrality of the Human Decision- Maker: Placing the human at the core of decision-making positions technology as a supportive tool, extending and enhancing human capabilities without replacing them. This preserves human responsibility and input in critical decisions.
- Increased Criticality of Technology: IA recognizes the fallibility of even advanced AI. Thus, critical decisions demand collaboration between humans and artificial intelligence, with heightened human supervision to mitigate errors and limitations.
- Continuous Optimization of Computational Models: The belief in IA driving continuous optimization aligns with the principles of continuous learning and gradual improvement. Technology adapts over time in response to human needs and feedback.
- Ethical and Sustainable Approach: Emphasizing the centrality of the human decision-maker contributes to ethical and sustainable AI development. This safeguards against risks tied to indiscriminate automation, ensuring responsible AI use. Addressing challenges like transparency, privacy, and fairness through ethical guidelines and regulations is crucial to harness the benefits of IA without compromising fundamental human values.

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