Università
Ca'Foscari
Venezia

Master's Degree

in International
Management

Final Thesis

A systematic literature review about the impact of artificial intelligence on innovation management: implications on different organizational aspects

Supervisor
Ch. Prof. Johannes Dalke

Assistant Supervisor
Ch. Prof. Chiara Saccon

Graduand
Alessandro Salvan

Matricolation number
871849

Academic Year
2018 / 2019

Faculty of Business, Economics and Social Sciences
Chair for Innovation Management
Prof. Dr. Bernd Ebersberger

Free Scientific Thesis to Obtain the Academic Degree
Master of Science

A systematic literature review about the impact of artificial intelligence on innovation management: implications on different organizational aspects

Alessandro Salvan
Management
Via Roma n.1308
45030 Pontecchio Polesine (RO)
3492339291
alessandro.salvan1@gmail.com

Second Assessor: Prof. Andreas Pyka
Academic Advisor: Johannes Dalke

Stuttgart-Hohenheim, 15/07/2019
University of Hohenheim

Abstract

Artificial Intelligence is developing and increasingly affecting many different aspects of current society, and business is among them. In particular, this new technology leads to innovation outcomes thanks to its different tools and applications, and this have been confirmed by academia and business practitioners as well. Probably due to the youth of the topic, a gap in literature seems to exist concerning a collection of contributions addressing the relationship between AI and innovation management, which appears very fragmented, and for this reason a systematic literature review will be conducted in this study, with the aim of presenting AI implications towards innovation management issues, clustering them by seven organizational functions, namely HR, R&D, Finance, Operations, Marketing, Supply Chain and Strategic Planning, thus providing insights for both research and executives. AI's developments over time will be pointed out, along with the consequent effects they have had on firms. Indeed, if initially AI has been just implemented as a mean for improving the traditional way of carrying out business practices, nowadays some AI applications seem to have the potentialities to completely reshape the organizations tasks and boundaries. Therefore, managers should take into account these implications in order to maintain their firm's competitiveness.

Acknowledgments

I would like to thank my thesis supervisor Johannes Dalke and professor Bernd Ebersberger of the Innovation Management chair at Hohenheim University for the useful comments, remarks and engagement through the learning process of this master thesis. They consistently allowed this paper to be my own work, but steered me in the right the direction whenever they thought I needed it.

But mostly, I must express my very profound gratitude to my parents, Luigi and Federica, and to my relatives as well, for providing me with unfailing support and continuous encouragement throughout all my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Sincerely, thank you.

Stuttgart, 15/07/2019

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AI	Artificial Intelligence
IC	Intellectual Capital
ANN	Artificial Neural Network

1. Introduction

It is undeniable that technological developments are shaping and changing not just our daily life, but the whole society as well. In particular IT is penetrating our habits and our routine duties, having also a relevant impact on how firms carry out their businesses. Among the various and wide range of tools referring to the "IT world", Artificial Intelligence (AI) is one of the instruments which seems to have a very relevant impact nowadays (Zammuto, Griffith, Majchrzak, Dougherty & Faraj, 2007). Indeed, its innovative features are contributing not only to reshape some tasks, but even to be one of the major sources of innovation in many fields (Huang & Rust, 2018). It is for this reason that it is also regarded as one of the disruptive technologies characterizing the so called fourth revolution (Majumdar, Banerji & Chakrabarti, 2018). So, since it seems to play a crucial role nowadays, defining it could deepen the understanding of this topic. One of the first times the term has been introduced can be traced back to McCharty (1960), who frames the AI challenge as the work of "programming computers to solve problems which require a high degree of intelligence in humans" (McCarthy, 1960, pp. 77). Following Dobrev (2012)'s opinion, AI can be informally defined as "such a program which in an arbitrary world will cope not worse than a human" (Dobrev, 2012, pp 2), or, according to (Huang & Rust, 2018)'s thought, as machines which manifests aspects of human intelligence. Going a little bit more in detail, Pavaloiu (2016) defines it as "automation of intelligent behavior created with the help of computer science" (Pavaloiu, 2016, pp. 21), which can potentially have a massive effect of disruption on many various domains, such as automotive, robotics, medicine, and with potential implications on how business are carried out as well. Another relevant contribution is presented by Dirican (2015), who describes AI as the scientific study field concerning computers which can think and act and even interact in many situations humans can operate too. Al-Zahrani & Marghalani (2018) agree with this concept, by recognizing it as machines able to imitate humans' cognitive capabilities. But the two authors also enrich this content, classifying AI as a bundle of tools exploiting algorithms in order to discover patterns and insights from an initial dataset, and even being capable of autonomous decision and forecast-making, thus learning over time (Zahrani & Marghalani, 2018). A similar belief has been expressed by Hamet & Tremblay (2017), who characterize it as "a general term that implies the use of a computer to model intelligent behavior with minimal human intervention" (Hamet & Tremblay, 2017, pp. 36), whose birth is generally strictly linked to the introduction of robots. Thus, looking at these definitions, a common conception of what AI is can be sketched. Hence, all these authors'considerations testify the huge relevance that this topic is gaining over time. And this is confirmed by many studies and researches linking AI to a broad variety of fields, from engineering, through applications in medicine, up to business and organizational issues. Hamet & Tremblay (2017) provide an illustration regarding AI implementation within medicine and health-care domain, where this technology finds application in supporting the drug delivery process to targeted organs, in assisting doctors during surgery operations, or even for taking care of aged people with limited mobility, enabling some robot-assistants. Differently, Belu (2013) underlines how this intelligent techniques have an impact within the engineering field of application as well, in the branch of renewable energies in his specific case. Furthermore, many linkages which relate Artificial Intelligence to business and firm's management can also be mentioned. The way services' tasks are performed can be affected through various AI means (Huang & Rust, 2018). Even automation seems to be improved or even

modified by such a technology, increasing functions' potentialities and replacing human employees in many tasks, hence allowing also for an overall cost reduction, which releases resources to be deployed in other organizational areas. Errors detection and work status tracking seem to be other duties made possible through intelligent devices introduction. Another essential source of competitive advantage for companies in the current business environment, being Knowledge Management, can be improved by AI, in order to capture wisdom already existing within the firm and even in order to develop new one, with the aim of enhancing decision-making quality (Metaxiotis, Ergazakis, Samouilidis & Psarras, 2003).

So, from the information listed so far, it seems easy to comprehend the significant value that such technological improvements have for both business and society, addressing many different branches of interest. Looking more specifically at academic researches and studies, among the subjects mentioned above a lot of relevant material can be found out about AI's implications related to organizational innovation. Many of them seem to place their focus on the innovation results which can be achieved through the introduction of intelligent tools and devices in a singular or multiple firm's departments. This is evident in Buzko, Dyachenko, Petrova, Nenkov, Tuleninova & Koeva (2016), who depict the improvements gained within the HR function thanks to the use of a cognitive machine learning system. This instrument allows to process a wider base of data, thus providing faster and more informative analysis, discovering the main factor influencing the amount of employees' training in this specific example. Pantano (2014) proposes innovative outcomes with the respect to marketing issues instead. She mentioned AI tools among the drivers for innovation in retail industry, due to their capacity to understand market and forecast future trends. Enhancements in manufacturing are described as well by Li, Hou, Yu, Lu, & Yang (2017), where AI contributes to cloud-working and collaborative manufacturing systems across enterprises, with some units gaining complete autonomy. The R&D department is affected as well, since the method of invention can now rely on predictions software, with not that much need for previous highly routinized labor-intensive research anymore (Cockburn, Henderson & Stern, 2018). According to this line of reasoning is the contribution by Buecheler, Sieg, Füchslin & Pfeifer (2010), in which AI is noticed as having an impact on crowdsourcing strategy for developing innovative ideas.

Therefore, a high number of investigations about this matter can be found out in literature. But also other sources strengthen the relevance of this topic. Indeed, evidence concerning the impact of AI towards innovation management within firms can be retrieved by business journals as well, hence testifying its huge value also for practitioners. Ransbotham, Kiron, Gerbert & Reeves (2017) affirm how these new technologies offer the opportunity to automate some organizational operations, not only enhancing process efficiency, but affecting the overall firm's strategy as well, inducing a rethinking of tasks and of the organizational structure as a whole, in this way boosting innovation at different levels. The decision making process is supported as well by AI, facilitating innovative choices and an increased orientation towards customers needs, in particular thanks to machine learning instruments, which allows software to generate and modify more sophisticated algorithms by themselves. A first step towards innovative products matching customers' requests, according to Kardon (2019). This is confirmed by Bean (2018) as well, who report positive managers' opinions about the exploitation of AI tools for exploring an high volume of data from different sources, from which they are capable to identify patterns and understand customers' behaviors. These features also allow for accelerating time-to-market of new product and services. Kiron (2017) highlights the effect that such a technology has on business strategy instead. It seems that executives must face new challenges if they want to fully take advantage of technology developments, related to shifts in employees'

skills requirements, in judgment criteria, which have to adapt to AI's characteristics, but also in how organizational boundaries are conceived. Indeed, ease in data collection opens up the possibility to exploit many data sources, building up platform for sharing valuable information among firms, and thus, co-creating with them (Kiron, 2017).

Summing up, both the academic research and business journals took and are still taking into account AI as one of the main driver of innovation from every organizational perspective. From the analysis carried out, many contributions emerged, testifying the relevance of the subject, and many of them seem to have been published during very recent years, thus signaling the youth of the topic. But, the contents of the studies seem to be widespread and fragmented, since study differ so much in methodology and content. Due to that, a gap in research can be identified, since it seems to be emerged a lack of studies aimed at gathering different researches about AI impact on innovation management issues.

Hence, this study will attempt to fill this gap, ,so trying to make clarity upon this topic and, in order to do that, a systematic literature review will be performed.

Before going more in detail towards the main content of the analysis, an appropriate framework has to be set, in order to better understand all the elements which will be included in the text subsequently. First of all, the theoretical definitions of AI listed at the beginning must be enriched, by providing a more detailed and technical overall picture. Some of the most common AI tools will be included under the AI definition throughout the analysis. First of all Neural Networks, which can be defined as "wide class of flexible nonlinear regression and dynamical systems. They consist of a " large number of "neurons," i.e. simple linear or nonlinear computing elements, interconnected in often complex ways and often organized into layers" (Sarle , 1994, pp. 1), considered intelligent due to the fact they learn and generalize from experience (Zhang, Patuwo & Hu, 1998). Machine learning algorithms are another typology of instruments belonging to the AI's world, which can be defined as "a general inductive process automatically" that "builds a classifier by learning, from a set of preclassified documents, the characteristics of the categories" (Sebastiani, 2002, pp. 1). Deep learning is another technique related to AI, since it allows to discover "intricate structure in large data sets by using the backpropagation algorithm to indicate how a machine should change its internal parameters that are used to compute the representation in each layer from the representation in the previous layer" (LeCun, Bengio & Hinton, 2015, pp. 1). Text mining can be mentioned as well, being defined as a tool "looking for patterns in unstructured text" and "discovering useful knowledge from unstructured or semi-structured text" (Mooney & Nahm, 2005, pp. 1).

These are the main broad categories treated as AI instruments along this research, each of them showing specific tools applied with peculiar features each. Then, since we are going to investigate the relationship between AI and implications regarding innovation management, a definition of innovation is required, and it can be framed as a "new combination of production factors that introduce discontinuity to product, technology, organizing principle, market, or set of behaviors [...] made possible by digital technologies" (Yoo, 2010; p. 6-7). Furthermore, since the main topic of this study regards technological development, Yoo, Lyytinen, Boland & Majchrzak (2012)'s contribution can be added up, affirming that the recent pervasiveness of digital technology translate into innovations because of its "generativity" feature, which basically means that a technology is capable of creating spontaneous novelties and value without any prompt and coordination among its varied adopters, as reported by Zittrain (2005). Given that, it is possible to clarify the meaning of the term "innovation management", which is defined as the act of transforming innovation's uncertainty into knowledge, balancing the available resources (Tidd & Bessant, 2014).

So, as said previously, since it seems that investigation about the relationship between AI and innovation management lacks clarity and given all these elements set up, a main research question can be claimed, whose answer will outline the overall purpose of this systematic literature review:

RQ: How is AI discussed in innovation management literature?

Considering this issue as a starting point, this study will go further in deeper investigating this topic. In chapter 2 the methodology used in order to execute the systematic literature review process will be profoundly discussed. Furthermore, some descriptive results regarding some crucial elements of the gathered papers will be disclosed, such as methodology used, industries involved or the typology of AI described or even implemented along the study. Thus, answers to the following sub-questions will be attempted through this section:

RQ1: What theoretical foundations are the studies based on?

RQ2: Which research designs are employed by the studies?

Then, in chapter 3, results gained from the selected papers with the respect to the main topic will be described and clustered by organizational departments. The aim of this section is to provide a broad overview about the main content concerning innovation management of the papers selected for the final sample. So, an additional research sub-question can be outlined:

RQ3: How innovation management is treated within the selected studies?

The result part introduces the discussion displayed in chapter 4, in which insights for managers and researchers will be discussed as a consequence of the information retrieved form the articles' sample. Hence, a conclusive research sub-question can be stated:

RQ4: What are the AI implications discussed for different business units?

Finally, in chapter 5 limitations of this study and suggested improvements to future research will be mentioned.

2. Methodology

2.1 Systematic Literature Review

As already disclosed in advance, the analysis concerning the investigation of the research questions stated above will be conducted through a Systematic Literature Review, in order to attempt the provision of a clear overview about this new and still developing topic. In order to carry it out, inspiration has been gained by the structures analyzed and described by Denyer & Tranfield (2009) and implemented by Calabrò et al (2018), then merging the features which fitted this topic the most.
After the "Question Formulation", research for relevant articles to be included in the analysis has been conducted, and, a well defined and precise path has been followed for executing an effective Systematic Literature Review, taking the cue from a study by Tranfield et al (2003). Accordingly to Calabrò et al (2018), in order to assess the quality of the sources which information have been retrieved from, the analysis has been conducted through a research platform focused on academic studies, being Scopus. Then, results have been filtered just for "Journals", trying to ensure as a final output only double-peer reviewed papers. This can be regarded as an effective control mechanism (Calabrò et al, 2018).
So, the search process can be splitted up into the following three phases, being Locating Studies, Study Selection and Evaluation and Analysis and Synthesis (Denyer & Tranfield, 2009; Calabrò et al, 2018).

2.1.1 Locating Studies

In order to get the desired output, namely a sample of articles tackling the Artificial Intelligence topic with the respect to its impact towards innovation management issues, some specific key words have been typed, which could be included in titles, abstracts or keywords of articles (Tranfield & Denyer, 2003). "Artificial Intelligence" and "AI" first of all, in order to ensure an output encompassing this broad topic, then adding up some specific tools belonging to this phenomenon, expanding the research basis, being "machine learning", "neural net*" and "deep learning", with the conjuction "or" in order to separate them. By typing the symbol " * " the search platform is allowed to search for every word containing those specific letters, in this way avoiding bias related for instance to plural and singular nouns, and so on (in this specific case by typing "net*", the words "network", "networks" "networking" and other words starting with "net" are allowed as an output). Then he word "Innovat*" has been included for relating the AI topic to the Innovation subject (again here the symbol " * " has the same function explained above, allowing as a result words like "innovation", "innovative" etc), introduced by the conjunction "and". After that, the research basis has been narrowed down by adding up some filters. First of all, limitations about the source typology have been inserted by choosing "Journals", so allowing just for double-peer reviewed quality, as already explained above. Then, limitations concerning the "document type", by filtering for "articles". Subsequently, the "subject area" has been chosen, in particular "Business, Management and Accounting". Finally, a specific documents' language has been selected, filtering only for "English". Doing so,

the final output obtained has been a sample of papers aligned with the established features, but still investigating not only business and management themes, but a wider range of topics. So, in order to be sure of reaching just papers concerning business and management issues, a subsequent exclusion of all the other fields of studies available, other than “Business, Management and Accounting”, has been conducted manually.
The final articles sample accounted for 59 double-peer reviewed academic papers.

2.1.2 Study Selection and Evaluation

Following one of the step proposed in the structure presented by Denyer (2009) and the guidelines suggested by (Calabrò et al, 2018), once having set all the features up, titles and abstracts of the whole sample of articles have been carefully read, with the purpose of examining if they fitted the research’s needs or not. Firstly, articles containing the terms typed down for the title, abstract or keywords list have been included in the final sample but also some others which have not showed those words but whose contents could be suitable for the research as well. Papers not matching those requirements have been immediately deleted. Moreover, some articles could not be included in the final sample due to publishing restrictions or huge fee to be paid in order to get them.

2.1.3 Analysis and Synthesis

After that, in order to perform the third step described by Denyer et al (2009), the whole text of the papers selected has been deeply analyzed, mainly with the support of Mendeley application for facilitating the grouping and reading phase. So doing, it has been found that some of them, even if containing right keywords, were not that much relevant for what concerned the content and the relationship between AI and innovation management challenges. Furthermore, some of the articles presenting the word “AI” within the abstract or keywords, did not treat this topic across the text, because the abbreviation “AI” is used also with different meanings, such as “Appreciative Inquiry” or “Applied Improvisation”. So, they have been discarded as well since they revealed lack of relevance. Thanks to this process, it has been possible to collect papers not disclosing all the keywords in the abstract but still discussing AI and its linkage with innovation management. The final sample collected accounted for 28 papers.
Following the steps described above, the review has been set up with the aim of satisfying one of the four criteria described by Denier et al (2009). It can be said that the literature review is “Replicable” in this case. Indeed, proceeding in this way, everyone could reach the same output or at least a very similar one (Denyer et al, 2009).
The following paragraph pursue to depict a general overview regarding the paper sample providing some figures.

2.2 Descriptive results

Once the final output has been established, all the articles have been summarized, reading the whole text of each one, then focusing on the most relevant features and findings, which have been reported in the table list (see appendix). As previously stated, the final sample of articles coming from the described process accounted for 28 papers. Taking the systematic literature review performed by Calabrò et al (2018) as an example, before going more in detail with the content of the articles, it is useful to list some general descriptive figures, in order to depict when and how this topic has been treated and tackled by different authors from a very broad perspective. Looking at the time distribution of the gathered papers, it is easy to recognize it as a really young topic. Indeed, just 4 out of 28 (~14%) have been published before 2000, and 20 out of 28 (~71%) after 2010, showing a peak in 2017 and 2018 (5 and 4 articles respectively). This clearly shows the explosion of the relevance of this topic within the academic field during very recent years, a growth which follows the development advances of AI tools, which are continuously improving from a technological point of view, opening up new opportunities towards different branches, and business environment is among them (Makridakis, 2017).

For what regards these articles' sources, the gained sample has been retrieved from 21 different academic journals, all of them concerned with management and innovation subjects as a main topic, except for "Engineering Science and Education Journal", obviously coming from the engineering world. Most of the articles come from different journals. Just three of them can be distinguished among the others, being "Creativity and Innovation Management" and "Journal of Knowledge Management", accounting for 3 articles each (~10%) and "International Journal of Project Management", being a source of two papers (~7%).

Examining more deeply the content of the articles, it can be easily noticed that a useful distinction in order to classify them regards the methodology implemented. In particular, the articles sample can be split up into two "macro-categories", being "Quantitative" and "Qualitative" kind of research. Within these two broad classifications, it seems that they present a substantial homogeneity in how the researches have been carried out. 18 articles (~57%) present a "Quantitative" approach, all of them implementing a specific AI tool to conduct an analysis, with the purpose of showing the superiority of these tools with the respect to previous methods, describing their characteristics and the kind of output it is possible to reach through them. Most of them (12, ~ 75%), rely on a Artificial Neural Network tools, which seems to be the most recent and implemented one for analysis of unstructured data, 2 of them (~ 13%) propose the application of Machine Learning tools (Guo, Sharma, Yin & Rong, 2017; Hoornaert, Ballings, Malthouse & Van den Poel, 2017), while 1 (~ 6%) apply a Fuzzy Adaptive algorithm (ART) (Rane & Mishra, 2018). 5 of them (~ 18%) apply a text mining tool, and only one of them show a different Text Mining software (AIMD) in order to collect data and build up variables for a regression (Gruning, 2011), even if with the same purpose of demonstrating the advantages which could be gained with the application of AI instruments.

The remaining 10 papers show a "Qualitative" approach instead. 9 out of 10 (~ 90%) present a review concerning the topic of interest, while within the only one exhibiting a different qualitative approach (~ 10%), a survey method for collecting data and information has been conducted (Kim & Trimi, 2007).

Then, a classification looking upon industries taken into account by different studied can be stated. 4 articles out of 28 (~ 14%) propose review or empirical analysis not addressing any

specific industry , so generalizing their results, while 5 of them (~ 19%) retrieve data and insights from several industries at the same time in order to conduct their analysis. In all the other remaining papers, the authors focus their efforts on a specific industry. Sectors taken into account are very disparate, including brewing, toys, IT software, DVD, healthcare, hospitality, construction, fitness, consultancy and service industry. Each of them appears in only 1 study (~ 4%). Just 2 sectors are investigated in more than one article, being manufacturing industry (4 papers, ~ 14%) and the bank and financial industry (5 papers, ~ 19%). Finally, cluster by organizational function should be displayed, in order to anticipate the further content analysis. It is important to state that some of the articles investigate more than one organizational functions, therefore some articles are taken into account more than once with regard to this grouping. 4 papers seem to go deeper into the HR function, 5 investigate issues related to R&D, 3 talks about financial duties, other 3 highlight innovative outcomes concerning operations department, 5 treat marketing topic, 5 are related to the supply chain function, while other 12 consider the strategic management department (results shown in fig. 1).
In the following chapter the content of the article sample will be displayed following this classification.

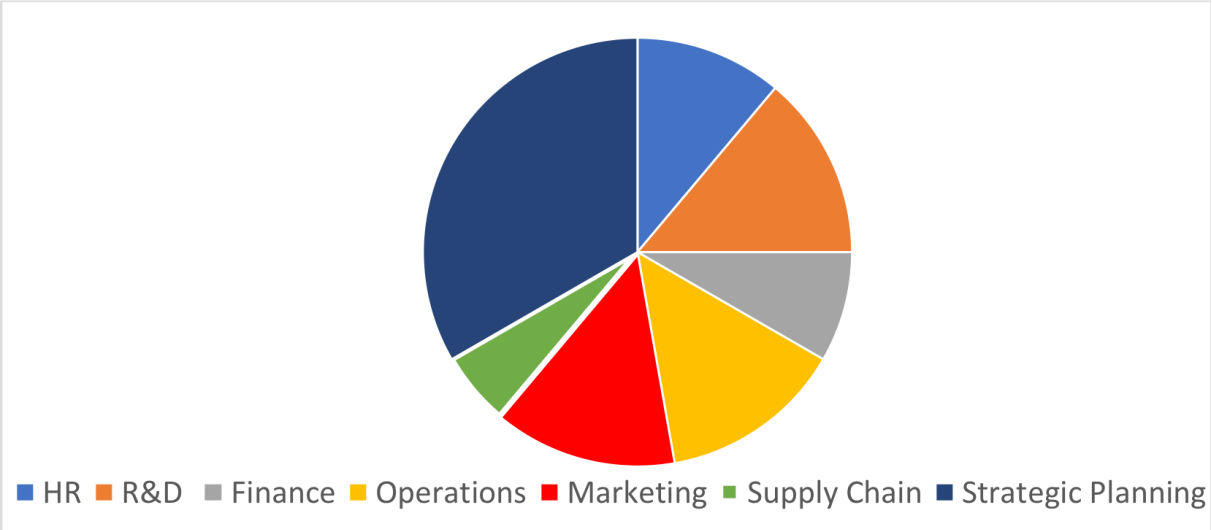

Figure 1. Organizational Department Cluster

3. Results

Since a lack of relevant studies applying a systematic literature review approach to the Artificial Intelligence (AI) topic and its impact on Innovation Management has been verified, a collection of contributions coming from different authors and research fields seems to be missing. Given that, this study tries to be one of the earliest to carry out such a task. In doing that, my aim would be not just contributing to enrich the academic field and to suggest further research paths, but also to help managers and entrepreneurs to clarify their knowledge about this topic, triggering their curiosity and allowing them to embrace different perspective when looking at their organizations.
So, with this aim in mind and in order to deal with a huge heterogeneity in scientific contribution regarding this subject, a catalogue of the 28 articles' main content and findings is proposed, splitting them up into 7 categories. These categories should mirror different departments which a typical firm is divided in. In this specific case, the categories are: HR Department, R&D Department, Financial Department, Operation Department, Marketing Department, Supply Chain Department and finally Strategic and Planning Department. Through this partition, the research's goal would be to highlight in a deeper way the different impacts that AI can have with the respect to innovation, narrowing down the discussion towards each of the listed organizational functions. Some papers tackle the AI topic from different perspective, underlining more than one aspect. This is why some of them are quoted several times across groups. Such a cluster should help the reader to better understand the different advantages and downsides of AI applications, which are the organizational departments most affected, how companies evolve because of such an introduction and the further challenges that managers and academics must face when handling these digital instruments. Summing up, this approach could facilitate the reader to draw a clear overall picture about Artificial Intelligence impact on Innovation Management.
The main sections of articles regarding that specific organizational department have been summarized, within each category, trying to grasp the most relevant implications from them.
Additionally, the content of the articles has been displayed in chronological order. This choice can be justified with the purpose of detecting potential development patterns within companies, and if they proceed simultaneously with technological improvements undergone by AI tools. Rephrasing, the final aim is to investigate how AI's enhancements affect companies' innovation management over time, and if their impacts lead to consequences regarding innovation issues within the same organizational functions or within different ones instead.
Given these premises, this research will go deeper into the main topic by analyzing the content of the articles clustered by organizational functions in the following paragraphs.

3.1 HR Department

The HR Department will be the starting point of my analysis. This organizational function's role mainly concerns personnel, and its core tasks is " to recruit and train workers and improve skills" (Jones, 2013, pp. 100).

AI's impact on this organizational function is highlighted in the first place by Mekid, Schlegel, Aspragathos & Teti (2013). They conducted a review about the innovative production machines and systems presenting automation features available at that time, most of them relying on AI tools, such as artificial neural networks, fuzzy logic, neuro-fuzzy systems and genetic algorithms. While describing advantages and challenges brought by instruments such as Intelligent Sensors, they address issues relating to Human Resources aspects, highlighting the lack of employees' skills within firms in order to exploit the whole potential of these tools. Qualified staff seems to be needed, both at strategic and operational level (Mekid et al, 2013). Moreover, the authors addresses this organizational function by stating that the complex technology which could be imposed by autonomous and inter-collaborative machineries, could demand professional experts, for managing service life and also for maintenance. But hiring people with such skills and knowledge, or training current employees is described by the researchers as an high costly process. This is the reason why it is seen as one of the major barriers for the intelligent machineries implementation by companies. But they also add that, referring to advanced physical interaction technologies, a different approach of some employees towards these machines could be requested. In some cases, these tools are able to predict the outcome of the process in different steps, so gaining higher control of it. In such a situation, the user would not be required to be high skilled or experienced. But technology understanding at top management level is still required even in this case (Mekid et al, 2013).
Another contribution involving the HR department is brought by Behera, Nayak & Das (2015). Indeed, the authors conducted an SPSS analysis, then validated with a Artificial Neural Network model, for exploiting its abilities to derive a function from observations through a "learning" process. In this way, a more reliable result can be obtained. The field investigated regarded the relationship between "IT adoption" and "IT performance". Since according to Zamutto et al (2007) Artificial Intelligence can be included in the broad IT definition, the results of this study can be extended to AI implementation as well. Among the results obtained, the authors extrapolate one insight concerning workers skills and experience. Indeed, IT adoption is positive correlated with IT performances just in case this technological tools are managed and exploited by skilled workers, combining software knowledge with specific understanding of the industry the firm is involved in (bank industry in this specific case). In this way, the firm can rely on human resources able to understand technological advancements, but also seizing market opportunities at the same time. In the authors' study, this is the reason why highly skilled workers level is positive correlated to high sales increases in a IT adoption context. Summing up, from this perspective, proper skills in relation to modern technologies can support innovation, and this insight has been obtained through the use of a specific AI application (Behera, Nayak & Das, 2015). So, the contributions of the two articles mentioned above seem to be aligned.

3.2 R&D Department

R&D Department can be defined as an organizational function dealing with "knowledge-intensive activities" (Andersson & Pedersen, 2010, pp. 1)
The first contribution which can be linked to this organizational function within the papers sample dates back to 1985 (Silverman, 1985), when studies concerning AI were at an early stage. In this academic work Artificial Intelligence is addressed as a very useful mean in order to

support the so called “inventor/engineer” during the innovation process, not just in solving “well defined problems”, but mostly with “ill-specified” ones (Silverman, 1985, pp. 151). Problems which belong to the latter category are not well known in advance, hence optimum-decision making tools cannot be useful for solving them. So, in the author’s assessment, instruments relying on emulation domains similar to human behaviors are required for solving this kind of situation. Furthermore, an explanatory example of how building up such a system is provided, highlighting its needs to be trained through data coming from organization’s real innovation processes. Questionnaires, workshops, interviews, psychological instruments and study of working reports could be all sources in order to collect useful data for training the descriptive theory and the cognitive process of these AI systems. Gathering such information could be useful to identify some “rule of thumbs”, or, using Silverman’s words, some “repetitive knowledge management tasks” (Silverman, 1985, pp. 155), which are stored and then applied by the system to support the expert during the innovation process (Silverman, 1985).

The R&D Department is taken into account by Waychal, Mohanty, Verma & Chatterjee (2011) as well. Indeed, they propose an innovation framework named PDCA, widely implemented within R&D environments of different industries, such as moulding, manufacturing and computer engineering, so testifying the relevance of this support tool for what concerns innovation. Waychal et al (2011)’s research presents the choice of an Artificial Neural Network model (ANN) in order to verify the outcome of this framework. From the results they obtained, the superiority of such instrument is described. First of all, being a self-learning tool, it can be trained by retrieving data from innovation projects’ features of different companies, adapting its structure on the basis of the information flows it receives. Moreover, it allows to verify innovative projects results in advance, so providing a better output and an higher level of reliability than any other tool or algorithm taken into consideration. In this specific case, most important levers and anti levers in order to successfully launch an innovative project are forecasted. Summing up, training time savings, higher quality output and forecasting properties are achieved with an Artificial Neural Network model applied to the innovation process (Waychal et al, 2011).

But also innovative strategies for gathering ideas and building up new knowledge are open up by AI. Indeed, as reported by Christensen, Nørskov, Frederiksen & Scholderer (2017) and Christensen, Scholderer, Hersleth, Næs, Kvaal, Mollestad, Veflen & Risvik (2018), specific text mining and machine learning software are capable of detecting innovative ideas from online communities, thus directly from the customers. In this way, technical and useful suggestions can be gained directly from the users of a company’s product. Moreover, different mindsets and perspectives are adopted by customers with the respect to R&D internal employees, hence enhancing the overall knowledge base of the firm. In summary, external sources can be involved within the firm’s innovation process, implementing a crowdsourcing policy for what concerns ideas. So, an open innovation strategy is put into action (Christensen et al, 2017; Christensen et al, 2018).

Finally, the most recent contribution regarding this organizational function is the one by Ferras Hernandez (2018), and it seems to adopt a completely different perspective with regard to the previous mentioned studies. Indeed, the author recognizes the high quality of AI’s cognitive features , but he is skeptical about the fact that this kind of technology could substitute human activity for what concerns Research and Development activities. Machines capabilities to grasp pattern from data are not considered enough in order to replace “intuition”, addressed as the most crucial quality to innovate, which is just owned by human beings. Using Ferras Hernandez’s words, “the key to scientific progress is not only to induce laws from data, but to intuit

which data could be used to induce laws not discovered yet" (Ferras Hernandez, 2018, pp. 261), and this could be achieved only through intuition. Despite this argumentation, the researcher concludes its study by stating that the development of AI towards emotional and artistic realm are undeniable, and this probably will direct human intervention to a marginal role (Ferras Hernandez, 2018).

3.3 Finance Department

Finance Department has been described as an organizational function "responsible for financial management and control as well as follow-up on business planning and strategic initiatives" (Burton, Obel & De Sanctis, 2011, pp. 65).

AI has found different applications within Financial Function following what is reported in literature. The first contribution in this regard is the one by Wood & Dasgupta (1995), who conducted a review about different AI tools existing at that time, along with their related features. The authors first of all list the different financial subfields where AI finds application, which gives an idea about the completeness of the treatment regarding this organizational aspect. Indeed, implementations can be observed in Equity Markets, ranging from companies' stock prices predictions to stock indices forecasting, and in Credit Evaluation and Bankruptcy Predictions models, claimed as one of the most successful neural network model execution, made possible thanks to the pattern recognition capabilities of AI tools. Furthermore, also Futures and Options category has been affected, and in this field as well Neural Network models have been assessed to achieve higher performances with the respect to previous static solutions. Finally, Bonds and Interest Rate Markets are taken into account, where Neural Networks find a very useful implementation in prediction of bonds volatility and interest rate related security. So the two researchers point out that AI seems to find relevant and various application in order to support and enhance financial insights, presenting its benefits compared to previous models. Additionally, they place their focus on the time costs that such a tools implementations requires, in terms of design firstly (60%), and then in terms of implementation and development (40%). It is argued that the output of such models highly depends on the quality of the inputs, in these specific cases being the past time series or past cases used in order to predict the future in financial terms. So the first step to be undertaken concerns decisions about inputs, then followed by the choice of architecture design. Finally, the implementation phase must be addressed, and since Neural Networks models owns the ability of continuously learning, a periodical support is demanded, "refreshing" the model set up. So, the whole process necessitates a lot and investments, both in terms of time and resources. But if designed and trained properly, these instruments "are capable of excellent and robust performances, specially when compared to other alternatives such as econometric operations research or statistical models" (Wood & Dasgupta, 1995, pp. 179).

In the articles sample the Financial Function is tackled by Grüning (2011) as well. A text mining tool based on Artificial Intelligence, named AIMD, has been put into action with the aim of building up variables from companies' annual corporate disclosures (the sample of firms accounting only for 600 German firms in this study), splitting up the content considering different organizational perspectives (R&D, Finance, Strategy, Marketing, Social and Environmental

Responsibility). Thanks to the construction of these variables, a statistical linear regression is then carried out, so assessing the impact of disclosures on four different capital market aspects, being share turnover, bid-ask spread, cost of capital and finally market capitalization. So, more in detail, AI here supports and encourages a different and deeper look at corporate disclosures, extracting form the written content different variables, thanks to Text Mining capabilities of AIMD. The construction of the variables for the subsequent statistical linear regression eases to display in a more direct and clear way the linkages between the variables themselves and the different financial aspects scrutinized, and this text analysis has been made possible without any human intervention. This last feature substantially differs this technology with the respect to the older ones, which, just provided assistance to human manual coding process, missing autonomy (Grüning, 2011). Moreover, proceeding independently, with no need for human external supervision, benefits are generated also from a cost perspective. As anticipated above, AIMD is able to perform complex semantical units analysis, considering the grammatic structure of sentences as well. So, input data for training this intelligent tool can be retrieved from a huge variety of disclosure sources, such as annual or quarterly reports, analyst meetings, press news, corporate web pages or conference calls. This enlarge the "training base" of this text mining instrument, so raising probabilities of a more reliable output. The final goal of this variables creation is to understand the kind of relationship they have with the different financial aspects taken into consideration, so suggesting managers the right way to handle firm's disclosures in order to reach the desired financial results. For instance, accordingly to results obtained through this study, an increase in information disclosure is positive correlated to an increase in share turnover. Given that, managers could decide which additional news should be made public in order to reduce information asymmetry among investors, thus incrementing share turnover. Otherwise, cost of capital has been found to be negative related to information disclosure, since a larger amount of news available reduce uncertainty, and so the premium price investors ask for risk decreases (Grüning, 2011).

An additional Artificial Neural Network instrument has been put into practice by Behera et al (2015). In this study, the authors implement this tool in order to verify results obtained through a statistical regression, which included information given by branch managers operating within the Indian bank industry. In this specific case, such an intelligent software has been exploited because of its capabilities to infer arbitrary mathematical functions from observed data. This innovative feature becomes useful in particular when managers face very complex patterns of data, and then they are supposed to deduce some valuable conclusions from their interpretation. This kind of task was not easy to be performed with previous linear statistical regressions, and so the introduction of Neural Network models has led to innovative outcomes, which can be considered higher for what concerns both quality and reliability. The content of this study's investigation regards the type of relationship between IT introduction and IT performance within the Indian bank industry and so, finance as a subject is taken into account and hence the results obtained are strictly related to this specific function. As stated just above, thanks to AI implementation, managers gain benefits from an easier data handling, not only implying cost and time savings as well, but also "more performing" outcomes and results, which can boost changes towards innovative financial practices within a firm. Here, from the branch managers' answers collected through a survey, a positive relationship between IT introduction and firm performances has been confirmed. Indeed, either turnover and market share are increased by IT implementation in financial services, which seems to be crucial for achieving these goals. So wrapping up, a useful relationship for a managerial point of view has been

assured by Artificial Neural Network, clearly showing right paths to be undertaken in order to better perform in financial innovation (Behera et al, 2015).

3.4 Operations Department

In order to define Operations Department, a Slack, Chambers & Johnston (2010)'s work can be retrieved. Indeed, these authors state that it can be considered as the function which "it is central to the organization because it produces product and services, which are the reason for its existing" (Slack et al, 2010, pp. 4).
Recent and relevant application of Artificial Intelligence affecting the Operations Function within firms can be found out in literature as well. The first contribution presented in chronological order within my sample of articles is the one by Roberts (1998). Through this review, different intelligent mechatronic systems applications are taken into account, and, among them, automated manufacturing systems implemented within factories are listed. The author describes as essential the application of this innovative technology in such an important function, since, using his own words, "it is in this environment that intelligent applications are most widespread and are especially important since manufacturing is a primary generator of social and economic wealth and is one of the principal means of raising standards of living" (Roberts, 1998, pp. 6). The innovative contributions that AI brought towards this organizational field are very diverse, such as the tools implemented. Fuzzy Logic and Artificial Neural Networks allow for a better and more reliable machines and for monitoring the assembly of devices and material handling. Moreover, exploiting also intelligent sensor placed in strategic positions in order to collect a huge amount of data, Artificial Neural Networks, combined with Genetic Algorithms, give the opportunity to go through these data and to carry out more efficient scheduling on production and inventory control, improving fault forecasts, and overall trend analysis, useful for management information system and for planning the overall production process as well (Roberts, 1998).
A similar trend has been emphasized more than a decade later by Mekid et al (2007) as well, but going more in detail into the subject. Indeed the authors conducted a review with the aim to shed a light on imminent and future innovations provided by intelligent production machines and systems, with a special focus on automation and control aspects. A production model composed by inhomogeneous elements is presented, where self reconfiguration and intelligence distribution among the elements are its core features. Every agent is then strictly connected to the others, building up a stochastic environment. In other words, an Autonomous Factory can be shaped, so enhancing control of communication channels and improving safety as well. This implementation can be regarded as an incremental step-forward with the respect to the common production system standards at that time, most of them relying on single agents systems. But it is not enough. Indeed, the introduction of Agent Control Systems demand for product or services innovation as well, with the aim to fully exploit their potentiality. Moreover, AI can find execution in relationship to Intelligent Sensors. Relying on intelligent computation techniques such as Artificial Neural Networks, Fuzzy Logic, Neuro Fuzzy Systems and Genetic Algorithms, these devices are capable to conduct self-diagnostic and self-calibration, to signal certain conditions, but also, to take decisions autonomously. Moreover, being a crucial source

of data collection, multiple intelligent sensors of different nature can be merged in order to combine their information, the so called “sensor fusion” (Mekid et al, 2007, pp. 39), so boosting decision-making. A synergic integration is created in this way. Additionally, AI placed inside these tools become useful to “grasp” and interpret “ambiguous or noisy sensor signals” (Mekid et al, 2007, pp. 39), namely inputs which require complex knowledge to be handled. Also, Intelligent Sensors affect processes control. Indeed, continuous feedback is provided, and, an immediate identification of fractures enhances the overall system reliability. More specifically, real time process monitoring allows for an immediate look at different parameters, making an eventual intervention more effective. Tools and machines condition monitoring, along with work material-state monitoring, are essential in order to integrate different instruments and process phases, thus building up a fully automatic system, able to look after itself. In order to facilitate the typologies of communication and information flows just listed, a more intuitive interface is needed.

STR, an acronym standing for “Self diagnosis, Tuning and Repairs”, is also reported as one of the leading technologies which will influence the whole European Manufacturing Sectors in the future. Instruments belonging to this wide category are various. Smart machines firstly, enabled by AI for maintenance and operator proactive assistance purposes mainly, being able to detect errors and autonomously learning from them, so deriving conclusions for further process improvements. Then, Adaptive Machines are mentioned, which, empowered by intelligent sensors, show capabilities to autonomously adapt to the variable conditions of the external environment. Abilities to track the external context, following previously set up parameters, allow these devices to change “behaviors” depending on the conditions. Autonomous Machines is used as a definition that encompasses the two categories already reported. These tools, equipped with intelligent monitoring, diagnosis control and failure prediction software, are a primary source of information about process state, from which they are able to adequately identify and diagnose breakdowns, taking care of them autonomously later on. So, it should be assumed that AI and its related instruments produce benefits for firms, allowing for various innovation introduction at operations lelvel. But, as the authors state, some barriers hamper their implementation, being “the low penetration of open controls in the manufacturing sector and the reluctance of some control manufacturers to allow access to their hardware and software” (Mekid et al, 2007, pp. 41). Moreover, there is a lack of trust about the artificial rationality for autonomous decisions, along with reluctance towards human intervention reduction, replaced by machines. Additionally, implementation of these intelligent type of systems seems to be quite expensive, so representing a huge financial constraint for many organizations. But the route to be followed in order to maintain competitiveness within the future business environment consists principally in generating and enhancing algorithms and technologies for pattern recognition and decision making, also enabling remote control and management, with the aim of getting better “model based/rule based/case based diagnosis” (Mekid et al, 2007, pp. 41).

Complex structures and algorithms as a mean to bring innovative outcome in terms of Human Machine Interaction are cited in Mekid et al (2007)’s study as well. These kind of solutions provide the possibility to insert inputs and give commands through speech or gestures, overcoming long and strenuous machine training time realized by the operator. Besides, object recognition and scene analysis are other innovative process features which can be implemented thanks to AI. A sequence of functions can be programmed after the identification of the specific input by the machine (object or situation), so obtaining a specific reaction to that along the whole process, making it autonomous. Other intelligent input devices are claimed as

able to track the interaction between humans and machines through all the process steps, controlling it and relying on more and better knowledge than an operator could do, without be high skilled or experienced. In other terms, an innovative and better output should be achieved in an autonomous way. Again, managers must face some issues for implementing them. First of all the high cost of such instruments. Furthermore, a general reluctance within firms to transfer own data through technology, because of safety reasons. In addition, the understanding of this kind of technology is not easy, requiring appropriate education and training. Finally, the last field of AI implementation affecting manufacturing processes presented in this study concerns Reconfigurable Manufacturing Control. This type of machines is considered to be the evolution of FMS (Flexible Manufacturing Systems). One of its core features regards the distributed intelligence among different units. Indeed, each of them should be able to determine its own individual role within a larger architecture, but also recognizing other units and communicating with them. Thanks to this structure, a higher degree of control is reached, capitalizing a widespread intelligent net, which enhance scalability. Moreover, exploiting reconfigurability features, machines and robots are now capable of dealing with uncertainty and turbulent environments. Being part of a broader system redefine roles, tasks and responsibilities, all of that leading to further innovation under different perspectives. A support role can be played by intelligent simulators, basically relying on AI softwares, which can provide forecasts about possible configuration of the systems' topology. Moreover, they supply radical new visualization techniques, which empower the end user to virtually simulate different final output. Again, complexity and high cost of technology are considered the main barriers.

Summing everything up, this huge list of machines and systems equipped with AI tools, clearly show the innovative outcomes that such technology could lead to in Operations duties, with consequent improvements under many perspectives, form costs to reliability, from safety to control or from data collection and use to changes in tasks, products and communications channels. But not just advancements are showed. Indeed, challenges faced by managers are described, with the purpose of drawing clear paths to exploit these technologies effectively (Mekid et al, 2007).

An additional and more recent contribution is provided by Wirtz, Patterson, Kunz, Gruber, Lu, Paluch & Martins, (2018). The authors chose a review as a methodology in order to present various innovations brought by robots in service industry, most of them affecting operations, in particular for what concerns frontline tasks, across several industries. More specifically, many of the new capabilities and characteristics embraced by these machines have been made real thanks to the AI and big data analytics. Defined as "system-based autonomous and adaptable interfaces that interact, communicate and deliver service to an organization's customers" (Wirtz et al, 2018, pp. 909), service robots seem to be able to carry out autonomous decision making, retrieving information from sensors and other sources as well, also adapting to the external context conditions, exploiting gathered data and, consequently, learning from former circumstances. Furthermore, it seems these robots could manage a so called "Automated Social Presence" (ASP) through their intelligent programming, behaving similarly to a human being and thus making customers feel like they are facing a real person. Different robots typologies are listed by the authors, even including among them AI software, due to their capacity of learning over time and without a continuous human intervention. So, placing machines instead of people in order to perform services can be considered an innovation already. This choice can be explained by listing all the positive implications the firm can gain from that. First of all, robots learn in a different way compared to humans. Indeed, while a real person take a long training time to get a deep understanding of the service in order to deliver proper results to the

organization, robots enabled with these intelligent algorithms and software can learn instantaneously. Moreover, service robots can be trained by updating codified knowledge and pattern recognition, by means of which the intelligent software can compare a substantial number of scenarios, being able to find out relationships between a cause of action and a given optimal result. In addition, these typology of devices implements a machine learning approach, exploiting computing power to detect optimal solutions from a very huge range of possible events, coming to conclusion through a structured and systematic trial and error method. Time and costs savings, along with a superior degree of reliability can be achieved in this way. More than that, robots do not vary their behaviors across time and depending on the unit in action, as human beings do. So, higher performances in terms of reliability could also be gained. Then, thanks to the chance to enable them with CSR software (Customer Relationship Management), such service machines can be programmed with the purpose of identifying the customer they are facing, hence delivering a highly customized output. Another advantage that companies could benefit from front line service robots introduction is correlated to economies of scale and costs. Indeed, the strategy of replacing employees with robots is supported by the lower overall costs of these technologies. Indeed, most of the expenditures are linked to their programming and training, presenting low or null further costs (this is the case of virtual robots specifically). Given these features, economies of scale are reachable, something that is not possible hiring more human beings. Despite what described so far, following the authors' opinion, such robots could be better performing only in a certain type of services, labelled as "Subordinary Service Role" (SSR) (Wirtz, 2018, pp. 911), while human presence can still play a major role in "Professional Service Role" (PSR) (Wirtz, 2018 pp. 911), where emotional and social capabilities are of primary relevance.. Looking at this topic from a macro level perspective, the researchers assert another time the relevance of robots' impact on the overall society. Indeed, firms can save resource due to lower costs and exploit economies of scale, as reported above, and so, strictly linked to that, availability and the delivery of scarce services now performed by robots can be increased dramatically, affecting many fields, such as education, health care, public transportation, thus boosting social welfare consequently. AI instruments applied to service robots ensure the possibility to let them take care of customers because of their capabilities of reacting to text and voice inputs as well. Text based services such as chatbots or voice based service including the most recent ones like Alexa or Siri can be reported as a clear example of that, which allow automatization and standardization of tasks performed only by human beings so far. Robots will outperform people in solving cognitive and analytical tasks requiring of an high complexity level, and Wirtz et al (2018) develop this concept through their study. Describing four different kind of analytical intelligence, they confirm the future, and in some cases also current, superiority of intelligent machines in delivering services compared to humans. Robots seem to be better than humans in carrying out repeated tasks and routines (mechanical intelligence), in data processing and machine learning for solving complex operations, but still predictable and systematic (analytical intelligence, also named "weak AI") and also in processing complex information, in unusual situations as well (intuitive intelligence, also called "strong AI"). But in order to effectively deliver a front line service, emotional and social qualities is assumed to be demanded in addition. With this regard, machines should be able to read, understand and respond to human beings' feelings and emotions, manifesting the so called "empathetic intelligence". But, following Wirtz et al (2018)'s thought, this type of technology is not that much developed yet. For this reason, it is widely supposed in literature that during the next few years, intelligent robots will dominate the service categories just requiring the first three typologies of intelligence listed above, while there will be still room for human

action for what concerns services requiring an higher degree of emotional and social competences. A good relationship built up between the customer and the service provider is essential where social closeness and affiliation strongly affect the service output, such as for high risk financial services. Trust generation is thus needed in order to make the customer feel comfortable.
So, tasks demanding a substantial cognitive effort will ask for people to get them fulfilled, with machines acting just support mean, so merging the emotional and empathetic sphere with analytic and cognitive skills, each emphasizing their qualities. Furthermore, customers seem to better forgive a human provider than a machine. So, artificial and human presence must be balanced carefully by executives. And with this purpose in mind, the authors present a list of service categories and the related optimal mix of human and artificial presence in order to best exploit advantages coming from both sides, so matching customer's requirements in each category. In services characterized by either simple cognitive and emotional tasks, as buying a train ticket or booking a courier pick up for instance, customers do not show high emotional involvement, just demanding for convenience, reliability and speed of the core service. Given these features, robots will probably play a dominant role within this field of application. The same conclusion can be deduced for what concerns services requiring complex analytical tasks but still simple emotional and social ones. In this case again, front office tasks have not a substantial impact on customers' service evaluation, who strongly judge back office tasks instead, asking for a reliable and convenient core service. Insurance and stockbroking belong to this typology, all of them requiring a low level of social interaction. Different remarks can be associated to services such as tourism, entertainment and sports, which rely more on an experience delivery through multiple touchpoints than on problem solving. Authentic experience, social interaction and shared emotions are among customers' main goals in these cases. Consequently, human capabilities seem to fit them more with the respect to AI-based machines. Finally, the last category presented in this review encompasses services characterized by complex analytical and cognitive tasks along with complex emotional and societal ones, high level education and healthcare among them. Due to high emotional features required, the human component seems to be crucial for delivering this kind of services, because of what described earlier. Robots do not own a suitable level of social intelligence and of communication skills in order to handle the service effectively. But at the same time, tasks appear complicated to be performed without AI support, due to the complexity of the core service delivery (Wirtz et al, 2018). Hence, a balanced collaboration between human beings and intelligent robots seems to be the best option in this case (Wirtz et al, 2018). Concluding, it can be said that intelligent robots could bring innovation within service operations from a very wide range of perspectives, with many collateral effects worthy to be taken into consideration (Wirtz et al, 2018).

3.5 Marketing Department

Innovation at different levels coming from AI tools and instruments can be found within Marketing Function as well. All the contributions retrieved with the respect to this organizational area seem to be quite young, so reflecting the current relevance that both practitioners and business theorists are placing on such a department, which is considered to play a crucial role

in understanding customers preferences and habits, at the same time acting as a channel to communicate with them, so nurturing a closer relationship.
First of all, Marketing Department can be depicted as the function in charge to " facilitate an organizations' control of its relations with its environment and its stakeholder"
and "handle the disposal of outputs" (Jones, 2013, pp. 99).
The older article included in my sample threating the AI application for marketing purposes is the one by Parry, Cao & Song (2011), in which different typologies of Neural Network algorithms have been implemented with the aim of forecasting a new product adoption, since it has been estimated that these analysis tools are capable to outperform previous broadly accepted forecasting methods, such as linear regression, binomial logit models and discriminant analysis as well. Furthermore, these instruments, set up with such intelligent software, seem to be better in finding out relationship between dependent and independent variables than simple logit models. Indeed, they own the capabilities to carry out a more complicated level of analysis, by including in the relationship between variables the impact of some external factors, such as the potential effect of network externalities on consumers' perception about innovation attributes. For instance, innovation's installed base size can affect customers' adoption decision, or, potential adopters' interactions with existing user can have an influence as well. Hence, being Neural Network algorithms characterized by an higher level of flexibility, they can provide significant improvements in terms of forecast accuracy. The Neural Network algorithms have been trained with customer's answers collected by mean of survey. So, useful data in order to forecast new product adoption through this modern technology are gathered directly from the market, screening consumers' preferences, and that is the reason why this study links AI applications to marketing issues. Moreover, through these instruments, market analysis can be realized, tracking consumers' behaviors, thus influencing the overall strategy if the firm. Going more in detail, three different Neural Network algorithms have been put into action in this study, being feed-forward neural network estimated with a backward propagation (NNPB), a feed-forwards neural network estimated with a generic algorithm (NNGA) and finally a Probabilistic Neural Network (PNN). Analysis have been based on only three economic variables, being price, innovation's installed base and availability of complementary products. Probabilistic Neural Network has been discovered to be the most performing of the intelligent algorithms listed above, confirming results obtained by other methods with an higher level of accuracy. Then, other positive and innovative consequence can be stated. Indeed, it has been demonstrated that PNN algorithms outperforms linear and other neural network models, even with a smaller base of data collected from the market (Parry et al, 2011).
Another contribution affecting marketing function is the one by Christensen et al, 2017). In this study the online communities field has been investigated, Lego' s fans and customers community (LUGNET) specifically, with the purpose of detecting innovative ideas from the crowd to be integrated within different organizational projects. Such a tasks is made possible thanks to the implementation of particular algorithms built up through text mining and machine learning techniques, which are part of the variegated set of AI instruments. Indeed, the idea of trying to extract useful and innovative ideas directly from costumers and users exploiting the brand community channel, namely a very common marketing channel, is not that newish, but two main issues are solved by the introduction of the two intelligent instruments just listed. The excessive amount of information collected within communities is the first challenge to be solved, since the majority of which does not express any relevant content with the respect to firm's needs, while the second one regards the complexity to automatically analyze this content, which is typed down in a unstructured form, thus requiring a lot of pre-processing work

before being analyzed statistically. Traditionally, the latter problem has been faced by manually coding unstructured text into structured data. But such an operation reveals itself to be quite expensive either in terms of time and costs, due to the huge amount of messages generated by the community that physical people should revise. However, exploiting the machine learning and text mining tools' support, it is possible to dramatically reduce both time and costs regarding these duties. Indeed, in this study an application of that has been practiced on Lego's online community, and it has been demonstrated how these algorithms are effective in detecting ideas, but also in marking and clustering texts in which they are incorporated. This process let managers and researchers avoid the pre-screening step. It has also been proved that such intelligent instruments provide a very satisfactory level of accuracy, since they have been able to identify 720 ideas text out of 1000, with a precision value of 0.91. In other terms, from a sample of 1000 ideas texts gathered from an online community, these AI software are able to recognize 910 texts containing true ideas and 90 not containing true ones. Given these figures, in order to get 100 innovative ideas, it is expected that the screening of 110 texts should be required. Resuming the argumentations proposed so far, it can be said that text mining and machine learning algorithms open up the opportunity to recognize if abstract entities (unstructured texts in this case) contain ideas or not, following a completely automatic process, not requiring humans' supervision and exploiting relationships with customers, built over time by means of marketing communication channels (Christensen et al, 2017).

The implementation of an AI software for internalizing innovative ideas from external sources has been utilized by Hoornaert, Ballings, Malthouse & Van den Poel (2017) as well. In line with latter contribution mentioned, crowdsourcing community is exploited for getting new sparks to be included within the New Product Development process, being the Mendeley community (software industry) in this case, a channel built up by the company in order to get feedback and suggestions regarding improvements of the service to be developed and included in further versions. Text mining's usefulness in order to organize the unstructured form of text in online communities and to ease the assessment process of ideas' quality is cited in this work as well. However, the focus of this study is different. Indeed, the impact of other AI applications have been tested, being two non linear machine learning algorithms (Stochastic Adaptive Boosting and Random Forests) in this specific situation. Thanks to this typology of analysis methods, Hoornaert et al (2017) could have gone further in the investigation of new idea effectiveness from online communities by assessing the impact of three variables, being content, contributor history and crowd feedback, on ideas' future implementation probability. Their results show that Stochastic Adaptive Boosting and Random Forests algorithms seem to outperform linear models implemented, since they are able to capture non linear interactions which are not taken into account by the latter methods, so underlining a first improvement brought by AI. Even if linear and non linear algorithms show similar outcomes when only "idea content" and "contributor history" are taken into account as variables, this is not true anymore when "crowd feedback" is included within the analysis. This is due to the fact that the first two variables provide instantaneous information, while "crowd feedback" generates useful data over time, so becoming available at a later stage. Thus, classical linear models do not seem to be appropriate in order to handle even the third variable, a task which is carried out by non linear ones instead, which are able to codify more complex structures of data. Moreover, other important findings from this contribution concerns how to effectively handle the information collected from customers for innovative purposes. Through the use of these intelligent instruments it has been found out that all the three variables have a positive impact on idea prediction performances, but "crowd feedback" is the variable which seem to have the heaviest effect.

By including just “idea content” and “innovator history” predictive performance improves up to 26%, while extending the model with “crowd feedback” the predictive performance is almost doubled, even reaching improvements of 48.1 %. So, roughly speaking, it has been extrapolated that the best option would be waiting for crowd’s opinion before starting to work on a new project. But it takes a while, since feedback from the community are built over time. So, given that the other two variables provide satisfactory predictive performance along with instantaneous data availability, they should be taken into consideration as well

Christensen et al (2018) treat the same topic one year later, following the works mentioned previously. Here a machine learning instrument has been adopted in order to detect ideas from an online community (brewing industry in this case). Its output has been compared with ratings from professionals coming from a Norvwegian brewery company, who has been asked to select texts containing ideas within the same online community. The results coming from the machine and form the human raters matched in about 75% of cases, hence highlighting the effectiveness of such an intelligent tool in screening texts potentially containing useful innovative ideas for firms. Consequently, time and effort in terms of human beings employed in handling those kind of data decrease dramatically with the respect to manual screening, thus facilitating the company’s openness to external sources of innovation, enhancing its innovation odds. So, results already disclosed in Christiensen et al (2017)’s antecedent research have been confirmed.

But in this study the authors go deeper in understanding text mining and machine learning potentialities. Indeed, they set also the goal to assess the quality level of ideas retrieved through AI software, comparing machines’ output with company professionals’ opinion, basing on four specific attributes, being novelty, workability, relevance and specificity. Ideas collected by means of intelligent programs seemed to score a medium grade for what concerns value and the overall idea quality, while a lower value of novelty than human examination has been attained. Hence, idea detected automatically show a lower degree of novelty but higher feasibility, that is a result which agrees with previous contributions in literature. So, AI usefulness with regard to new ideas detection from online communities has been confirmed by this study, in line with the previous ones reported previously. Therefore, online communication channels can be exploited differently for innovation purposes with regard to innovation (Christensen et al, 2018).

Another study linked to Marketing Department but which presents both different core topic and application of AI is the one elaborated by Al-Salem & Mostafa (2019). The authors apply a particular research instrument, named Self Organizing Maps (SOMs), a neural network tool trained with an unsupervised algorithm, which provide a huge support to marketing employees in “exploring and visualizing complex patterns in high dimensional data” (Al-Salem & Mostafa, 2019, pp. 146). In other words, it can be framed as a flexible clustering technique, helpful to organize data in different groups, operating beyond the rigid traditional and linear statistical assumptions. Thus, this kind of intelligent tool seems to outperform previous clustering approaches. Al-Salem and Mostafa (2019) exploit its functionalities in order to draw different segments within financial services industry in Kuwait, with the final purpose of understanding their needs and desires, consequently adapting strategy and even directing service innovation paths accordingly. For carrying out such an analysis and training the algorithm, data about attitudes of Kuwait’s population have been collected by mean of questionnaire. From SOMs’ output it is possible to visualize the variety of features and cultural issues valuable for the sample of people chosen, so offering to managers the opportunity to better and deeper understand customers, raising chances to take actions aimed at satisfying them. In this case, SOMs

application underlines that among Kuwaitis two opposite mindsets prevail with regard to financial services. One composed by people looking for highly innovative and internationalized financial services, and the other one characterized by consumers more stuck to traditional offers. So executives can decide the right route to be undertaken, relying on the information gained from this more powerful and reliable automatic segmentation tool. And this for sure will boost the creation of more innovative and customized financial services (Al-Salem & Mostafa, 2019).

3.6 Supply Chain Department

From the articles I retrieved, it is evidenced how AI could have an impact on the Supply Chain Function as well. It is defined as “the business area responsible.. from procurement and production to shipping and distribution to the retail trade” (Burton et al, 2011, pp. 65).
The first study is the one by Albino & Garavelli (1998), who clearly describe the training and application phase of a back propagation neural network, with the purpose of enhancing subcontractor rating in large construction industry. Indeed, in such a sector, more than 50% of incomes are gained by subcontracting, so decisions regarding partners and collaborators become crucial. This paper sheds a light in particular on the innovative and easier process which this intelligent tool require in order to be trained and generate the desired information. Due to the fact it provides the opportunity to be instructed through real examples, it does not demand the construction of rigid mathematical rules or other formal mechanisms, thus making the training process smoother and less costly. Moreover, decision-makers can upload different data typology more freely, without any constraints forced by formulas or other tool’s requirements, and this is a really innovative outcome for subcontracting rating instruments. It should be evident that, inclusion of additional data and variables leads to a better and more reliable evaluation. (Albino & Garavelli, 1998).
Additional research focused on Supply Chain Management topic is conducted by Ghorbani, Arabzad & Tavakkoli-Moghaddam (2014). In their study the authors explore the potentialities of a specific tool enabled with AI features in order to evaluate quality of some distributors operating in a particular manufacturing industry. Such a task is considered crucial for a firm’s success when expanding globally through exports, since collaborations with local partners aimed at best serving foreign markets are seen as the most effective channel. So, the relevance of such a choice becomes essential for a company’s overall business’ competitiveness. The intelligent instruments implemented is the “fuzzy adaptive resonance theory (ART) algorithm” (Ghorbani et al, 2014, pp. 159), which can be described as an unsupervised learning algorithm, which is capable of clustering arbitrary data into groups showing similar characteristics. This modern intelligent software can be regarded as an evolution of the previous methods utilized for this kind of analysis, simply called ART. Fuzzy ART, relying on a more powerful software learning base, allows for introducing non binary variables in addition to binary ones, hence enlarging its training data foundation. More complex and explanatory information can be integrated, subsequently allowing for a deeper and more detailed distributors’ clustering and evaluation, thus being in line with the latter work presented (Albino & Garavelli, 1998).It seems evident how, thanks to these intelligent program, distributors are categorized by different attributes and then ranked, highlighting the best options. Results achieved by the authors

clearly outperform the ones obtained with previous software. So, this tool's innovative improvement is proved here, since evaluations can be executed at an higher quality and reliability level compared to the past (Ghorbani et al, 2014). Wrapping up, despite no so much effort seems to have been spent on Supply Chain field in research, these few contributions testify that AI can bring innovative results in this organizational function as well.

3.7 Strategic Planning Department

The last function taken into consideration by the articles composing my sample is the Strategic Management Department. It can be outlined as the function which "facilitate the control and coordination of activities within and among departments" and also try to "improve the organization's ability to create value" (Jones, 2013, pp. 100). It is also responsible for the strategy formulation (Jones, 2013).
The first contribution in chronological order is the one provided by Wiig (1999), who forecasts further developments concerning Knowledge Management in firms. Among different aspects, he sheds a light on the AI' s role, which, through the applications of various intelligent agents, such as natural language understanding (NLU) and processing (NLP), reasoning strategies or knowledge representations, can become a very relevant mean in supporting knowledge handling. And this will probably be due to the provision of enhanced capabilities regarding knowledge organization and of instruments that ease knowledge application to very crucial situations. Indeed, automation of specific processes can strongly support employees on making sense of the situation, boosting their capabilities and creativity in order to find new solutions. Furthermore, peculiar intelligent devices could help executives in easily collecting and clustering different kind of data, also from external sources, with the purpose of detecting the status of workers and processes as well, within and outside plant. Thus, the working environment arrangement can also be affected by AI. Changes in knowledge organization, in the type of data available and even in working environment, due to the introduction of intelligent instruments, could act as a mean for triggering the Intellectual Capital (IC) of a company, which is regarded as one of the key features in order to innovate and consequently for launching new products and services. Thus, decision at a strategic level about how to exploit these opportunities across the whole firm should be carefully taken (Wiig, 1999).
Moutinho & Phillips (2002)'s study links strategic implications with AI tools as well. Here, a Neural Network analysis has been carried out in order to gather informative data about some planning choices to be made within the financial industry. This specific Back Propagation algorithm has been chosen because of its outstanding prediction performances with the respect to classical linear regression analysis, in particular when unstructured or semi-unstructured inputs must be investigated. Indeed, thanks to this capability of handling non linear data, it was possible to train the algorithm through managers' not structured answers to questions presented within the survey, and this enhanced the potentialities of inputs implemented, thus leading to more informative output . For instance, from the analysis carried out by the neural network algorithm, important insights have been collected related to innovation handling, coming directly from the executives involved in daily business practice. It seems that firms in bank industry must innovate setting customer's necessities satisfaction as their most important goal, tailoring services accordingly. A formal planning seems to be suggested, with the final purpose

of tracking and quickly reacting to environment's fluctuations. So, the innovation strategy should be "market-oriented" (Moutinho & Phillips, 2002, pp. 108). Furthermore, from the intelligent software's analysis it emerged that a long-term perspective adopted in innovation strategy could enhance firm's business performances, and the introduction of the latest technologies could be a feasible way in order to reach that. Wrapping everything up, in this study as well has been demonstrated how AI tools could have an impact on innovation management at a strategic level (Moutinho & Philipps, 2002).

Kim & Trimi (2007) emphasize the role that AI has on boosting Knowledge Management effectiveness, therefore following a research path concerning a strategic view of the whole organization, opened previously by Wiig (1999). In this research AI has been classified as one of the four most important IT tools for supporting four different Knowledge Management models, and, more specifically, data mining, intelligent agents and neural networks have been resulted as the peculiar instruments with the higher impact. But the main important finding of this study concerns the fact that AI software will outperform other IT tools in supporting the "Innovator model" (Kim & Trimi, 2007, pp. 153), which is aimed at boosting the generation of "new knowledge through creative thinking and interchange of ideas internally or with collaborating partners" (Kim & Trimi, 2007, pp. 153). This is due to the fact that AI provides the chance to manage and work with a huge variety of unique and unstructured data, being customers' problems and needs in this specific case, hence providing adequate support for delivering highly customized and innovative services solutions. Cooperation between employees and such intelligent tools can also guarantee an adequate flow of information in order to enhance innovative outcomes, so a previous strategic organizational arrangement with the purpose to fully exploit these capabilities seems to be required (Kim & Trimi, 2007).

Lee, Leong, Hew, & Ooi (2013)'s work also focuses on Knowledge Management, thus on strategic choices which must be taken by a firm. Here, a "feed-forward back-propagation algorithm" (Lee, et al 2013, pp. 861) has been exploited in order to investigate the relationship between Knowledge Management and Innovation. This kind of software has been chosen because of its peculiarity of "learning" by both linear and non linear input, thus providing better results. Therefore, with the use of such an instrument, the authors have been able to collect very useful insights concerning innovation management. Indeed, it seems that firm's innovative performances are linked with knowledge sharing including external partners, with knowledge storage as well, which affect transmission of information within a company, and innovative capabilities of employees consequently. Moreover, knowledge application in order to create an innovative mindset among employees appears as a crucial aspect to be taken into account. Concluding, the investigation of the Knowledge Management topic, which has an influence across many organizational functions, has been carried out through the AI's support, and, thanks to that, more informative and reliable insights for both practitioners and researchers are gained. From a strategic perspective, this tool shed a light on where to invest more resources in order to be continuously innovative (Lee et al, 2013).

A different field of application has been showed by Costantino, Di Gravio & Nonino (2015). AI takes the shape of an Artificial Neural Network (ANN), a non-linear and non-parametric algorithm which has demonstrated superior performance, also with the respect to other AI tools, in "answering correctly… to inputs not previously encoded, handling the uncertain, unpredictable and noisy external environment" (Costantino et al, 2015, pp. 1748). This model has been implemented in order to forecast success probabilities of different innovative projects which a company would be willing to undertake. Deeper explaining what just quoted, an Artificial Neural Network could be trained also through real examples, firm's disclosures and documents, and

even business cases. Thanks to these peculiar features, such an intelligent program is able to "catch and share the knowledge of the experts" (Costantino et al, 2015, pp. 1749), thus reproducing their thinking abilities, grasping also implicit knowledge from the experiences explained within documents and cases, and from that, developing effective conclusions and forecasts. In other words, it can substitute the executive's strategic thinking. In this specific research, the neural network was trained by using different type of data. Indeed, both survey directed to managers concerning projects' Critical Success Factors (CSF) and documents deeply analyzing projects' content have been retrieved, while experts' judgments have been useful in order to train the algorithm. After running the analysis, managers got an evaluation of all the different projects taken into account based on the CSF they choose, hence having the opportunity to easily assess the degree of risk related to every project before deciding to allocate resources upon it (Costantino et al, 2015).

AI used for generating predictions are also described by Claveria, Monte & Torra (2015). Here, three different typologies of neural networks have been exploited, with the purpose of gathering forecasts about tourism demand for a specific set of countries. But the peculiarity here regards the fact that, such tools allow to account for cross-correlations among foreign visitors markets to a specific destination, thus having the chance to "simultaneously obtain forecasts for all countries, without having to estimate the models for each market" (Claveria et al, 2015, pp. 1522). Thanks to these new intelligent software' capabilities, customers' demand can be assessed in advance, therefore anticipating trends. With this useful knowledge available, managers should be able to adapt their offer in the hospitality industry, raising the probabilities to meet clients' needs. So, neural networks tools provide a mean for tracking the market, and in this way it support the innovation process, in terms of services in this specific case. Indeed, executives will try to do their best to follow customer's request, regarded as the "most basic force driving the industry's development" (Claveria et al, 2015, pp. 1534). Then, it can be said that the innovation path is channelized in a way starting from the top strategic level, relying on very robust and reliable forecasting analysis, which would lead to decisions that will affect the entire company.

An Artificial Neural Network (ANN) has been applied by Brophey, Baregheh, Hemsworth, Wachowiak, Hay & Ben Dhaou, (2015) as well. Here again, such a tool has been chosen because of its outperforming features with the respect to linear model of analysis, in particular for its capabilities to extract patterns and detect trends from complex and non-saturated datasets (a survey on past innovation managers' experiences in this case), very useful for supporting managers in decision making processes. In this research this instrument has been implemented in combination with a "Risk Action Success framework" (R/A/S), in order to identify patterns and linkages among the three variables included in the model, especially because of the non linearity of their interactions. Furthermore, the Neural Network allows for carrying out analysis at multiple layers of important variables, such as stages of innovation, risk severity and risk categories, hence providing a more informative output to innovation managers, about how risk is perceived for every specific action undertaken, along with the associated success rate. So, such a tool become very useful for strategic planning purposes. Indeed, by detecting relationships between risk, actions and success rate, executives can forecast different scenarios, establishing a fixed level of risk and then evaluating the possible actions to be executed in order to be successful in a certain innovative process for instance. Furthermore, Artificial Neural Network takes into account a dynamic set of data, continuously developing and evolving, so not looking at the innovation as a static process, and this can be considered aa a novel approach. The whole model is built up with the aim of dealing with an higher level of complexity

for its evaluations and predictions, thus providing an output closer to real world's dynamics. Therefore, the overall goal of the application of such a tool is to enhance the whole decision-making during the innovation management process, which should lead to increase firm's performance in terms of innovation (Brophey et al, 2015).
Similar argumentations has been outlined by Kwon, Lee & Roh (2016), who described the implications of the so called DEA-ANN approach, which, through an Artificial Neural Network algorithm, allows to generate "what-if scenarios within a volatile business environment" (Kwon et al, 2016, pp. 714). In this case again, AI's forecasts capabilities facilitate the innovation process, reducing risk in launching novel projects (Kwon et al, 2016).
Guo, Sharma, Yin, Lu & Rong (2017) proposed a competitor analysis carried out by combining different modern IT instruments instead. Among them, two tools enabled with an AI program has been implemented, being a specific text mining instrument (NLP) and a machine learning software (PCM). They have been exploited in order to extract a specific set of words containing targeted information from some online platforms which contain important data about health and fitness mobile apps, such as reviews and comments. Indeed, after being trained by some experts, the combination of these intelligent algorithms allowed to grasp knowledge regarding fitness mobile app industry's providers and to cluster the data retrieved following a scheme of pre-settled features, thus providing a quick and easy interpretation of the industry situation, and, as a consequence, getting an insight upon competitors' characteristics. The whole process worked automatically, with no need for human intervention, apart from the initial training. So, in this case, AI first of all reduces time and cost efforts in order to track sector's competition, allowing for automatic processes in detecting both structured and unstructured data, from many various sources, therefore increasing the reliability and quality level of the analysis as well, not reachable through previous methods. Indeed, data-handling flexibility of such tools gives the opportunity to rely on a wider base of data, but ensuring objectivity at the same time, since the parameters for the research are always the same. Moreover, it provides a very effective and organized way to look at the main aspects of competition in a specific industry, hence suggesting how and towards which features innovation has to be channelized for outperforming other players. Hence, the strategic level is taken into account for this role.
In line with the crowdsourcing topic, in part treated in the latter article mentioned, is the contribution of Brown (2017). In this review, AI is tackled indirectly, with any specific tool investigated. Instead, the author highlights the general relevance of such a modern technology in order to retrieve data and information of any kind from different places and situations, through complete automatic processes. Sensors placed in strategic locations or even worn by humans which continuously track targeted variables are becoming one of the most used and important data source for firms, which can gain new insights from them. Data collection leads to the development of innovative improvements in products or services offered. Furthermore, thanks also to the growth of other IoT devices and instruments, data retrieved from separate physical locations can be then merged together. And this characteristic opens up opportunities to create new offerings able to better satisfy clients' needs, since managers can rely on data collected from sources which sometimes even interact with their target. In other words, AI's developments in this direction directly affect strategic decision-making, which has to face challenges and opportunities offered by the so called "sensor-based entrepreneurship" (Brown, 2017).
Diversely, Rane & Mishra (2018) 's study presented a specific model in order to boost innovation's probabilities (DIIPS), which, through the support of different intelligent instruments such as Artificial Neural Network (ANN) and a certain text mining tool (NLP), can be trained also by

unstructured data, such as business cases among the others. In summary, such a model provides the opportunity to exploit big data analytics for developing innovative business breakthroughs in a systematic procedure, and it can be brought as an additional example of how AI has the potentialities to affect the innovation management process, making it systematic, thus more efficient and quicker, but also raising up the innovation odd's of a firm, thanks to the broader set of sources which can be used for data training and thanks to predictions capabilities of intelligent tools implemented as well, very useful to seize new opportunities (Rane & Mishra, 2018).

Then, an interesting contribution on the AI's effects on innovation management has been showed by Garbuio & Lin (2019). The research's focus concerns a very specific industry, being health care, and it is aimed at analyzing the innovative implications that the AI introduction has brought into such a sector. Indeed, recent developments regarding this kind of technology have led to a wide range of benefits not just for customers, but for many other different stakeholders as well. Doctors can gain easy and reliable forecasts about patients' diseases, patients themselves can exploit intelligent tools, by having access to personalized and actionable data., but even company's employees could get positive outcomes from the application of such tools, like easing their job by capitalizing the larger amount of information they obtain through tracking clients' habits for instance. Therefore, the challenge faced by managers and entrepreneurs concerns mainly the target group that your business wants to satisfy. Changes in target groups' selection will affect the whole business model, and several different archetypes can arise. AI tools can be implemented to provide higher quality information to clinicians, hence planning a traditional business model. But other strategies can be applied, such as connecting patients with the most fitting doctors with regard to a specific disease, utilizing smart matching algorithms for instance. In this case a platform business model is built up. Moreover, many sides can be taken on board within a platform business model. And this is the case of some companies such as CareSkore, Enlitic, and Welltok, which implement machine learning algorithms and other AI applications with the purpose of collecting every kind of data about patients, thus processing risk assessment and population management. Such firms, even if patients plays a crucial role for their business, do not target them as their main customers groups. Indeed, they provide these information to insurance companies mainly, hence involving three different parties. And these are just some of the countless business solutions which can be put into action by entrepreneurs and managers, opened up by various intelligent instruments and software. Summing up, AI affects business models and strategy innovation as well, offering many opportunities. Among them, the open innovation strategy deserves to be mentioned. Ease in data transfer and analysis allows for sharing information among different players, therefore potentially involving different knowledge sources into the co-creation of new products, services, or even business models as well by (Garbuio & Lin, 2019).

Despite all the benefits related to the innovation topic described by many authors, a different opinion, even if partial, is presented by Ferras-Hernandez (2018). The authors recognizes the positive implications that AI can bring to strategic management in the first place. Indeed, intelligent machines are capable to identify patterns from data observations or "to determine the key characteristics of a product to be launched in a particular market" (Ferras-Hernandez, 2018). Furthermore, these tools are increasingly being developed in particular for what concerns the complexity of their decision-making capabilities. So, they can greatly support and help human beings in many organizational tasks. But, in order to be innovative, this machine typology lacks an attribute typical of human beings, that is "intuition", which is strictly related to creativity and emotional skills, and it is regarded as one of the most essential factors in

modern strategic management, due to the fact that it goes beyond the rational thinking, hence it is too complex to be replicated by algorithms at the current state of the technology. Indeed, while AI tools are able to detect laws from data, intuition has the capability to “induce laws not discovered yet” (Ferras-Hernandez, 2018), and this is the crucial aspect that matters if firms want to go forward on the knowledge frontier and innovate. So, it seems that AI’ support in strategic decisions concerning innovation provides several benefits, but the human beings’ role is still necessary, even if, looking at the improvements that this technology is gaining over time, including also creativity and higher strategic thinking skills, it will be soon be replacing employees at these organizational levels as well (Ferras-Hernandez, 2018).

4. Discussion and implications

The systematic literature review carried out attempts to bundle together the widespread and fragmented research concerning the relationship between AI and innovation management, therefore depicting a more clear overview about this contemporary relevant subject. Interpretation of results and findings from different contribution collected have been split up in order to better focus on the two main perspective this study address: the managerial and the academic ones.

4.1 Managerial Implications

Starting from the HR department, managers must face a shift in skills demanded in order to fully exploit such a new technology's potentialities. Hence, executives are encouraged in redefining their hiring parameters, making them match with AI's requirements (Mekid et al, 2013). Since an higher degree of human-machine interaction is demanded by various autonomous and inter-collaborative intelligent machines, both for service life and maintenance, this implies the necessity for professional experts with a different set of skills, concerning both AI competencies and business knowledge related to the industry in which the firm is operating (Behera et al, 2015). Thus, AI leads to innovation regarding hiring requirements and processes. But such a change requires a huge amount of resources and effort, in monetary terms first of all, but also for what concerns inertia in people' mindsets (Mekid et al, 2013). Thus, executives must carefully balance all these aspects before undertaking the introduction of such a technology.

It has been stated that Innovative implications affects the R&D department as well from a managerial perspective. The first AI tools applications have been implemented because of their superiority compared to previous instruments with the respect to their predictions capabilities of new products and projects. Indeed, they support the employees in charge for discovering invention in solving "ill defined problems" (Silverman, 1985, pp. 151), hence, problems not well understood in advance. Moreover, since these algorithms are able to manage not structured data, executives can train them with various sources, also internal to the firm, with no that much need for adaptation. Thus, they can rely on more informative and predictive outcomes, saving expenditures and time simultaneously. Furthermore, an extended use of these tools, can help managers to build and develop some "rules of thumbs" in order to handle ill defined problems as well (Silverman, 1985, pp. 155). Most recent developments of AI software have shown to support the innovation process in various ways, helping managers in enhancing innovative outcomes, making them relying on unstructured and more informative algorithms training base (Waychal et al's, 2011; Rane & Mishra, 2018).

But thanks to AI, managers can also look beyond the traditional innovation process, gathering crucial information and innovative ideas for new products to be launched
from external sources, such as brand online communities. So, the overall R&D strategy could be affected, moving from a traditional one, completely performed within company's boundaries, to an open innovation strategy (Christensen et al, 2017; Christensen et al, 2018). Therefore, technological developments have led to completely reshape companies in this case, and directors should plan the right organization and structure in order to seize these new opportunities. Implications concerning the financial function must be taken into account by executives

as well. Higher performances in rate and volatility forecasts ensure improved decision-making related to financial matters. Besides, since these tasks are now carried out automatically, demanding less human's effort, resource and time savings are additional consequences. The most important issue faced by chiefs concerns the design step of the algorithms. If properly set up, they can clearly outperform linear statistical models (Wood & Dasgupta, 1995). But innovative outcomes could affect other financial aspects as well. Through text mining instruments (AIMD), managers have the possibility to track the impact of company's disclosure on the financial markets, building up variables directly form different written text sources, in order to get an overview of their relationship with specific financial targets. Thus, by modifying those variables, different financial effects can be achieved. For instance, more information disclosed can reduce market uncertainty, so decreasing cost of capital. So, if managers are interested in modifying this financial aspect, thanks to AI they could focus on the right variables to be handled in order to achieve a satisfying result. Moreover, AI algorithms allow for the use of disparate information sources for the training phase in this case as well, such as company's reports about internal projects or mandatory disclosures. Thanks to that, executives do not have to waste time in retrieving data, and furthermore, they can rely on unstructured kind of information, such as real business cases, which are much more informative and generate a higher quality output as a consequence. So, this characteristic can hugely variate the overall financial strategy of the firm (Gruning, 2011). Therefore, AI's implementation over time with regard to financial department has shown a deep focus on the function's technical aspects in the first place, later expanding its effects from financial arguments to other business duties, up to the strategic positions. So, managers are asked to adopt an holistic perspective of the firm when applying these instruments. Relevant implications for Operations managers can be mentioned too. Indeed, many innovative implications can be stated for what concerns Operations Department. AI introduction leads mostly to improvements in manufacturing processes. Tasks automation, intelligent sensors tracking process status and surrounding environment, allowing also data gathering are just some of the wide range of opportunities made possible by AI. Executives must exploit those tools, particularly information collected from sensors, in order to carry out analysis, deepening their knowledge about operations and improving processes even more. Additionally, implementing such intelligent instruments would allow managers to detect problems or too slow production phases in real time, thus having the chance to take actions for reducing tasks' downtime immediately. In this way, time and costs savings in terms of production can be achieved (Roberts, 1998). Machines able to execute self-diagnosis and self-adaptation help companies to reduce the overall human effort towards manufacturing processes, letting managers allocate resources to other organizational areas. Such characteristics allow to deal with turbulent external contexts. An higher flexibility extent is preparatory for reaching more innovative outputs. Furthermore, bosses are suggested to take advantage of the connectivity features which AI machines are enabled with, in order to create a stochastic working environment, improving both control and safety as well. In order to facilitate the typologies of communication and information flows just listed, a more intuitive interface is needed. Hence, the challenge of managers and researchers concerns to better investigate sensors and data sharing, finding out more usable platform solutions. Moreover, this flow of information across the firm could support knowledge generation, hence leading to innovative ideas about process' enhancements and even new products creation as well. (Mekid et al, 2007). Then, executives are asked also to design and implement a proper Knowledge Management System, primarily for mapping tasks requirements and configuration of the overall system, form either a software and hardware points of view. This Knowledge Management system should process

both quantitative and qualitative information typologies, considering a wide range of organizational aspects, such as costs, reliability, robustness, scalability and complexity as well, among the others.
Additionally, a proper organizational designed is required in order to boost innovation probabilities. However, some barriers must be overcome in order to introduce such instruments. First of all, an higher degree of knowledge about AI is asked to managers, in order to properly handle these tools, designing processes within the and training employees accordingly. Digital data sharing is another issue executives have to address, by increasing security and privacy level of information transfers, both internally and externally with the respect to the firm's boundaries. Last but not least, a general reluctance towards innovative and complex machines can be noticed. Thus, managers must invest in deepening AI knowledge, so balancing costs and revenues coming from AI introduction (Mekid et al, 2007). But improvements can not be seen only in manufacturing processes. Indeed, robots empowered with AI software could affect the way services are designed and delivered. Services can be performed automatically first of all, hence, saving costs and resources. AI Algorithms can learn quicker and take the best decisions comparing a relevant number of different scenarios, picking up the optimal solution with the respect to the specific situation, not deviating from the trained set of solutions. Furthermore, being inanimate, they do not differ their behavior over time like humans do, hence providing higher service quality and reliability. In addition, thanks to their capabilities to react to sound and text inputs, robots are able to interact with customers, building up a comfortable atmosphere, a crucial element in service' evaluation. But, even if AI is being developed in social and emotional skills as well, human beings seem to still be superior in this regard (Wirtz et al, 2018). So, executives' main challenge concerns how to balance the humans and machines in order to completely take advantage of this interaction. For instance, repetitive and standardized services could be delivered autonomously by machines, while other duties demanding an higher level of customization and empathetic skills could be executed by humans, with robots as a support mean. Moreover, they need to adopt a cost perspective when thinking about robot implementation. Indeed, since machines typically show high programming costs but low further ones, economies of scales can be reached by replicating the service on the mass market, not possible with people as employees. Then, other questions arise, such as human beings' unemployment and the job losses management in case of machine replacement. Directors should try to balance the advantages of machine' implementation with downsides due to human capital' losses. Data security is then an additional aspect to be taken into account. Robots are enabled through software and algorithms, and for this reason they can be hacked, threatening value of data. Managers must ensure an high level of IT security before introducing this kind of technology (Wirtz et al, 2018). So, for what concerns Operations, efficiency and security management can be seen as common issues over time related to innovation.
Marketing managers have to consider AI' impacts on innovation as well. Thanks to Neural network algorithms, forecasts regarding markets and customers' preference can be carried out with an higher degree of accuracy, in terms of both reliability and output, in particular if compared to previous linear model. The flexibility of such intelligent tools constitutes a huge advantage for managers, who can put less effort in searching for data, also using secondary sources, saving time and costs, but achieving more accurate forecasting results about new product adoption at the same time. Moreover, thanks to forecasts abilities embodied in Artificial Intelligence, some information can be just estimated instead of collecting them from the market. And for sure, such an opportunity boosts firm's innovative outputs, making the innovation process easier and less costly. The most challenging issue for executives concerns choice of

the right variables for assessing customers' perceptions of a new product, which constitute the foundation of a good analysis (Parry et al, 2011). Text mining tools can support the innovation process as well, gathering ideas directly from customers, exploiting marketing communication channels, such as brand online communities. With AI instruments, it is possible also to follow the development of these ideas over time, thus increasing the potentialities of this technology with regard to innovation. Some implications affecting marketing tasks can arise from that, in particular about how different touchpoints in order to get in contact with customers, such as social networks or brand communities for instance, can be managed and capitalized. Costs and time savings will be an additional consequence of these Artificial Intelligence instruments introduction, since idea tracking of unstructured input (online texts in this case) are performed with no human intervention. Thus, this capability to autonomously identify ideas from platforms filled up with many messages, most of them not useful, carries out a "pre-filter" phase (Christensen et al, 2017, pp. 26), helpful for deleting not effective material and allowing managers to further analyze a smaller amount of text, which should encompass ideas with an higher probability. Moreover, implementing such intelligent machines instead of human beings for carrying out the ideas screening task is less costly, even if a little bit of accuracy and quality is lost. Managers must set criterions for filtering ideas, choosing if it is more profitable for the company to deal with a huge amount of thoughts, thus requiring more resources allocated to their evaluation, in terms of time and costs, facing the risk of getting many not useful ones, or if restricting the volume of data, aware of the fact that many effective innovative contributions can be missed. Then, time management of ideas is regarded as an additional issue, since sometimes customers can anticipate the launch of a product of even some years. So, lead time between users' contributions and product's placement on the market by the firm deserve much more focus.

So, given the benefits catalogued, it seems crystal clear that practitioners must place a lot of effort and interest upon this subject, developing channels to engage and communicate with customers, integrating them into companies' new product development process, (Christensen et al, 2017; Christensen et al, 2018). But it is not enough to settle communication channels and touchpoints with customers in the right way. Executives must take into account also AI algorithms able to track the dynamics within these platforms, since some innovative ideas can be generated over time through feedbacks and comments. So, it emerged how crucial can be to manage a good relationship with customers, who can be a really useful source of good quality ideas, by trying to avoid resentment, keeping them engaged. Quick answers and proof of interest towards their thoughts could help in achieving these results (Hoornaert et al, 2017). But AI software can support managers to segment the market as well, elaborating unstructured information and providing an accurate cluster as an output. Directors should rely on these tools in order to get a clear overview of the most evaluated product's features by consumers, with the aim of channelizing further innovative products towards those specific directions (Al-Salem & Mostafa, 2019). AI has been shown to affect also supply chain as department in terms of innovation. Neural networks and fuzzy adaptive algorithms are implemented in order to evaluate partners along the value chain of the firm, and this is due first of all to the chance to be trained with more informative unstructured data, such as organizational reports and real cases, and secondly to the more complex analysis they are able to execute. The final output displays partners grouped and ranked by different variables, thus allowing easier and more reliable evaluations (Albino & Garavelli, 1998, pp.13; Ghorbani et al, 2014). But some challenges can be faced by executives in charge of the evaluation task. Indeed, the training phase appears to

be crucial. Retrieving the right information, drawbacks of the fuzzy algorithms can be compensated. Furthermore, being a very adaptive intelligent instrument, by changing input typology along with evaluation parameters, the algorithm can be exploited also with regard to other organizations and industries (Ghorbani et al, 2014). So, in this way, “at the management level, some logic and psychological barriers limiting the adoption of other information systems can be removed” (Albino & Garavelli, 1998, pp.13). Finally, implications towards strategic management must be mentioned. AI have shown useful features in order to support KM, through data collection and storage tools. Moreover, intelligent programs could elaborate these information as well, thus allowing managers to better make sense of the situation, improving decision making. Connection among intelligent tools and devices ease data transfer, getting a more frequent knowledge flow within and outside the firm as well. Managers are suggested to properly design implementation of these tools along with the firm’s structure, with the aim of boosting employees’ IC, which is regarded as one of the main sources of innovation (Wiig, 1999; Kim & Trimi, 2007). Furthermore, handling unstructured data, AI pushes executives to look at a broader range of information typologies, also beyond organization’s boundaries, hence gathering more diverse ideas and suggestions. And this will probably enlarge innovation’s odds (Kim & Trimi, 2007). So, starting from technological development, directors have the chance to shape not only the organizational design, but the organizational culture and mindset as well (Lee et al, 2013).

AI tools could influence a company’s inventiveness at strategic level also in other ways. Indeed, managers could rely on neural network algorithms with forecasting capabilities, which can learn autonomously from complex sources like business case and reports. Directors should take them into account in order to assess the feasibility of new projects, thus reducing decision-making time and allocating resources to projects with the higher success rate, or even handling different key indicators in order to achieve desired performances. Therefore, innovation management could hugely benefit from that (Costantino et al, 2015). Executives have the possibility to exploit AI prediction functionalities to channelize innovation through tracking market’s preferences, therefore knowing in advance the product or service’ s features to be developed to satisfy customers (Moutinho & Philipps, 2002; Claveria et al, 2015). Different scenarios forecasts is an additional characteristic provided by AI instruments, which are also able to process a dynamic set of data, thus adapting their outputs to external context’s changes. Managers should be aware of that during the innovation process, since, by clearly displaying all the different projects with the related level of risk, it is more likely that successful decisions will be taken about new products to be developed. And such a feature is incredibly useful in the turbulent business environment nowadays.

Indeed, knowing which actions must be performed in order to successfully handle risk in specific situations could help managers to develop some rules of thumbs over time, with the aim of standardizing some steps along the innovation process, improving innovation efficacy and efficiency at the same time. Additionally, this modern technology allows executives to tackle innovation and its related risk with a systematic approach. This could matter a lot when new risks with the respect to the ones already examined by the neural network arise. In such a situation, managers are already trained to think more critically, knowing how to go deeper for better understanding the entity of the risk through the use of the software, categorizing and storing it to build up accumulative knowledge, which can also be exploited in further innovative projects. All the Artificial Intelligence’s features mentioned clearly open up opportunities for building up a wider knowledge base and a more reliable and methodical innovation procedures, which should support better managers’ decision making concerning current innovation

in the first place, but which should help them to develop the right mindset to undertake completely new projects as well. So, such an approach should let them moving forward in the attempt to handle the so called “everything’s different, every time” innovation management problem (Brophey et al, 2015, pp.1). Strategic decisions could be affected by Text mining and machine learning tools as well, implemented with the purpose of screening competitors features from online communities and forums. Directors must be aware about these applications, in order to know which are the right variables to be addressed in further projects for outperforming other players, taking the right decisions accordingly (Guo et al, 2017). Thus, since many opportunities and threats are detected and displayed by these instruments, executives are
asked to interpret these insights in order “to create new winning strategies in the marketplace” (Guo et al, 2017). But AI implementation has shown to open up different roads for what concerns also business models planning. Indeed, depending on the tools chosen and on the way they are applied, different options can be adopted. Traditional business models but also platform ones are facilitated through this technology, allowing also to take more than two sides on board. Indeed through text mining and machine learning instruments, data can be retrieved from one side, then screened, interpreted and sold to a third player for instance.
So, executives must clearly define business’ targets and the value typology they want to deliver, then selecting the appropriate Artificial Intelligence instruments which best fit and support their overall strategy and business model, of course accordingly with the available resources. For instance, a choice can be made between developing an appropriate algorithm, for delivering higher quality diagnosis, or more focus can be placed upon data management, with no need for spending resources on technical algorithms developments, concentrating efforts on how to manage incentives of different actors involved. Another aspect to be taken into account by managers regards the open innovation strategy. Indeed ease in data transfer and analysis allows for merging information coming from different players, therefore potentially involving different knowledge sources into the creation of new products, services, or even business models as well by (Garbuio & Lin, 2019). Hence, as already stated previously, AI potentially lead to a complete organizational design and business model reshape.
Summing everything up, it can be undeniably stated that development undergone by AI have led to huge enhancements in supporting companies’ innovation process. Algorithms and software are developed and enhanced continuously over time and it seems they are becoming more and more similar to human brains, in many cases outperforming them for specific duties. Thus, in order to profitably operate in whichever current business environment or industry, the implementation of such a technology seems to be quite mandatory. But there will still be room for human beings’ centrality in business and innovation issues, since human nature owns peculiar features that even intelligent machines seem not to have completely developed yet, such as creativity and intuition (Ferras-Hernandez, 2018). Therefore, humans must be aware of the advantages they could gain from AI introduction, but they must know which are their characteristics that still outperform technology. With this in mind, human beings need to balance their role with role of machines, in order to merge the best features of both sides. I personally think this is the path to be undertaken in order to move both business and society to a further step, without losing human centrality in both business and society.

4.2 Theoretical implications

The proposed contributions do not address just a managerial perspective. On the contrary, implications concerning academic research can be mentioned as well. The relationship between AI and innovation management has been investigated from various perspectives first of all, attempting to shed a light on a young and fragmented subject. Then, different approaches for addressing the innovation topic, and innovation management more specifically, have been presented. The R/A/S framework is one of them, allowing academics to start thinking about unanswered questions, and pointing out risk as a main variable to be taken into account, providing a method to cluster it in different categories (Brophey et al, 2015). Models encompassing predictions features are other instruments examined (Costantino et al, 2015), being implemented as decision making support tools, such as the DEA-ANN approach, considered as a more effective and reliable support means for innovation purposes if compared with previous innovation models (Kwon et al, 2016). Furthermore, other different AI instruments have been tested, different neural network typologies for instance, thus allowing to detect the one with an higher accuracy in forecasting performances for research purposes (Claveria et al, 2015). But also text mining software (Christensen et al, 2017; Christensen et al, 2018), machine learning programs (Hoornaert et al, 2017) or PNN neural networks algorithm (Parry et al, 2011). In this way, their features have been disclosed, hence allowing for a comparison with both previous analysis means and other AI tool as well. In this way, researchers can draw a broad overview about the current state of technology, and they can also pick up the instrument which most fit their study's purposes, or even identify downsides, attempting to further improve their applications. Moreover, from these contributions academic can understand the gap between theoretical research and practice, hence knowing how to help managers in effectively implementing these modern technologies. (Mekid et al, 2007, pp. 36). But they can also detect knowledge gaps which are not covered by current studies as well, thus opening up new channels of investigation for further research. In general, a closer relationship to firms and managers, an open communication aimed at sharing information and opinions could be an effective solution in order to see practical implementations of arguments just developed theoretically and also in order to detect practical problems and issues, which could become the basis of subsequent research.

5. Conclusions

Artificial Intelligence developments are affecting many aspects of our life, finding application in many fields of the society nowadays. Since this technology seems to open up very interesting scenarios and opportunities for what concerns innovation, mostly regarding business and organizations, as confirmed by several articles retrieved from both academic and business journals, through this study an attempt to shed a light on the relationship between AI and innovation management has been carried out. A systematic literature review has been executed in order to grasp the main findings of 28 double peer-reviewed papers, with the final goal of answering a main research question, being " How is AI discussed in innovation management literature? ".

The analysis of the articles' contents have been split up in 7 organizational functions, being HR, R&D, Finance, Operations, Marketing, Supply Chain and Strategic Planning, in order to make clear how AI's applications can affect innovation across the whole firm. Answer to the main research question has been given by addressing different sub-questions. First of all, thanks to the provision of some additional descriptive results regarding the articles sample, the theoretical foundations of the studies investigated have been displayed, such as the research design employed, in order to draw an overall picture of this topic research context. It emerged a huge industry heterogeneity, which testifies the wide extension of AI tools' application, underlining their relevance in the current business environment. Both qualitative and quantitative approaches have been implemented in order to address this topic in literature. Then, all the organizational departments have been treated, but the most addressed one seemed to be the strategic planning function.

Then, through findings interpretation, insights concerning how innovation management is treated has been given. Furthermore, implications for both managers and academia have been highlighted. AI technological developments seem to hugely affect innovation management from different perspectives. Algorithms with predictions capabilities, more complex data handling, abilities in interaction with both human and the external environment for self-adaptation, idea detection from any kind of written text and even a satisfying level of social empathy are just some of the main AI's characteristics which support practitioners and academics in boosting innovative methods and outputs substantially. In general terms, human beings must be aware of the positive implications which can be gained by such a technology, in order to wisely implement it, merging and balancing its features with human ones, with the aim of cooperate and fully exploit both potentialities.

6. Limitations and further research

This study presents some limitations as well. First of all the research conducted show constraints due to the key words typed down in the research platform. So, changes in key words can lead to different article samples, thus affecting the overall results. Moreover, filters has been chosen in order to narrow the topic down towards business issues in English language. Papers in languages other than English could provide relevant information and contents in this regard. Moreover, the research platform for double peer reviewed papers' retrieval has been limited only to "Scopus". Further research could exploit other research platforms in order to

expand the research base. Since no text mining tools have been used for screening and clustering papers' contributions, further research could exploit text mining software in order to raise the objectivity level in exposing articles' findings. Then, due to the fact that the topic is still young and still in development currently, the article's base analyzed is not that much extended. Further studies could rely on a wider base of contributions, thus providing more meaningful advices to practitioners and researchers. From that, additional organizational departments, which have not been treated in this analysis due to the lack of material, could be investigated, such as the accounting function among the others.

References

Albino, V., & Garavelli, A. C. (1998). A neural network application to subcontractor rating in construction firms. *International Journal of Project Management*, *16*(1), 9-14.

Al-Salem, F., & Mostafa, M. M. (2019). Clustering Kuwaiti consumer attitudes towards Sharia-compliant financial products: A self-organizing maps analysis. *International Journal of Bank Marketing*, *37*(1),142-155.

Al-Zahrani, A., & Marghalani, A. (2018). How Artificial Intelligent Transform Business.

Andersson, U., & Pedersen, T. (2010). Organizational design mechanisms for the R&D function in a world of offshoring. *Scandinavian Journal of Management*, 26(4), 431-438.

Bean, R. (2018). How big data and AI are driving business innovation in 2018. MIT Sloan Management Review.

Behera, A. K., Nayak, N. C., & Das, H. C. (2015). Performance measurement in banking & software firm: An empirical research. *Global Journal of Flexible Systems Management*, *16*(1), 3-18.

Belu, R. (2013). Artificial intelligence techniques for solar energy and photovoltaic applications. In Handbook of Research on Solar Energy Systems and Technologies (pp. 376-436). IGI Global.

Brophey, G., Baregheh, A., Hemsworth, D., Wachowiak, M., Hay,D., & Ben Dhaou, S. (2015). The" Everything'S Different, Every Time" Innovation Management Problem: A Promising Model Development. *International Journal of Innovation Management*, *19*(05), 1550057.
Brown, T. E. (2017). Sensor-based entrepreneurship: A framework for developing new products and services. *Business Horizons*, *60*(6), 819-830.

Buecheler, T., Sieg, J. H., Füchslin, R. M., & Pfeifer, R. (2010). Crowdsourcing, open innovation and collective intelligence in the scientific method: a research agenda and operational framework. In The 12th International Conference on the Synthesis and Simulation of Living Systems, Odense, Denmark, 19–23 August 2010 (pp. 679-686). MIT Press.

Burton, R. M., Obel, B., & De Sanctis, G.. (2011). Organizational design: A step-by-step approach. Cambridge University Press.

Buzko, I., Dyachenko, Y., Petrova, M., Nenkov, N., Tuleninova, D., & Koeva, K. (2016). Artificial Intelligence technologies in human resource development. Computer Modelling and New Technologies, 20(2), 26-29.

Calabrò, A., Vecchiarini, M., Gast, J., Campopiano, G., De Massis, A., & Kraus, S. (2018). Innovation in family firms: A systematic literature review and guidance for future research. *International Journal of Management Reviews*.

Christensen, K., Scholderer, J., Hersleth, S. A., Næs, T., Kvaal, K., Mollestad, T., ... & Risvik, E. (2018). How good are ideas identified by an automatic idea detection system?. C*reativity and Innovation Management*, *27*(1), 23-31.

Christensen, K., Nørskov, S., Frederiksen, L., & Scholderer, J. (2017). In search of new product ideas: Identifying ideas in online communities by machine learning and text mining. *Creativity and Innovation Management*, *26*(1), 17-30.

Claveria, O., Monte, E., & Torra, S. (2015). A new forecasting approach for the hospitality industry. *International Journal of Contemporary Hospitality Management*, *27*(7), 1520-1538.

Cockburn, I. M., Henderson, R., & Stern, S. (2018). The impact of artificial intelligence on innovation (No. w24449). National Bureau of Economic Research.

Denyer, D., & Tranfield, D. (2009). Producing a systematic review. *The Sage handbook of organizational research methods*, 671-689.

Dirican, C. (2015). The impacts of robotics, artificial intelligence on business and economics. Procedia-Social and Behavioral Sciences, 195, 564-573.

Dobrev, D. (2012). A Definition of Artificial Intelligence. arXiv preprint arXiv:1210.1568.

Ferràs-Hernández, X. (2018). The Future of Management in a World of Electronic Brains. *Journal of Management Inquiry*, *27*(2), 260-263.

Garbuio, M., & Lin, N. (2019). Artificial Intelligence as a Growth Engine for Health Care Startups: Emerging Business Models. *California Management Review*, *61*(2), 59-83.

Ghorbani, M., Arabzad, S. M., & Tavakkoli-Moghaddam, R. (2014). Service quality-based distributor selection problem: a hybrid approach using fuzzy ART and AHP-FTOPSIS. *International Journal of Productivity and Quality Management*, *13*(2), 157-177.

Grüning, M. (2011). Capital market implications of corporate disclosure: German evidence. *Business Research*, *4*(1), 48-72.

Guo, L., Sharma, R., Yin, L., Lu, R., & Rong, K. (2017). Automated competitor analysis using big data analytics: Evidence from the fitness mobile app business. *Business Process Management Journal*, *23*(3), 735-762.

Hamet, P., & Tremblay, J. (2017). Artificial intelligence in medicine. Metabolism, 69, S36-S40.

Hoornaert, S., Ballings, M., Malthouse, E. C., & Van den Poel, D. (2017). Identifying new product ideas: waiting for the wisdom of the crowd or screening ideas in real time. *Journal of Product Innovation Management*, *34*(5), 580-597

Huang, M. H., & Rust, R. T. (2018). Artificial intelligence in service. Journal of Service Research, 21(2), 155-172.

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. nature, 521(7553), 436.

Lee, V. H., Leong, L. Y., Hew, T. S., & Ooi, K. B. (2013). Knowledge management: a key determinant in advancing technological innovation?. *Journal of Knowledge Management*, *17*(6), 848-872.

Li, B. H., Hou, B. C., Yu, W. T., Lu, X. B., & Yang, C. W. (2017). Applications of artificial intelligence in intelligent manufacturing: a review. Frontiers of Information Technology & Electronic Engineering, 18(1), 86-96.

Kardon, D. (2019). Five AI Solutions Transforming B2B Marketing. MIT Sloan Management Review.

Kiron, D. (2017). What managers need to know about artificial intelligence. MIT Sloan Management Review.

Kwon, H. B., Lee, J., & Roh, J. J. (2016). Best performance modeling using complementary DEA-ANN approach: Application to Japanese electronics manufacturing firms. *Benchmarking: An International Journal*, *23*(3), 704-721.

Jones, G. R. (2013). Organizational theory, design, and change. Upper Saddle River, NJ: Pearson,.

Majumdar, D., Banerji, P. K., & Chakrabarti, S. (2018). Disruptive technology and disruptive innovation: ignore at your peril!. Technology Analysis & Strategic Management, 30(11), 1247-1255.

Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. Futures, 90, 46-60.

McCarthy, J. (1960). Programs with common sense (pp. 300-307). RLE and MIT computation center.

Mekid, S., Schlegel, T., Aspragathos, N., & Teti, R. (2007). Foresight formulation in innovative production, automation and control systems. *foresight*, *9*(5), 35-47.

Metaxiotis, K., Ergazakis, K., Samouilidis, E., & Psarras, J. (2003). Decision support through knowledge management: the role of the artificial intelligence. Information Management & Computer Security, 11(5), 216-221.

Mooney, R. J., & Nahm, U. Y. (2005). Text mining with information extraction.

Moutinho, L., & Phillips, P. A. (2002). The impact of strategic planning on the competitiveness, performance and effectiveness of bank branches: a neural network analysis. *International Journal of Bank Marketing*, *20*(3), 102-110.

Kim, S. K., & Trimi, S. (2007). IT for KM in the management consulting industry. *Journal of Knowledge management*, *11*(3), 145-155.

Pantano, E. (2014). Innovation drivers in retail industry. International Journal of Information Management, 34(3), 344-350.

Parry, M. E., Cao, Q., & Song, M. (2011). Forecasting new product adoption with probabilistic neural networks. *Journal of Product Innovation Management*, *28*(s1), 78-88.

Pavaloiu, A. (2016). The Impact of Artificial Intelligence on Global Trends. Journal of Multidisciplinary Developments, 1(1), 21-37.

Ransbotham, S., Kiron, D., Gerbert, P., & Reeves, M. (2017). Reshaping business with artificial intelligence: Closing the gap between ambition and action. MIT Sloan Management Review, 59(1).

Roberts, G. (1998). Intelligent mechatronics. *Computing & Control Engineering Journal*, *9*(6), 257-264.

Silverman, B. G. (1985). Toward an integrated cognitive model of the inventor/engineer. *R&D Management*, *15*(2), 151-158.

Sarle, W. S. (1994). Neural networks and statistical models.

Sebastiani, F. (2002). Machine learning in automated text categorization. ACM computing surveys (CSUR), 34(1), 1-47.

Slack, N., Chambers, S., & Johnston, R. (2010). Operations management. Pearson education.

Tidd, J., & Bessant, J. R. (2014). Managing innovation: integrating technological, market and organizational change. John Wiley & Sons

Waychal, P., Mohanty, R. P., Verma, A., & Chatterjee, A. (2011). Towards a framework for innovations. *International Journal of Business Excellence*, *4*(5), 493-518.

Wiig, K. M. (1999). What future knowledge management users may expect. *Journal of knowledge management*, *3*(2), 155-166.

Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., & Martins, A. (2018). Brave new world: service robots in the frontline. *Journal of Service Management*, *29*(5), 907-931.

Wood, D., & Dasgupta, B. (1995). An innovative tool for financial decision making: The case of Artificial Neural Networks. *Creativity and Innovation Management*, *4*(3), 172-183.

Yoo, Y., Boland Jr, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for innovation in the digitized world. Organization science, 23(5), 1398-1408.

Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., & Faraj, S. (2007). Information technology and the changing fabric of organization. Organization science, 18(5), 749-762.

Zhang, G., Patuwo, B. E., & Hu, M. Y. (1998). Forecasting with artificial neural networks:: The state of the art. International journal of forecasting, 14(1), 35-62.

Zittrain, J. L. (2005). The Generative Internet. Harvard Law Rev. 119(7) :1974–2040.

Appendix

i. Appendix with Data Used

Table 1. HR Department

Study	Methodology	Research Question	Main Findings
Mekid et al (2007)	Qualitative	• What are the imminent and future key aspects in innovative production machines and systems	• More integration of current and future technology required to build a strong platform for various applications featured with interoperability, trust, security • An immediate action is required on smart strategies for the design patterns and agents to enable intuitive components for high quality dynamic user interfaces.
Behera et al (2015)	Quantitative	• Analysis on the relationship between IT adoption with its usage and IT performance in Indian banking and software firms	• IT performance was found to have a positive correlation with factors such as efficiency, effectiveness as well as profitability of service firm

Table 2. R&D Department

Study	Methodology	Research Question	Main Findings
Silverman (1985)	Qualitative	• To indicate a fertile AI research area of integration of cognitive processes for real • To illustrate the 'immediate' payback results of the intuitive-complex innovation process to organizations	• A1 and organizations can both benefit from the synergism of research efforts aimed at probing and understanding the innovation process from a more rigorous perspective.
Waychal et al (2011)	Quantitative	• To formulate a specific innovation process framework	• The framework has the potential to analyze the innovative results and to synthesize levers and anti levers for facilitating the execution

			of innovations of different kinds
Christensen et al (2017)	Qualitative	• Proposing a method in order to investigate the presence of ideas in online communities	• Machine learning and text mining are useful tools for identifying ideas in online communities • Hidden ideas can be gathered from a huge amount of text, supporting researchers' work
Christensen et al (2018)	Qualitative	• Text mining tools can support idea discovering and can lead to open innovation strategy	• Automatic idea detection systems are sufficiently valid to be exploited for an initial ideas screening • Ideas detected are less novel, but more feasible
Ferras-Hernandez (2018)	Qualitative	• To investigate the implications due to AI developments	• Human still have intuition as an advantage with the respect to AI • But AI will soon overtake humans' capabilities: which will be the implicaitons?

Table 3. Finance Department

Study	Methodology	Research Question	Main Findings
Wood & Dasgupta (1995)	Qualitative	• Describing ANNs application in financial area • Give ideas how to develop an ANN application	• ANNs capable of learning in a more robust way • ANNs outperform linear models
Gruning (2011)	Quantitative	• To investigate the relationship between annual report disclosure, market liquidity, and capital cost	• Annual report disclosure positively affects market liquidity in the German capital market • Information disclosure changes individual expectations, indirectly

			leading to portfolio adjustments
Behera et al (2015)	See table 1	• See table 1	• See table 1

Table 4. Operations Department

Study	Methodology	Research Question	Main Findings
Roberts (1998)	Qualitative	• To demonstrate how the synergistic combination of manufacturing and AI acts as a driving force towards innovative applications	• Products or processes containing intelligent controllers • Intelligent paradigms used for product design • Sensors and actuators for online data acquisition and management information systems
Mekid et al (2007)	See table 1	• See table 1	• See table 1
Wirtz et al (2018)	Qualitative	• To explore the potential role which service robots will play in the future	• Definition, key attributes and tasks performed by service robots • Consumers' perceptions of service robots • Overview about ethical issues surrounding service robots

Table 5. Marketing Department

Study	Methodology	Research Question	Main Findings
Parry et al (2011)	Quantitative	• To examine the usefulness of a probabilistic neural network (PNN) algorithm in order to	• PNN algorithm significantly outperforms the logit model, and also two

		forecast new product adoption	neural network algorithms, namely backward propagation model and feed-forward model
Christensen et al (2017)	See table 2	• See table 2	• See table 2
Hoornaert et al (2017)	Quantitative	• To propose a model that can assist managers in efficiently processing crowdsourced ideas by identifying the most predictive aspects of ideas useful for future implementation	• Non-linear machine algorithms outperform linear models • Crowd feedback is the best predictor for idea implementation
Christensen et al (2018)	See table 2	• See table 2	• See table 2
Al-Salem & Mostafa (2019)	Quantitative	• To cluster Kuwaiti consumers choice of Sharia-complaint financial products and services	• Three distinct segments: enthusiasts, laggards and rejectors • Enthusiasts are the larger group

Table 6. Supply Chain Department

Study	Methodology	Research Question	Main Findings
Albino & Garavelli (1998)	Quantitative	• A neural network investigation to support executives in subcontractor rating.	• The NN capability of seizing knowledge by examples and not by rules represents a very interesting and innovative factor even in terms of managerial in- novation • The absence of formal mechanisms to support the evaluation • Subcontractor rating has been proposed to support general

			contractor management more effectively than other techniques
Ghorbani et al (2014)	Quantitative	• To provide a new tool to categorize and select distributors	• Distributors are categorized according to their similarity degrees between them • It does not only determine the best distributors, but also categorize all of them. • The algorithm is adaptive and can easily apply to other organisations and companies

Table 7. Strategic Planning Department

Study	Methodology	Research Question	Main Findings
Wiig (1999)	Qualitative	• To investigate further developments of KM within firms	• New advances in KM will bring great possibilities for creating new eco- nomically important products and services. • Increased reliance on automated intelligent reasoning may assist knowledge workers by identifying and making available relevant support information and knowledge, making preliminary sense of

			the situation, and locating and presenting suggestions for how to handle it.
Moutinho & Phillips (2002)	Quantitative	• To investigate managers' perceptions about the impact of a variety of planning practices on competitiveness, overall performance, strategic planning effectiveness and marketing effectiveness	• Bank branch effectiveness is affected by management practices • The overall performance of the branch depends highly on both long term thinking and innovation • Long-term thinking seems to have also a high degree of impact on strategic planning effectiveness
Kim & Trimi (2007)	Qualitative	• To examine the underlying components of information technology (IT) that support different models of knowledge management (KM)	• Regardless of the type of KM model utilized, the most widely used IT by management consulting firms was the internet-related technology (e-mail, internet, and search engine • Second important IT component was data management technology • The third one was collaborating IT technology • The fourth important IT was artificial intelligence
Lee et al (2013)	Quantitative	• To analyze the relationship between knowledge management (KM) and technological innovation in the Malaysian manufacturing sector	• KM are positively and significantly related to technological innovation

Costantino et al (2015)	Quantitative	• To introduce an innovative methodology to support executives in assessing projects during the selection phase	• The design, validation and test of an artificial neural network model automatically relates CSFs to project success, according to the company experience. • Modifying the architecture or replicating the learning process on a bigger amount of data, the capability of classification improves, reducing the number of errors and increasing the level of accuracy
Claveria et al (2015)	Quantitative	• To apply a new forecasting approach to enhance predictions within the hospitality industry	• AI techniques allows the estimation of the evolution of demand from all different markets simultaneously • AI methods provide more accurate estimations of anticipated tourist arrivals for effective managerial and policy planning • This new procedure allows managers to include the common trends in customers from all markets in neural networks to anticipate the demand evolution for all different markets simultaneously
Brophey et al (2015)	Quantitative	• Testing a decision-making modern tool in order to support the innovation process	• The model offers an opportunity to learn from what worked best before • The model offers the capacity to use quantitative techniques to model the overlapping risks and actions during

			innovation-related decision-making • List of actions to be undertaken by managers when facing specific risks
Kwon et al (2016)	Quantitative	• To design an innovative performance modeling system by jointly implementing data envelopment analysis (DEA) and artificial neural network (ANN)	• DEA model detects trends and useful features regarding the Japanese manufacturing industry • BPNN, combined with DEA, demonstrates promising evaluation skills in predicting efficiency scores and best performance benchmarks
Guo et al (2017)	Quantitative	• To show an innovative tool aimed at monitoring a firm's market position with the respect to its competitors	• Product feature comparison and market structure analyses reveal an app's position in relation to its peers analyses of the revenue model, pricing policies and market structure enables managers to detect future opportunities and to predict better paths of action concerning all the aspects of a firm's operations • With better, explicit information on rival firms in terms of their product features, new product development can be enhanced by delivering superior or unique functionality • Human- related cost reduced

Brown (2017)	Qualitative	• To clarify the next generation of crowdsourcing • To develop a framework for supporting sensor-based entrepreneurs plan, to develop, and map new products and services.	• Use of the crowd as a source for idea generation • Use of the crowd and crowdsourcing as a business model and a strategy within the new product/service development phase
Rane & Mishra (2018)	Quantitative	• Proposing a model supporting ideas discovering and innovation in order to achieve business excellence	• Organizations implementing the DIPPS model have higher success rate and the probability of reaching their set goals
Garbuio & Lin (2019)	Qualitative	• To provide a critical analysis about AI-driven health care start ups • To identify business models archetypes made possible by AI	• AI is reducing information asymmetry between health care providers, payers, and patients, redefining the health care landscape • Patients are the objects of a value chain system nowadays • Firms capable to deal with a huge amount of data and to guarantee both security data security and privacy will be able to seize new opportunities
Ferras-Hernandez (2018)	See Table 2	See Table 2	See Table 2

ii. Declaration of originality

I, Salvan Alessandro

Born on 24/02/1994

Matriculation number: 764504

hereby declare on my honor that the work attached to this declaration

- □ Homework/Presentation
- □ Bachelor Thesis
- × Master Thesis
- □ Diplom Thesis

has been independently prepared, solely with the support of the listed literature references, and that no information has been presented that has not been officially acknowledged. All parts of this work that were taken verbatim or in spirit from publications or outside communications are individually marked as such.

Supervisor: Johannes Dalke

Thesis: ***A systematic literature review about the impact of artificial intelligence on innovation management: implications on different organizational aspects***

Semester: 4th

I declare herewith, that I have transferred the final digital, not write-protected text document (in the format doc, docx, odt, pdf, or rtf) to my mentoring supervisor and that the content and wording is entirely my own work. I am aware that the digital version of my document can and/or will be checked for plagiarism with the help of an analyses software program.

Signature