Managing Uncertainty with Artificial Intelligence: Managerial Attitudes and Perspectives

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ABSTRACT

Making decisions under conditions of uncertainty with lack of knowledge about the probabilities of future events is a very difficult endeavor. When uncertainty occurs, managers often resort to intentional bias by making decisions that encompass guesses about future events. Decision-making (DM) processes in the advent of Artificial Intelligence (AI) have been seen as more effective, accurate, and flexible. Consequently, it would be reasonable to assert that decision makers facing uncertainty would be inclined to rely on AI tools to help them effectively handle such uncertainty. However, the full potential of this synergistic approach depends on the attitudes and beliefs that decision makers have regarding the usefulness of AI. This research examines managers' perceptions on the usefulness and impact of artificial intelligence (AI) on decision-making (DM) processes in organizations facing uncertain conditions. The paper claims that, under the existence of proactive attitudes toward AI, the application of AI tools may help in reducing risk and uncertainty when making strategic decisions. The research approach is qualitative and exploratory in nature.

Key words: Uncertainty, Artificial Intelligence, Managerial Attitudes, Decision-making

INTRODUCTION

The diffusion of Information Technologies (IT) in organizational settings began more than six decades ago. Through their integration in organizational processes, technological advancements have affected the nature of work and enabled the displacement and or the replacement of various tasks and jobs. Despite their pervasiveness, there is mixed data about the impact of automation on productivity growth and GDP. While unemployment rates in advanced economies are low, wage growth and productivity are stagnating, and inequality is rising. On the other hand, the social effects of integrating AI in decision making processes are ambiguous when assessed, primarily, through the prisms of transparency, inequality, fairness, and accountability. Additionally, there exist beliefs and attitudes on the part of decision-makers that could mediate the integration of AI to support or enhance DM.

This research focuses on DM under uncertainty and the implications of the rapid advancement and deployment of AI in DM processes in the light of managers intentions and attitudes. AI has both advanced almost to the level of replacing human intelligence and affecting many organizational processes, among them decision-making. An essential aspect of this research project is examining whether AI and human intelligence (HI) can coexist and, if so, what are the enabling conditions for a synergistic coexistence. It offers insights on the conditions required for AI to complement rather than replace HI in organizations.

The research in AI has not come yet with an accepted definition of the term. “AI is normally referred to as the ability of a machine to learn from experience, adjust to new inputs and perform human-like tasks” (Duan, Edwards & Dwivedi, 2021). AI enables systems to perform tasks that, if performed by humans, would require intelligence (Cao, et al, 2021).

The extant research in AI development mentions three overlapping periods, each broadly centered in one of these concepts: expert systems, knowledge-based systems, and machine learning/data mining (Duan, Edwards. & Dwivedi, 2021). Early applications of AI were developed to automate routine, predictable tasks, and decisions. Following the initial era, AI applications took on several roles, namely assistant, critic, second opinion, expert consultant, tutor, and automation (Bader et al, 1988). In subsequent developments, applications of AI had the goal of either supporting/assisting decision-makers or replacing them (Edwards, Duan & Robin, 2000). Over time, the rise of supercomputing has made possible the utilization of AI in more complex tasks requiring cognitive capabilities (Mahroof, 2019).

Although AI has existed for more than 50 years, it has been the advent of super computers and big data technologies that has catapulted AI to the current levels of development, deployment, and utilization in the workplace (Duana, Edwards. & Dwivedi, 2021). As a matter of fact, a host of recent reports attest to the increasing utilization of AI to support decision-making in organizations. (See: Bean, 2018; Miller, 2018; Daugherty & Wilson, 2018; McKinsey,2020; Ransbotham et al, 2020).

Despite its pervasiveness, the full potential of the symbiosis between HI and AI in decision-making is contingent on the level of AI acceptance by decision makers (Edwards et al, 2000), which in turn, is mediated by the beliefs, attitudes and intentions of managers and decision agents regarding the potential benefits and drawbacks of AI (Dwivedi et al, 2021). Several researchers have indicated that, aside from the effectiveness, accuracy and flexibility afforded by AI (Metcalf et al, 2019), there are growing concerns about the negative impacts, such as poor decisions, and hidden biases (Shrestha et al, 2019).

Acceptance and utilization of AI tools by decision makers depend on multiple factors, such as performance expectancy (i.e., degree to which decision makers believe AI tools will help them perform better), effort expectancy (i.e., degree to which decision makers believe AI tools are easy to use), peer influence, facilitating conditions, and concerns of personal wellbeing (Venkatesh et al., 2003), among others. These attitudes are, in turn, affected by the benefits and risks associated with the utilization of AI tools (Breward et al, 2017). Decision makers who want to incorporate AI tools in their decision-making processes should exhibit positive attitudes and intention to use such tools in a symbiotic fashion. Making effective AI-assisted decisions under conditions of high levels of uncertainty assumes decision agents believe that a symbiosis between HI and AI will help them perform better and more easily when facing uncertain, complex situations.

ARTIFICIAL INTELLIGENCE AND DECISION-MAKING

In recent years, the utilization of AI to support DM has become one of the most important goals of developers and practitioners. According to Davenport and Ronanki (2018), (quoted in Duan, Edwards & Dwivedi, 2019), AI applications can be categorized as one of the following: Cognitive Automation (i.e., automation of back-office processes), Cognitive Insights (i.e., detection of patterns from data and statistical interpretation of their meaning), and Cognitive Engagement (i.e., decision makers engagement through natural language processing, intelligent agents, and machine learning).

One of the main factors affecting critical decision-making is related to the fact that decisions are frequently made under high levels of uncertainty. Additionally, they intrinsically involve high levels of ambiguity. Such decisions are usually complex and have serious impacts on organizations. The combination of computational processing capacity and advanced AI tools has been indicated as a factor that may help in reducing such complexity. Moreover, AI is said to provide effective tools to facilitate the handling of uncertainty and risk.

Designing AI tools to support DM is a complex endeavor. Firstly, the lack of a clear definition of AI makes the task a difficult one. Secondly, there exist multiple sources of uncertainty which add high levels of ambiguity in the potential outcomes. Finally, AI tools designers frequently rely on their own biases when facing high levels of uncertainty, an element that could affect the quality of AI-based decisions.

AI decision systems development encompasses four distinct phases: concept development, problem and data identification/access, model development, and model implementation/use. In developing AI models, designers need to take into consideration four sources of uncertainties, namely our actions, environmental factors, responses from others to our actions, and, most importantly, the conceptual model that frames the problem. Despite the complexity associated with developing AI systems, there is consensus that some AI systems are superior to humans as decision-makers. As an example, aircraft collision avoidance systems produce outcomes that are better than those produced by humans. Also, the systems controlling self-driving cars are more effective than human drivers. However, there are some ethical issues that need to be addressed before reaping all the benefits from AI. As an example, autonomous vehicles systems are designed to select the course with least harm by using mapping and sensors, following the underlying logic of the “trolley problem” in which some courses may not be appropriate. In most cases, it is not easy to resort to external manipulation of these systems to handle uncertain events that may occur in a dynamic situation.

DECISION-MAKING UNDER CONDITIONS OF UNCERTAINTY

The process of making decisions entails the following: gathering of intelligence and problem formulation, design of alternatives, selection of a course of action to attain a purpose, and implementation (Simon & March, 1976). As such, decision-making is a process that relies on information and knowledge (Wu & Shang, 2020). While information corresponds to facts that imply the states of nature, knowledge includes interpretative frames that facilitate an understanding of those facts (Wu & Shang, 2020). Each stage in the decision-making process has its own type of uncertainties.

Building on Simon's framework (Simon, 1947) of decision-making, this paper introduces a model (Figure 1) to help managers streamline their concerns of the impact of AI on organizational decision-making under conditions of uncertainty.

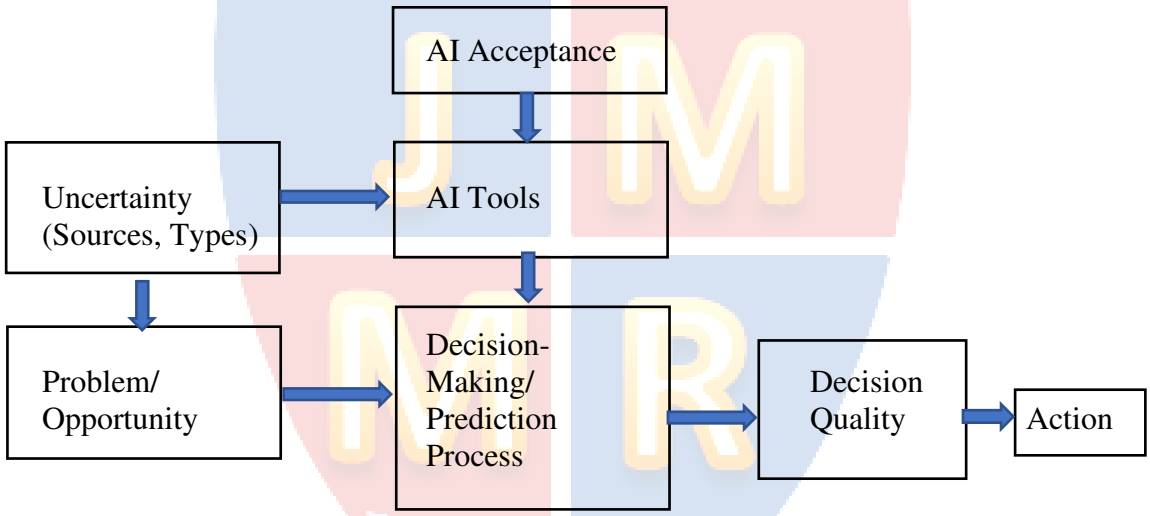

Figure 1: DM, Uncertainty and AI

Decision makers face uncertainty and ambiguity while tackling a problem or opportunity. While uncertainty deals with the lack of ability to recognize relevant variables and their functional relationships, ambiguity entails the potential existence of multiple interpretations (Wu & Yang, 2020). Failing to address both factors may affect the quality of decisions if not handled appropriately. For the purposes of this research, the focus will be on uncertainty. Unlike uncertainty, which encompasses a difficulty to both recognize essential variables and their interrelationships and understand the task, risk corresponds to the statistical analysis of probable states of nature and courses of action (Wu & Yang, 2020).

At this point it is appropriate to indicate that uncertainty is not the same as risk, two constructs that are often confounded by decision makers. While probabilities of events are not known in uncertain situations making almost impossible the prediction of outcomes, risk deals with situations where the probabilities are known (Knight, 1921). Understanding the differences between risk and uncertainty increases the accuracy of decision-making processes. Managerial understanding of risk and uncertainty has evolved. Handling uncertainty is a difficult endeavor given that it involves unknown variations. Consequently, managers should resort to flexible

strategies instead of attempting to control it. On the other hand, the presence of risk is managed through assessment, contingency planning, and mitigation strategies (Rasmussen, 2021). Also, it is easy to construct predictive models when probabilities are known.

Additionally, it is worth mentioning that the nature of available information affects the managerial understanding of risk and uncertainty. As a matter of fact, in risky situations there is, most likely, an abundance of llongitudinal data that can be gleaned and analyzed to facilitate the job of both analysts to estimate probabilities and managers to make informed and accurate decisions (March & Shapira 1987). However, uncertainty most likely involves situations without historical data, something that may force managers to rely on judgement and scenario planning when making decisions.

While human intelligence may help in reducing uncertainty and ambiguity by applying intuition and holistic methodologies, AI may assist in handling the four types of uncertainty that occur in decision-making process, namely, Data Uncertainty, Prediction Uncertainty, Judgment Uncertainty, and Action Uncertainty.

According to Lipshitz & Strauss (1997), quoted by Wu & Yang, the sources of uncertainty include incomplete information, inadequate understanding, and undifferentiated alternatives. As Wu & Yang conclude, uncertainty is a three-dimensional construct that encompasses informational uncertainty (i.e., incomplete information), environmental uncertainty (i.e., unpredictability of the environment and lack of capacity to understand the task), and intentional uncertainty (i.e., individual intentions and the existence of multiple needs and preferences).

The level of uncertainty in organizational decision-making increases from operational to tactical to strategic decisions. Operational decisions tend to be more routinary than unpredictable, so uncertainty at this level is rarely encountered. On the other extreme, strategic decisions are more uncertain and, in cases, unpredictable. In the middle, tactical decisions usually exhibit moderate levels of uncertainty combined with some degree of routine.

RESEARCH METHODOLOGY

Based on the literature review, a research framework that includes an actionable model to help managers cope with the adoption of AI tools was developed (see figure 1). In addition, the framework offers means to explicitly interpret the dynamics of uncertainty, a factor that is both usually hidden in the decision-making process, and occasionally out of consideration by most managers and decision makers.

Using the framework as a template, the authors conducted interviews to gather information that could both shed light on the attitudes and intention to use AI to aid decision-making, especially in the presence of considerable levels of uncertainty, and derive some recommendations that would help managers determine how to integrate AI tools to aid DM in their organizations.

The bulk of the data collected comes from 42 interviews at various managerial and analytical levels from organizations in the tri-state area of Metropolitan New York City. The organizations and industries included in the sample were varied, including financial, services, high-tech, manufacturing, telecommunications, and pharmaceutical. The average years of experience of those who responded is about 12 years. Their background ranges from engineering, financial/accounting, computer science, and general business.

Given the qualitative and exploratory nature of the study, the sample size is smaller than that commonly used in survey-based, confirmatory research and consistent with studies dealing with qualitative themes (Miles & Huberman, 1984). There has been some controversy in the literature on organizations regarding the usefulness of applying perceptual rather than objective measures. However, the perceptions of an organization's members are important in the sense that, very often, perceived elements are used when making decisions (Duncan, 1972).

RESULTS

There was no consensus among respondents on the definition of uncertainty. Answers ranged from defining uncertainty in terms of ambiguity and unpredictability as "the inability to predict future events accurately" (March & Shapira, 1987), to defining it as lack of complete information about the future (Keeney & Raiffa, 1993). Some answers confounded uncertainty with risk and probability in terms of missing information about the likelihood of a state of nature to occur (Mishra & Raghunathan, 2004). One may conclude that such general and imprecise understanding of uncertainty compounds the complexity of developing accurate AI decision-making models. What further confirms this conclusion is the lack of consensus among respondents about the type of uncertainty AI models are equipped to handle the most.

Only 33% of the respondents indicated they were aware of the AI applications they are using at personal and organizational levels. A meager fifteen percent -15%- was aware of the type of AI algorithms used in their company. This finding makes salient the disconnect managers have with specific types of technological innovations in their company. Consequently, their contributions to impact design and development are minimal thus hammering their ability to judge the accuracy of the outcomes of AI models.

Managers' awareness about AI applications in their companies varied depending on the level of their involvement in critical decisions. Most managers indicated they have a basic understanding of AI applications in data analysis and process automation. Some managers have a deeper knowledge of AI applications and integration in various organizational processes and their usefulness in predictive analytics and supply chain optimization. High level managers have deeper awareness and understanding of AI application in strategic business decisions. The study found that factors such as leadership and training have a crucial influence on the level of awareness of employees regarding the impact of AI on company overall operations. The attitudes of top management regarding the importance of deployment and integration of AI application into decision-making processes was indicated as a factor that has a high impact on the effectiveness of the use of AI.

Additionally, from the responses obtained it was found that a company's culture toward technological innovation impacts managerial awareness regarding industry trends related to the use of AI applications. Overall, the study found that an increased awareness of AI applications is extremely important to help both making accurate decisions about the implementation of the appropriate AI application and reducing the uncertainty about its outcomes.

Managers indicated a high level of concerns about the presence of bias and fairness in the decision outcomes of AI applications which may be skewed due to the uncertainty built in the model. However, they also indicated that bias and unfairness also exist in the human decisions making process. The ethical issues stemming from the integration of AI systems in decision-making, while it is a concern, it is not something difficult to correct (Mittelstadt, et. Al 2016).

Overall, while uncertainty may bias the ethical aspects of using AI applications, only 10% of the respondents indicated that they had some reservations.

Managers also raised concerns about the level of uncertainty in AI systems, especially when these systems have full autonomy and control over decisions made. The issue of full control by AI algorithms without human intervention has been debated widely (Boddington, 2017). Another issue managers raised is how to deal with uncertainty in ensuring that AI systems are transparent and accountable. Managers usually struggle in understanding the complexity of AI algorithms, an issue that both tends to be not transparent, and raise concerns about its accountability (Wachter, et al. 2017).

Regarding workshops and training about any aspect of AI applications, only 20% of the respondents indicated that they had some training. On the other hand, respondents indicated that 40% of decisions they make required some computer application regardless of the level of intelligence embedded in the applications they used.

One may conclude from the responses gathered in the study that, aside from the mentioned benefits of using AI to support and enhance DM, there should be an environment supportive (i.e., the existence of facilitating conditions) of the integration of AI tools in organizational decision-making.

MANAGERIAL AND POLICY IMPLICATIONS INSIGHTS

AI has been around for a while but as a transformational force in business is still new and its impacts are still uncertain. Managers and analysts interviewed believe that AI may simplify the formulation of problems by facilitating the handling of more variables. However, it will not necessarily reduce uncertainty in each construct or phase of the DM process. AI systems may help to reduce uncertainty simply because they can manipulate more variables/inputs than humans when making decisions. Managers interviewed support the concept of combining human and machine intelligence in solving problems rather than AI entirely replacing humans. However, the question remains: if AI tools provide all possible outcomes, would humans make/select the exact/best choice?

While there is agreement among respondents that increasing access to data and capability to manipulate it will reduce uncertainty in DM, there is also the perception that this would create a power shift, which, in turn, would increase uncertainty. The rational model of DM is limited as the presence of uncertainty undermines the rational choice paradigm. We need to explore non-rational DM theories and consider that decisions made extremely quickly can be as good as those made cautiously and deliberately. It seems approaching AI as an enabling tool is a reasonable strategy to adopt.

Another approach is to consider using a fraction of the data available to apply judgement. Here, managers' DM focus will shift from operational and tactical to strategic. Furthermore, the mindset of managers needs to shift from project management to project leadership.

There are several areas where managers can utilize AI systems to enhance the accuracy of strategic decisions and handle uncertainty more effectively. One strategic application is to enhance predictive analytics for market trends by using machine learning algorithms and data mining. Additionally, managers can generate insights when optimizing resource allocation through the application of various simulation algorithms. Furthermore, managers can apply advanced scenario planning by modeling numerous business scenarios to generate various strategic alternatives (Gartner, 2022). Another area of strategic importance is customer

segmentation. Here, AI algorithms are useful in analyzing complex and large datasets to generate managerial insights, thus reducing uncertainties (Chung & Kwon, 2023). Also, AI algorithms and systems are useful in analyzing and generating real-time data-driven insights. This type of analysis is useful in detecting emerging threats and opportunities that will allow managers to react to dynamic and complex environments in a timely fashion (Sharma & Gupta, 2021). All the above-mentioned applications will help in the process of effectively handling uncertainties.

To augment the quality of AI tool outputs, managers need to think more holistically by discovering additional opportunities. They need to keep learning and support a participative leadership style. While this is not an easy approach since the tendency is to build complex models, as many believe they are superior, managers should consider building simple and more sensitive models. Avoiding complex models sometimes is imperative as they are often over-fitted and not flexible. Finally, there is the issue of bias implicit in AI tools. While on one hand, AI may help to reduce bias, on the other hand, it can also scale it up.

SUMMARY

In an uncertain environment, elements of volatility and ambiguity are abundant, something that complicates decision-making processes, thus forcing the use of cognitive biases. In fact, managers would need to resort to making intuitive decisions when uncertainty prevails. Notwithstanding, the decision-making process is still moderated by the contextual determinants of the decision. To the extent that managers believe AI enhances DM, AI applications could be useful in helping decision makers reduce cognitive biases. However, this area of research is complex and requires extensive studies to develop practical approaches that help managers when making decisions under conditions of uncertainty

Concluding, the bottom line is that there is an urgent need to build models to account for the increased acceleration in technological innovation and diffusion of AI-based applications. This paper offered insights to help management design policy in response to the lack of effectiveness in decision-making and the implementation of AI applications. This research project assessed the strengths and roles of AI and HI in decision-making processes. The results shed some light on the question of whether AI systems should be designed to either replace HI or augment it.

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