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Use of Artificial Intelligence as a Product Manager

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Abstract

In modern times, the capabilities of artificial intelligence have increased significantly. However, the application of artificial intelligence is still unknown largely in product management. This research study involved an assessment of the role of artificial intelligence in product management and its different aspects. A systematic literature review based on PRISMA guidelines was performed, which revealed that techniques like machine learning, artificial neural networks, and fuzzy logic are being used in statistical processes like planning, designing, reporting, production, sales, and risk analytics. In these areas, the application of artificial intelligence is still in its infancy and depends significantly on either the product manager or the product management team. Even though artificial intelligence can serve as a helpful tool, it cannot replace the product manager.

Keywords:

Artificial intelligence; Product management; Systematic literature review; Machine learning; Artificial neural networks.

1. Introduction

In general, the COVID-19 pandemic across the globe highlighted the need to reconsider existing working approaches and methods and has increased the vulnerabilities of different industries, indicating more sustainable and human-centric solutions are needed [1]. Currently, the transition to the new normal from the old normal can be observed and recognized as an opportunity to renew and reshape the industry's role in society [2]. The concept of Industry 5.0 was released in this context. Based on Industry 4.0 and its principles, Industry 5.0 focuses on the application of modern technologies like AI or artificial intelligence, advanced digitalization, and big data. The change is concerned with the deployment of solutions for a more sustainable, human-centric, and resilient industry [3].

Actually, it is pointed out by Breque et al. [2] that AI is one of the key enabling technologies that will be helpful in shifting to Industry 5.0. AI is, however, not a relatively new field. For instance, several people began to work on intelligent machines after World War II. In 1947, Alan Turing might be recognized as the very first person to study AI [4]. Ever since then, AI has evolved and is in a hype phase right now. AI is being used, for instance, in various novel scenarios such as the diagnosis and detection of patients, the development of vaccines and drugs, and product design and development [5]. It is worth noting that the application of modern technologies not only benefit manufacturing processes but also business procedures and processes such as product design and development are necessary in and contribute to the success of an organization in the market.

In the existing literature on project management, one of the key trends is the use of AI for product development and work management. PMI, for instance, explores the role of AI in PM and highlights that AI alters the types of projects being delivered and their management [6].

Even though such reports highlight that AI's application facilitates project management and product development and how they benefit product managers, there is a lack of studies that highlight how AI facilitates various processes and procedures involved in the development of a project [7]. To the best of our knowledge, there is a lack of a systematic literature review performed on the application of AI in product development and management. In fact, there is a lack of any study that highlights if AI can even replace the need for a product manager. Therefore, the question arises whether AI can serve as a product manager. That is why the objective of this paper is to assess the role of AI in product development through the analysis of the literature on it. In the existing literature, a systematic literature review has not been performed on it, which sets this paper apart.

This research paper adds significantly to the existing literature by offering critical insights into AI's role in product development [8]. The rest of this research paper is organized in this manner: Section 2 highlights the research methodology and techniques used for the collection of data. Meanwhile, Section 3 offers a descriptive view of results and discussion. It also explores the implications of the research findings. Section 4 concludes the entire research paper and discusses its limitations.

Individual techniques

Artificial Neural Networks (ANN)

ANN which are built on the same principle as is neuroscience acts as a key in the fields of medicine [20], engineering and those parts of science where similar techniques are functionally applicable. The thorough analysis of the data and its enhancement with addition of certain learning lessons by deriving in more data for the past and comparing results with analysis for similar project [21]. The essence of neural networks are advantaged in the following beneficial effects, The information can be handled with ability to flow through the network, the system may be controllable to missing or incomplete data; Resilience to failure, the network can be able to learn the system and work at a time of parallel operations [22]. Attributes of ANN has scientist using its simulation models of the thinking of the human brain in computational of various projects across the text analytics, research, and management projects [23].

Neural Networks of High Order (HONNS)

The neural network of high order HONNs for the discrimination of nonlinear noise was developed in the 1960s but was forgotten because of the large number of terms of higher orders [24]. Since the late 1990s some scientists, who noticed some exceptions on ONNs, began to use HONNs to solve specific classification problems. In HONNs, the outputs of the neurons are transmitted, while the feedback to the transmitter neuron of the previous layers is made two-way transmission of signals in the signals of the previous neuron is job hindrance. The basis is networks from the Hopfield model [25].

Hopfield Neural Network (HNN)

The Hopfield Neural Network (HNN) is characterized as a high-degree ANN [26], it is encoded from a single layer of completely linked neurons and it presents a solution to the combinatorial optimization problem [27]. It accepts a problem energy function biased toward a particular local minimum and identifies the local minimum where the optimal solution is located [28].

Fuzzy Logic (FL)

Fuzzy Logic (FL) is also a high-level technique, often described as an approach to cope with uncertainty and imprecision in the environment. As in the case of the human mind, when the brain follows a simple set of heuristic principles concerning uncertainty and vagueness, the fuzzy logic can be an important device for permitting the automated systems to be used to tackle any complicated subject [29]. Basically, the fuzzy logic can be applied for the fuzzification, rule base, inferential engine, and defuzzification [30]. However, FL has a variety of problems to solve, including a fuzzy membership function configuration, composition of operator determination, and a fuzzy rules framing suitable to any application area [31]. The difficulty of the FL algorithm is that the importance of FL parameters is based on the judgment and experience of a specialist. The hardest thing of the FL algorithm is the calculation of the parameters without a specialist [32].

Fuzzy Cognitive Maps (DCMs)

DCMs are a form of graphical structures used to represent the causal inference in cognitive maps [33]. Fuzzy Cognitive Maps (DCMs) are suited to disciplines that include categories with fuzzy concepts and relationships as they perform in the domains of politics, historiography, and job management [34]. DCMs comprise each node related to a fuzzy set or facts of occurrences and dares model events, behavior, values, aims or processes. This method benefits with the scenario analysis and other advantages such as visual modeling, simulation and prediction which enable us to model the various scenarios for the path to future states [35]. This strategic planning method is most common in technology management which is constantly adapt to the state of situations. Although the DCMs have a wide use in the scenario analysis, there are little existing methods and tools for effective evaluation of precisely computed scenarios [36]. DCMs have been applied in the simulation of the software development and inventory management scenarios and the security risk analysis in the ERP development. Despite their initial function in the integration of strategic planning with information systems and processes, DCMs still did not encase the whole spectrum of complete analysis of project options from the beginning. Moreover, though DCMs have been recently utilized for prioritizing IT projects, their links to the models based on the business architecture developed later through business modeling activities are not publicly recognized [37].

Genetic Algorithms (GAs)

Genetic Algorithms are significant adaptive methods to solve search and optimization problems based on the intensity of genetic processes in nature. This approach is ascribed to the algorithms' basic points, as they use the principles implied in natural evolution themselves [38]. The central claims Natural selection and survival of the fittest predetermined by Darwin observed in 1859 are used in problems' optimization and solution . The application of this method will help Genetic Algorithms be stronger and more adaptive, as they are successful with a large variety of issues whilst traditional methods fail [39]. While they might be seen to be vastly irrelevant as they are "less reliable than deterministic approaches in guaranteeing optimal solutions to particular problems," the results of the study claim that the algorithm scans an acceptable set of solutions at a faster rate compared to any other sampling algorithm [40]. The relevance of broad applying these algorithms is also dependent on the fact that not only tasks that previously lacked special techniques such as engineering, planning, games, and image processing are now seen everywhere, but the methods of these areas of study have facilitated broader applicability to relevant problems [41]. Architecture of Genetic Algorithms explains the basic principles by which the algorithms are guided. Additionally, Genetic Algorithms are effective in multiprojects planning which involves vague solutions; perfect solutions are achievable, which is not only immune to change but also leads to an increase in the development phase time. While an optimal solution will generally solve the problems if it fits some of the constraints of the problem, there is a solution that is best for any particular set of constraints.

Fast-Messy Genetic Algorithm (FmGA)

Fast-Messy Genetic Algorithm (FmGA) is primarily known for its efficiency in achieving good solutions in problems with vast amounts of varied permutations [42]. Creating and forming a fusion with different approaches could, in fact, close all the gaps [43]. Quantum genetic algorithms have an immense advantage over classical ones because they have the ability to change the building blocks, hence to find the best partial solution and reach the global solution make n times faster [44]. The philosophy of FmGA has been used in resource management in the schedule determination of project planning and engineering practices. FmGA is, without a doubt, one of the successful philosophies for Mult objective and combinatorial problems used almost everywhere [45].

Support Vector Machine (SVM)

Support Vector Machine SVM is a more effective approach than traditional statistics [46]. The Success of Support Vector Machine model involves its application to solve classification or regression issues. Support Vector Machine also functions as a neural network that must be trained and tested using a specific dataset. SVMs may acquire underlying patterns in large datasets, positioning them as effective instruments for managing complicated data in this area, it succeeds neural networks [47]. In reality, SVM, an analysis and planning tool, is one of the most well-known classification mem works. SVM falls into the classification algorithms, which is a subgroup of linear classifiers. Support Vector Machine is capable of creating linear or hyperplanes separating planes in the initial input space or transformed space [48].

Bootstrap Technique (BT)

The Bootstrap Technique was introduced as a general technique for calculating measures of the whole population on the averaging of estimates [50]. These estimates were computed from relatively small independent samples. Configured by selecting at random observations from a bigger data set, the samples made likely duplicating the same episodic rotation of observation in a short sample by the replacement sampling. [51] Bootstrap Technique happens as a result of the compilation process that is, by repetition of sampling, statistics calculations and following averaging [52]. In turn, the bootstrapping method is a flexible and powerful tool for quantifying the uncertainty of the estimator or statistics, regardless of the learning mechanism [53]. Bootstrap Technique shows a chance of a project being victorious by training a model with an instance that then examines its performance on data that is not in the special sample. Data analysis acquired this technique of bootstrapping regularly accommodates a Gaussian distribution and hence have a limited use. The BT application extends across several fields including medicine, the management of finance and other management fields [54].

K-Grouping Means

K-Grouping Tools, K-Means Clustering Algorithm is a fundamentally excellent procedure for k-grouping information randomly acquired. K-means that does use heuristics, such as Lloyd's algorithm, are so straightforward and can indeed be quickly implemented with large datasets. [55] A function often utilized by researchers engaged in market segmentation, computer vision, geostatistics, astronomy, and agricultural data mining has worked on lambda-mode too, helping to roll out solved configuration one. Its overall simplicity, together with convergence, no being further guaranteed, has misled even lifetime users of the methodology [56]. The K-mean method has only a couple of disadvantages like the fixed setting for good solution and extensive calculations , which make the time of such calculations so lengthy. However, it regularly converges in practical application, particularly in pattern recognizing duties.

2. Research Method

In order to collect data from relevant journal articles and identify adequate and credible journal articles from the existing literature base on artificial intelligence, a systematic literature review is performed. The underlying aim is to acquire, assess, and interpret data from the most relevant studies from 2015 onwards. In order to perform the systematic literature review, PRISMA or preferred reporting items for systematic reviews and meta-analyses approach is used. Actually, it was selected mainly due to its capabilities in improving the results and guaranteeing its replicability [9]. In addition, it also offers a structured process that helps perform a detailed systematic review.

2.1 Data Collection and Selection

In the case of a systematic literature review, the collection of data is a rather critical aspect. In order to collect data, a number of search terms were used including "AI and product development," "machine learning and product development," "role of AI in product development," etc. These search terms were used in various databases including Google Scholar, Scopus, Web of Science, and JSTOR. In these databases, a timeline was selected in which research studies from only 2015 onwards were screened. From these databases, 141 journal articles and research studies were collected and screened. For the inclusion of research studies in the screening procedure, their abstracts, titles, and findings were checked. All the research studies that were deemed irrelevant were not included in the research study.

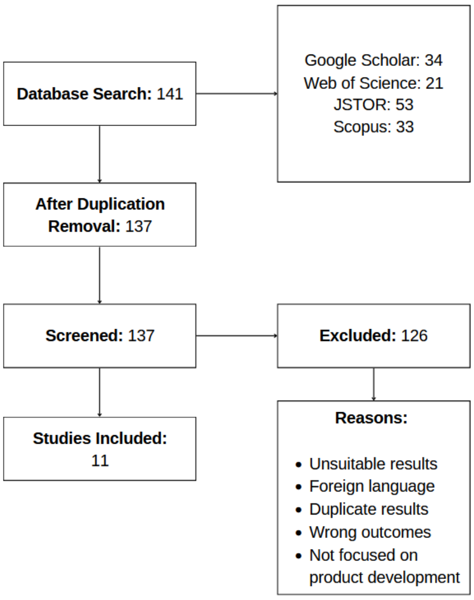

Figure 1:*Data Selection based on PRISMA*

Considering the fact that more than one research platform was used for the collection of data, the first step was concerned with the elimination of duplicates, which helped remove 4 journal articles. The screening was subsequently performed to identify and use only the most relevant and adequate studies. With screening, around 126 studies were excluded due to their lack of focus on product development, wrong outcomes, duplicate results, foreign language, and unsuitable results. Upon the completion of the screening stage, 11 studies were included in the analysis of the data.

3. Results and Analysis

Table 1:*Systematic Review of Studies*

Authors	AI Techniques	Product Development Aspect	Findings
Tan, Chen, & Yeo[10]	Natural Language Processing and Machine Learning	Reporting	The proposed system is based on NLP and ML techniques for the creation of consolidated reports. It is identified to automate and track individual projects and reporting deadlines, send reminders, and enable the online submission of reports.
Azadeh, Moghaddam, Nazari, & Sheikhalishahi [11]	Fuzzy Multivariate Decision	Conceptual Design	The proposed FDEA-based AHP model is capable of proposing the optimal layout and design among all the given alternatives with respect to layout-dependent, qualitative, and operational variables. The design selected by the model

			was verified to be indeed the best for the given case.
Shiboldenkov & Nesterova [12]	Machine Learning	Production	The application of machine learning is capable of facilitating the automation of production systems. Autonomous robots can be controlled for the effective manufacturing and production of required products and systems.
Chae, Shin, & Kim [13]	Collaborative Filtering based on Generative Adversarial Networks	Sales	The proposed recommendation framework is callable for improving the recommendations for the target audience. In comparison with traditional algorithms, the proposed algorithm demonstrates higher recommendation accuracy.
Kwong, Jiang, & Luo [14]	Fuzzy Regression, Chaos-Based Fuzzy Regression, and Non-Dominated Sorting Genetic Algorithm-II	Affective Design and Engineering	The proposed model is capable of creating effective product designs that may be used to acquire insights about whether customers and target audiences prefer the product or not. The model requires further improvement for creating affective designs that suit different products other than an electric iron.
Pourkiaei, Ahmadi, & Hasheminejad[15]	ANN and Parametric Neural Network	Modelling	Group Method of Data Handling and Parametric Neural Network are used to create a model that can predict and control the behavior of a 25W fabricated PEM fuel cell. The results indicate that the neural networks are capable of predicting the voltage of the fuel cell and controlling it effectively.
Aziz & Dowling [16]	Machine Learning	Risk Analytics	The application of machine learning in risk management is capable of offering predictive insights regarding the risks that might be faced during product development and project

			management.
Li, Gao, & Li [17]	Genetic Algorithm	Scheduling and Planning	The Nash equilibrium based on game theory has been used and a hybrid algorithm has been developed. The results of the algorithm indicate that it can be rather useful in product scheduling and planning.
Ghoreishi & Happonen [18]	Machine Learning	Product Designing	Machine learning-based algorithms can be used for acquiring suggestions about product design. Instructions can be fed to create virtual prototypes of products that help product managers view what their products would look like with specific design features.
Rodríguez, Gonzalez-Cava, & Pérez [19]	Machine Learning and Fuzzy Logic	Product Planning	The proposed decision-making system based on machine learning and fuzzy logic is capable of offering critical decisions about product planning and operating a production plant.

3.1 Implications and Discussion

In this research study, the goal was to explore the role of artificial intelligence as a product manager. The review of the selected research studies offers some interesting results. The 11 studies reviewed explored the use of artificial intelligence in various areas of product development ranging from planning to reporting. However, some critical areas of product management including human resource and team management, rewards and compensation, and decision support were some areas that were not explored in the reviewed studies. The following are the key areas of product management in which artificial intelligence was used:

- Scheduling and Planning
- Product Modelling and Designing
- Production
- Reporting
- Risk Analytics

Rodríguez, Gonzalez-Cava, & Pérez [19] and Li, Gao, & Li [17] explored the utilization of artificial intelligence in project planning and scheduling. When it comes to Rodríguez, Gonzalez-Cava, & Pérez [19], the authors relied on two key AI technologies including fuzzy logic and machine learning. The proposed decision-making system was capable of providing critical insights about product planning and operations. For instance, the system required instructions and inputs before it produced outputs. The decision-making support made decisions for the project manager. While the proposed solution was capable of offering insights about what decisions would lead to the achievement of desired goals, it had multiple uncertainties.

In addition, it required the project manager to feed instructions about the situation and context of the product. The authors also determined that the decisions made by the system required adjustments before they could be implemented. Li, Gao, & Li [17] relied on the use of a genetic algorithm, more specifically the Nash equilibrium based on game theory, for the development of a model that could help accurately schedule and plan the product. The proposed framework is capable of helping with assembly sequencing, process planning, and scheduling problems. However, the framework relies on the input from the project manager and it has been tested in a simulated environment, which means that its application is significantly limited in the real world.

On the other hand, when it comes to design, Azadeh, Moghaddam, Nazari, & Sheikhalishahi [11] and Kwong, Jiang, & Luo [14] have used fuzzy multivariate decision model and fuzzy regression, chaos-based fuzzy regression, and non-dominated sorting genetic algorithm-II respectively for testing the ability of AI and its applicability in product designing. The model proposed by Azadeh, Moghaddam, Nazari, & Sheikhalishahi [11] is capable of proposing the most optimal and effective layout and design among all the other alternatives with respect to layout-dependent, qualitative, and operational variables. While the model could propose the layout for the facility, it depended on instructions from the project manager. For instance, it had to be fed with instructions regarding several designs and variables. Based on the data offered, it could select the most optimal design.

The AI-enabled model created by Kwong, Jiang, & Luo [14] could generate affective designs for an electric iron. However, the designs required corrections from the product manager and the model had to be offered critical instructions and direct supervision before it could produce the designs that could be offered to customers. Pourkiaei, Ahmadi, & Hasheminejad [15] developed a modeling algorithm based on artificial neural networks and parametric neural networks to make sure that the behavior of a product could be controlled and managed in an effective manner. The proposed model was capable of predicting the behavior of a fabricated fuel cell and managing it adequately.

It is, however, critical to note that the proposed model was rather redundant and required significant computational power. While the model was capable of predicting the behavior of the fuel, it should be noted that several predictions were erroneous and required the oversight of the product manager. Without the oversight of the product manager, the predictions could adversely influence how the fuel cell was controlled and managed. Tan, Chen, & Yeo [10] utilized machine learning and natural language processing for product reporting. The proposed model was capable of creating comprehensive and individual reports based on the instructions and input such as deadlines, goals, and progress. The model was rather effective in the production of adequate reports that could be shared automatically with designated authorities including the project manager and the leader.

Similar to other models, the reporting model relied on extensive instructions from the project manager. For instance, without the instructions, it would not be possible for the model to generate reports and share them with different authorities. In addition, while the model proved effective in sharing reminders and assessing project progress based on the goals, it was not completely autonomous. The project manager had to use it at certain intervals for the generation of required reports. Even then, the reports had to be checked before being shared to ensure that they were accurate, and inaccurate information was not included in the reports. Even though the model was able to generate reports, it only generated reports containing information that it was pre-programmed to. For instance, the model was unable to include anything in the report that it was not programmed to. As a result, it can be said that the model can be used as an added tool but it cannot be used autonomously for sharing and generating reports.

Chae, Shin, & Kim [13] proposed a recommendation framework based on collaborative filtering. Generative adversarial networks were used for the development of the sales model. It is worth noting that the model was capable of evaluating customer data comprehensively before personalizing recommendations and sharing news about the product with them. The product manager was able to use the proposed model conveniently to share news and personalized content without experiencing any difficulties. However, the type of content that the model could recommend to clients was limited to a significant extent. In addition to it, the model was not autonomous and could not analyze the data of customers on its own. It required long prompts and the datasets about customer information and previous history had to be fed. In addition, the model was limited in its computational power and could not reach a large number of customers at a single time.

In addition to it, Aziz & Dowling [16] indicated that a machine learning-based risk analytics model could be considered and used for the assessment of a product and highlight different risks and their severity in an effective manner. In fact, it is capable of not only identifying but also rating different risks to indicate their severity in a project. It offers predictive insights about the risks and challenges that may be faced during the project or development of a product. However, for the operation of the model, it was essential for the product manager to offer it critical insights about the project such as the context and the type of the project. A major limitation of the model was the generalization of the risks. For instance, it identified and highlighted the risks that could be faced in any risks. It lacked substantial insights about why a risk like scope creep could be experienced and faced in a particular project.

On the basis of the research studies assessed and models evaluated, it can be said that various techniques of artificial intelligence such as machine learning, genetic algorithms, artificial neural networks, natural language processing, and fuzzy logic among others. However, these techniques have been used for the development of models that could facilitate and help manage standard aspects of product development including planning, designing, reporting, sales, and risk analytics among others. Even in these areas and aspects of product development, the developed models are not autonomous and depend significantly on the instruction and intervention of the product manager. Additionally, the developed models are rather prone to making inaccurate results and outcomes that require the oversight of the product manager.

The application of artificial intelligence techniques can prove to be quite effective in standard product management processes and procedures. However, the developed models must be autonomous and applicable to any type of project or product. In addition, they should not require the constant oversight of the product manager. Their application in more dynamic processes, however, is still questionable and requires significant work. Of all the studies involved in the systematic review, not one study involved the use of AI techniques for processes like reward management and team management. Actually, AI models are capable of assessing large amounts of data for the identification of correlations, trends, and patterns, which can facilitate inventory management, demand forecasting, and resource allocation for products. It can be helpful for product managers in making informed decisions about resource utilization, production timelines, and market demand. Similarly, AI-based models can rely on existing datasets to generate design alternatives, optimize existing designs, and even perform simulations for products.

In more dynamic areas like human resources and team management, the application of AI is quite challenging. This is mainly because they involve a high degree of subjectivity and complexity. Different factors like organizational culture, interpersonal dynamics, and employee preferences can be highly challenging to quantify and assess using AI models. In addition to this, since AI models based on ML and ANN tend to rely on historical data for making predictions and suggestions. In dynamic areas of product development where circumstances can change in a rapid manner, historical data might not reflect future or current conditions accurately, which limits the effectiveness of different AI-driven solutions.

Furthermore, in more dynamic processes of product management like human resources and reward management, the application of AI also raises critical legal and ethical concerns about bias, fairness, and privacy. Decisions related to compensation, promotion, and hiring require careful consideration of these factors which can be quite challenging for AI models to address in an effective manner. Not to mention, these processes tend to involve human judgment, emotions, and interactions, which are quite difficult for AI systems to replicate. Even though AI models can be used for improving decision-making in these areas, human oversight and input are necessary for ensuring ethical behavior, empathy, and fairness. In standard processes, the application of AI is quite prevalent because standard processes depend on structured data that can be collected and analyzed easily, which makes it rather easier to train AI models and drive effective results. These processes also have more quantifiable and tangible outcomes, which makes it easier to evaluate the impact of AI interventions in terms of quality enhancements, efficiency improvements, and cost savings.

On the basis of the findings, it can be said that the application of AI in product development and management is still in its infancy. Even though it has been explored by multiple authors and researchers, there is a lack of effective models that have been developed on a scale that can be used in a concrete manner without experiencing issues and problems. All the models that were reviewed in this research study require the oversight of product managers before they can make decisions based on the results produced by models. The product managers need to assess the results generated by AI models before they can consider implementing them. It clearly indicates that artificial intelligence cannot replace product managers. Although AI-based models can be used as tools after being refined and trained on large amounts of data, they cannot replace product managers. Significant oversight and intervention from product managers are required to use AI-based tools in product management, especially in dynamic processes such as human resources and rewards management.

4. Conclusion

Artificial intelligence is undoubtedly one of the key trends and areas being explored and studied in project and product management. The reviewed studies clearly indicate and attest to the potential of artificial intelligence and its various techniques in product management. However, artificial intelligence cannot yet serve as a product manager. While various algorithms and refined models can be used as tools to assist and facilitate product management, they cannot replace a product manager. They are still in their infancy and most of the designed models that have been studied in this research study are limited to only one function and require extensive instructions and intervention from the product manager. In addition, the models are also prone to generating inaccurate results that cannot be used without checking and reviewing multiple times.

Future research studies need to focus on the development of more refined models that can be used autonomously with minimal instructions and interventions from the product manager. For instance, models that report, design, and assess risks should be more hand-free and they must be applicable to just about any product. In addition, there is a need for future research studies to focus on the creation of AI-based models that can facilitate not just standard processes but also more dynamic areas including human resources, team management, product leadership and decision-making, and rewards management among others.

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