

# AI IMPLEMENTATION IN INNOVATION PROCESSES: AN UNCERTAINTY PERSPECTIVE

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## ABSTRACT

**Purpose:** AI applications are increasing in accuracy and effectiveness, and simultaneously gaining more popularity internationally. While consumers online have historically been the main target market for businesses, AI may have several uses, including decreasing company risks, streamlining HR tasks, and anticipating cash flow and other functions in supply chains. The potential advantages of AI have been recognized and used, particularly in larger companies with plenty of resources. Its application to supply chains, however, is still in its early stages.

**Design/methodology/approach:** Drawing upon existing literature, this research presents a comprehensive framework that empowers supply chains to seamlessly integrate AI at various levels of the product innovation process, enabling them to stay competitive and overcome uncertainties associated with introducing innovative products.

**Findings:** The proposed framework provides valuable guidance for organizations in supply chains, fostering efficient and effective utilization of AI in their quest for introducing cutting-edge products. Managers need to develop an understanding of utilizing different AI functions effectively for innovative products, reducing uncertainty during this process and gaining competitive advantage at the same time.

**Originality/value:** For supply chains the use of AI can bring considerable opportunities as the technological and green transfer challenge them decision loaded with complexity and uncertainty in supply chains. The paper aims to integrate different functions of artificial intelligence, information acquisition, divergent data processing, and usage of neural networks, at the different levels of innovation process stages to reduce uncertainty and to facilitate networked designing of innovative products meeting the modern-day business environment requirements.

**Keywords:** AI Integration, Innovation process, Conceptual framework, Uncertainty, Supply Chain

## Introduction

Innovation processes are seen as one of the main sources of competitiveness for many organizations. While the processes have the possibility to offer great opportunities of value for the organizations, those can be costly and time-consuming effort with high uncertainty involved. Many different models for managing innovation processes have been proposed in the previous literature, however only a few of those focus on the uncertainty in the process and how it could be managed. Indeed, managing uncertainty can be crucial point for companies in order to ensure successful results from the different stages of the innovation process.

Artificial intelligence (AI) model like ChatGPT, that relies on deep learning techniques to make use of the enormous amount of data for producing text responses, has triggered a debate regarding its effective utilization for different domains of businesses (Wenzlaff and Spaeth, 2022) and particularly innovation management (Bahoo et al., 2023; Bouschery et al., 2023). In this regard, researchers have argued that artificial intelligence can rationalize arbitrary and chaotic innovation processes by reducing confusion and

random behavior in decision-making (Pietronudo et al., 2022) to generate novel ideas for exploration (Haefner et al., 2021). Most of the existing literature on artificial intelligence and innovation is restricted to analyzing artificial intelligence influence on innovation process or different types of innovation, however, the

question remains how AI could influence innovation management processes along dealing with different types of uncertainty.

Uncertainty in the innovation processes is caused by a number of things and the sources typically are numerous challenging the decision-makers abilities to make the best choices (Vilko et al., 2014). While the product cycles in the marketplace are getting shorter and products and services increasingly complex, the solutions related have become more complex to manage and inherently more uncertain with their outcomes (Dost et al., 2016). This can be especially challenging for small and medium sized enterprises with limited resources and capabilities. Simultaneously, the new technological innovations such as AI have been seen as an answer as an efficient way to help in managing the innovation processes by offering access and ability to structure vast information and even providing solution options to some complex problems (Haefner et al., 2021). Indeed, as a new relatively new service the AI has gained much popularity especially with the newly invented language-model based solutions like Chat-GPT, which has enabled the accessibility and easiness- of-use of the software. Furthermore, researchers have reported that adoption of AI technology can improve corporate business model innovation, product innovation, process innovation, social innovation, and other innovation outcomes(Bahoo et al., 2023; Mariani and Nambisan, 2021).

Clearly, AI can provide benefits for the innovation process, however as a new phenomenon the full potential of it, is still somewhat unclear. In order to shed some light to this issue we put forward a conceptual model of how a language-based AI model could be applied in the innovation process to manage uncertainty. In doing this, the paper synthesizes innovation process management and uncertainty theories with AI literature. As a result, aim of the paper is to provide understanding how AI can assist innovation process dealing with different levels of uncertainty and different amounts of information. More precisely, our contribution is in putting forward a conceptual framework and furthermore to instigate scientific discussion about the role of AI in the innovation process from the perspective of two essential elements, namely the amount of data available and the level of uncertainty related.

### **Theoretical foundation**

The theoretical foundation of the paper is based on three different scientific literatures. Firstly, the innovation literature, where we are focusing on the process of innovation management. Secondly, AI literature where we focus on its implementation in innovations and finally to the supply chain uncertainty literature where we focus on the different natures of uncertainty and decision-making.

#### Innovation process

Understanding of the innovative process has been changing through the years with the development of new technologies (Žižlavský, 2013). Scholars divide this process into a minimum of three stages. For example, some scholars have included 1) searching, 2) selecting, 3) implementing and 4) learning (Tidd and Bessant, 2020) while other scholars have identified five stages: 1) idea generation and mobilization, 2) advocacy and screening, 3) experimentation, 4) commercialization, and 5) diffusion and implementation (Mariello, 2007). In frames of this study the next stages of the innovation process will be considered: 1) new idea generation and discovery, 2) idea screening, 3) concept experimentation, and 4) idea development and monetization (Truong and Papagiannidis, 2022). The innovation process model is not linear and is presented in the Figure 1 below.

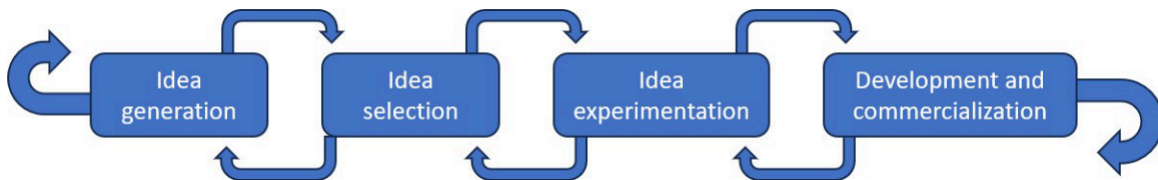


Figure 1: A four-step innovation process

- 1) New idea generation and discovery is the start of the innovation process for development of new products, services, and business models. This stage includes identification of existing unsolved

problems demanding novel solutions and application of various techniques (e.g., brainstorming, creative and or design thinking, complex opportunity recognition) (Truong and Papagiannidis, 2022).

- 2) Idea selection stage focuses on screening of ideas, identification of the most innovative ones for further development (Truong and Papagiannidis, 2022). It involves evaluation of ideas, identification and measuring benefits and threats. At this stage it is essential to develop a strategy and criteria for transparent evaluation of ideas (Truong and Papagiannidis, 2022).
- 3) Idea experimentation is a core phase of innovation process (Thomke, 2001). This involves testing ideas in the exact setting and time, and in many cases involving customers on this stage is essential (Mariello, 2007; Truong and Papagiannidis, 2022). Systematic experiments assist in refinement of ideas and creation of new products or solutions. Accepted by target groups, innovations are taken to the next stage. In addition, the application of certain technologies leads to more efficient experiments or even to the discovery of new possibilities and new products and solutions (Thomke, 2001).
- 4) Development and commercialization embrace further development of a validated idea into the product or service and bringing it to the market (Truong and Papagiannidis, 2022). The inherent part of this stage is marketing activities and preparing customers for the launch of innovative products or services (Eveleens, 2010). Some scholars follow approaches considering post-launch stages focused on support of innovation, re-innovation and scaling.

#### AI implementation in innovation

Artificial intelligence (AI) can be defined as the system's capacity for data interpretation and makes use of computers and other devices to improve personal capacity for decision-making, problem-solving, and innovation (Bahoo et al., 2023). Due to AI's capacity to foster creativity, existing literature has just lately begun to focus on understanding how AI may enhance innovation management procedures (Bahoo et al., 2023; Haefner et al., 2021; Truong and Papagiannidis, 2022). By encouraging creative and unconventional thinking, AI can be said to play a substantial part in the invention process (Martin and Wilson, 2016). AI has a substantial impact on the innovation process, because of corporate digital transformation, automated services, e-commerce, and technology adoption (Bahoo et al., 2023; Haefner et al., 2021).

Additionally, the stage of business innovation known as idea generation benefits greatly from information processing and the use of data sources (Nelson, 1985). Without technology, managers might have trouble collecting and analyzing the data they need to find new opportunities or resolve issues for their businesses (Bahoo et al., 2023; Williams and Mitchell, 2004). Thus, the organization has adopted and implemented general-purpose AI-based technologies because humans are unable to process enormous amounts of data. Therefore, idea creation strategies and research methodologies for organizations in supply chains are transformed by AI technology (David, 1990).

Moreover, due to human limitations, managers' knowledge built on their learning is constrained; consequently, the prospects and answers they discover resulted in incremental innovation (Bahoo et al., 2023; Gavetti and Levinthal, 2000). Managers use advanced AI-based technologies like machine learning, which broaden their current knowledge domain to form a new field, to develop competence in radical innovation (Bahoo et al., 2023; Posen et al., 2018). The managers must also assess and put into action the best opportunity or problem-solving strategy. A business normally cannot generate a valuable incrementally creative offering or alternative without implementing AI-based technologies. Adopting AI-based technology will thereby increase the success of the evaluation and implementation (Bahoo et al., 2023; Bresnahan and Trajtenberg, 1995).

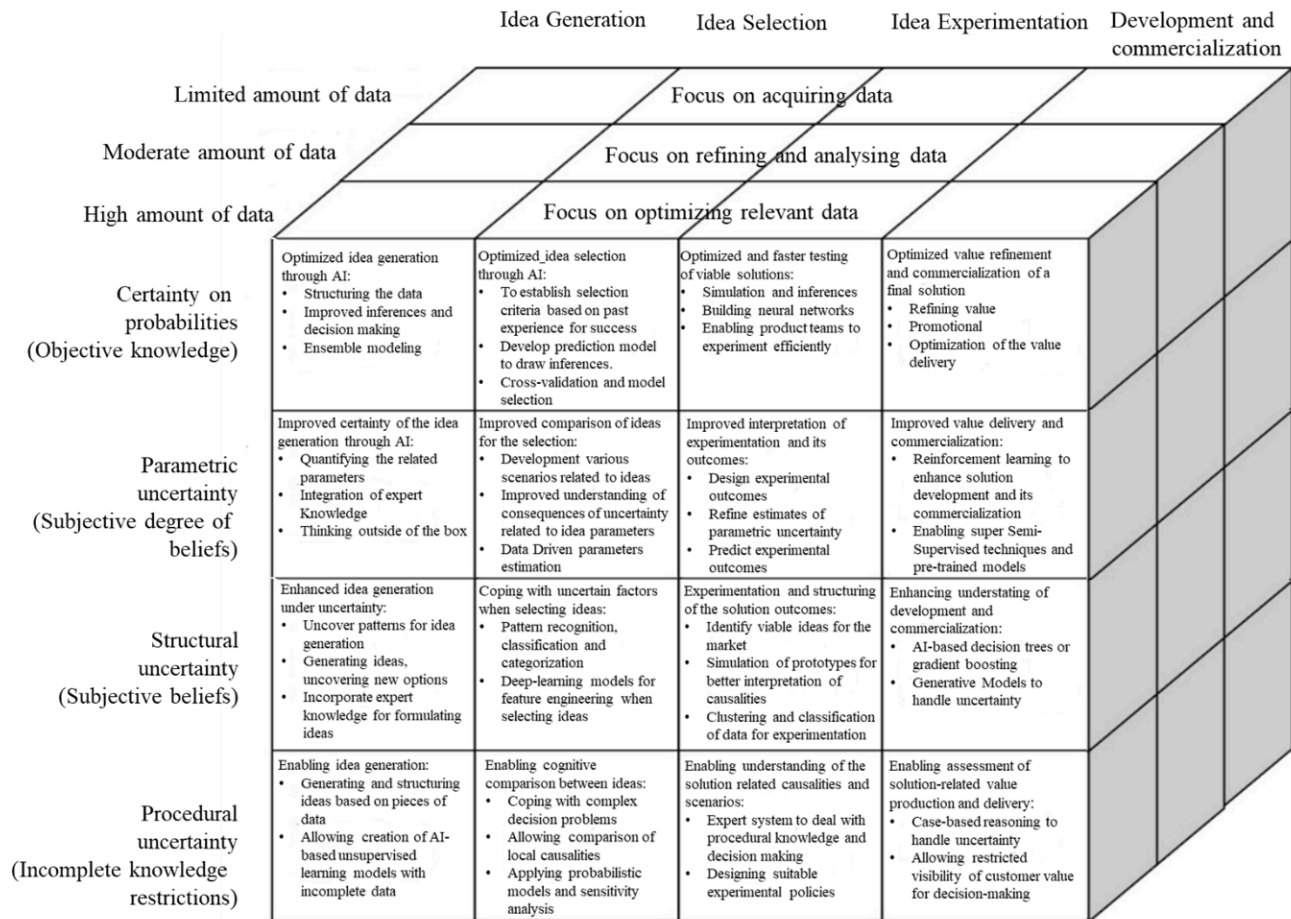


Figure 2: Proposed conceptual framework integrating AI for managing uncertainty in innovation process

### Uncertainty in innovation

The uncertainty theory is based mostly on Knight's (1921) theories of certainty, risk and uncertainty, where the main distinctive feature of uncertainty is described to be unmeasurable concept (Knight, 1921) meaning that it can't be calculated. The uncertainty related to the innovation process can be considered to derive from within the innovation system or outside of the system (Bergek et al., 2010). One of the ways to classify uncertainty is by distinguishing it to three different types, namely parametric, structural and procedural depending on the level of information is available from the environment and on the decision-makers cognitive decision-making abilities (Dosi and Egidi, 1991; Langlois, 1983; Vilko et al., 2014). The uncertainty related to innovations has been discussed in innovation literature by several authors (Freel, 2005; Jalonen, 2012). Overall, eight different types of uncertainty can be distinguished in the literature (Jalonen, 2012): 1) technological uncertainty, 2) market uncertainty, 3) regulatory/institutional uncertainty, 4) social/political uncertainty, 5) acceptance/legitimacy uncertainty, 6) managerial uncertainty, 7) timing uncertainty, and 8) consequence uncertainty

While the types are essential in determining the source of uncertainty, the level and how uncertainty could be managed in different levels is typically neglected. Therefore, the aim in this paper is in the management of different levels of uncertainty in the innovation process.

### **Conceptualizing AI-integrated uncertainty management in innovation processes**

Innovation management by nature is proactive by nature and always includes 'unknown' uncertainties in it. However, in many ways it is necessary to manage the different uncertainties related to the innovation process for the decision-maker to handle. By introducing AI into the process, some of the limitations of the decision maker can be overcome which can give improve the success rates of the process. In Figure 2 we illustrate a proposed conceptual model of an AI-integrated innovation process uncertainty management cube. The process is divided into a four-step innovation process as can be noticed from above the cube. The upper left side of the cube determines the amount of data available for the process and the focus in management in different levels. Thereafter the left side of the cube illustrates the different levels of uncertainty ranging from certainty on probabilities (where there is certainty about the probability and impact of different events in the innovation process) which can be calculated and optimized using AI. The second level refers to parametric uncertainty, where the decision maker has only degree of subjective beliefs about the probability of the events (structure of future is known, parameters are uncertain), where AI can improve the process and related certainties of the parameters. Third level indicates structural uncertainty, where the structure of the future is not clear and the decision maker struggles in forming a clear picture of all the upcoming events, their causalities and impacts. In here, the role of AI is in building the bigger picture and helping in forming understanding about the causalities. Finally, the procedural level refers to the situation where only bits and pieces of the future are known, and the cognitive abilities of the decision maker do not allow proper decisions to be formed. In here, the role of AI is to help to form partial cause-and-effect relations and to help decision-makers to structure the relations between data bits to enable at least partial understanding of the innovation process.

### **Discussion and implications**

The use of AI has become an increasingly popular both in scientific and managerial literature. While the utilization and different applications of the large-scale language-based models is becoming more common in different solutions, the scientific literature about the integration of AI to the organizational innovation processes is still in its infancy. This paper proposes a three-dimensional theoretical framework to conceptualize the use of AI in managing the uncertainty related to the different stages of innovation process. The framework enhances the understanding of the integration possibilities and the role of AI in different situations, namely with different levels of uncertainty and different amounts of data available. While synthesizing different theories we provide a detailed categorization and suggestions how to apply AI in the different situations which enables more effective.

#### Scientific implications

This research responds to recent calls for more research on the application of artificial intelligence (AI) to innovation contexts (e.g., Cockburn et al., 2019) and dealing with uncertainty at the same time during these stages. Responding to this, we have developed a practical framework that is useful for scholars in innovation research given the rapid development of digital technologies (AI in particular) and related innovation management practice and have contributed to ongoing debate on AI utilization for innovation management (Bahoo et al., 2023; Haefner et al., 2021).

#### Practical implications

The framework offers fresh perspectives and may help managers deal with the uncertainty that arises during the various stages of innovation processes and may obstruct the successful launch of innovative products. In particular, managers' thorough understanding of AI's implications for innovation processes and various levels of uncertainty that exist during these stages could lead to effective utilization of resources (financial and intellectual) for innovation. Furthermore, utilizing the AI Innovation-uncertainty framework introduced in this research, managers and decision makers can further assess the best alternatives to launch incremental and radical products based on customer requirements and avoid unwanted results.

#### Future research directions

We recommend future scholars to test proposed AI innovation-uncertainty framework in the real-world innovation processes context to produce replicable findings. Additionally, scholars can test the proposed framework for developing various types of innovations across different organizational settings. Scholars can also develop different types of scales for proposed models to test it quantitatively and can also rely on qualitative research design to contribute to this debate on AI-utilization in innovation context.

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