ROBOTS IN BUSINESS: A REVIEW

Ala' Al-Mahameed

Universitat Rovira I Virgili, Spain

Jorge Pelegrín-Borondo

La Rioja University, Spain

Mario Arias-Oliva

Universitat Rovira i Virgili, Spain

Abstract:

Robotic technology is used extensively in different kinds of business. Actually, the deployment of these technologies into business practices is becoming a necessity, not a choice, in order to survive in the business world, and to maintain a balance in the competition with the other competitors. The main feature of the robotis its ability of gathering complex information and executing physical actions based on that information in a superior way. This ability enables the robot to replace, supplement, or even transcend human performance in various tasks.To understand how the robotic technology perceived and implemented in the business world, the research (1) overviewed the effect of the Artificial Intelligence (AI) and machine learning on the robotic technology advancement, (2) mentioned some examples of the robotic technology in different fields and their impact and (3) discussed the acceptance of the robots, by reviewing the related literature. The research points out the importance of the Technology Acceptance Model (TAM) on the acceptance of the robotic technology in business fields. Furthermore, the research advised to draw more attention to the social factors, such as warmth and competency, beside the importance of the investigation in emotions and behavior desire of the workers, especially when they have to work side by side with robots in workplaces. Moreover, if human perceive robot as too close to humanbeing, it will fail into "uncanny valley", and in turn it will be perceived less emotional. Another important note was related to the fear and anxiety that form such technologies. The research mentioned that AI lacks human intelligence. It is specialized in very specific type of tasks, not being able to perform many of the tasks that people can do. In the learning capacities, nowadays it is not possible to compare machine learning ability to the human ones. In addition to that, AI and

machine learning are seen as tools, the fear does not come by AI and machine learning themselves, it comes from how people will use them.

Keywords: Robot in business, Technology acceptance, Human-robot interaction

ÍNDICE

1. INTRODUCTION

Robots' ability for autonomous mobility and to perform a set of tasks had been captured by writers' imaginations. But recently, robots have emerged from the pages of science fiction novels into the real world (Graetz & Michaels, 2015). Different types of robots were developed, such as, industrial, mobile, educational, collaborative and service robots (Park & del Pobil, 2013).

Robot can be defined as a mechatronic device that can be programmed to do automatic procedures or can be controlled through computer based mechanical interface (Diana & Marescaux, 2015). Consequently, the main feature of a robotis its ability of gathering complex information and executing physical actions based on that information in a superior way. This ability enables the robot to replace, supplement, or even transcend human performance in various tasks (Taylor, Menciassi, Fichtinger, Fiorini, & Dario, 2016).

This advancement in technology should not be seen as a threat, it represents a great opportunity for both individuals and society to improvewelfare, especially in the fields where these technologies will be applied. Additionally, the relationship between robots and humans differs in nature from the relationship between human and other machines.For instance, the industrial robot is defined as a reprogrammable and automatically controlled robot that has the ability to perform multipurpose manipulations with three or more programmable axes. It could be fixed or mobile, and used in industrial automation applications (ISO, 2012). We can find as well service robots, that are designed to live with humans and to perform different type of tasks. It could be defined as a set of mobile robots, designed to work in populated environments, such as, hospitals, offices, restaurants, universities, museums and homes. They are developed to perform different tasks like cleaning, education, learning, entertainment and care. There are some of autonomous and intelligent robots used in home assistant tasks (Bennewitz, 2004). However, educational robots are used in language learning, teaching

assistant, development of social skills and so on. They have the social ability to interact with students (Cheng, Sun, & Chen, 2018).As well, in the medical sector, the main idea of using robots is to improve patient safety and to perform surgical care remotely when needed (Haidegger, Sandor, & Benyo, 2011). But, making the entire surgical procedure or a part of it, is imagined as a potential futuristic application of the robots (Pessaux et al., 2015).

Artificial intelligence and machine learning technologies are embedded into the robotics technology. And the vast development in both of them, enables new features and improvements in the robot's development. For example, motion control, vision, grasping and understanding data patterns are some of the AI and machine learning inventions, which are implemented in robotic technology(Robotics Online Marketing Team, 2018).

This research analyzefrom a theoretical perspective the use of robotic technologies in business, with emphasis in places where direct interactionof robots and humans is expected, as the case of employees or customers. In this context will be important to study social skills on the one hand, and the technical and cognitive capabilities needed to perform these tasks on the other (Devin, Milliez, Fiore, Clodic, & Alami, 2016).We will discuss firstly the development in the AI and machine learning, and how these developments improve the capabilities of the robotic technology. After that, the research will review some examples of the robot use in different business fields and how it was perceived by human. Then the research will discuss the robot's acceptance, especially when the social interaction is involved, by reviewing the related literature. And finally, the conclusion will point to some important notes related to the use and acceptance of robotic technology in business.

2. ARTIFICIAL INTELLIGENCE

The Artificial Intelligence (AI) was introduced by McCarthy (1956) in Dartmouth Conference, which is considered the year of AI birth. Since that year, different works had been established in AI development. Actually, it is studying the human intelligence behaviors (recognition, problem solving, learning, perception, language use, creativity and manipulation of symbols) to produce models that can be used in creating computer programs, which have the capability of simulating human intelligence. These programs can be used for different purposes, such as, voice recognition, shapes recognition, theorem prove, games running, language translation, composing music, medical diagnosis formation and forming expertise (Sołtysik-Piorunkiewicz, Ziuziański, & Furmankiewicz, 2014). For instance, people do not move randomlyin their environments, they ordinarily follow a particular path or movement patterns based on their intentions. The ability of mobile service robot to know these patterns using the AI algorithms will make it able to keep track of people motions and improve its behavior (Bennewitz, Burgard, & Thrun, 2002). Moreover, chatbot is an artificial intelligence program, used to simulate human behavior through audio or textual conversation (Shawar & Atwell, 2007). It could be used for language learning, like computer assisted English learning chatbot (Jia, 2009), or for psychotherapy as DoctorChatbot (Weizenbaum, 1976).

3. MACHINE LEARNING

Machine learning is related to build computers that have the ability to learn from past experiences. It is a combination between different sciences, including computer science, statistics, data science and artificial intelligence. Recently, the development of machine learning is driven from the new learning algorithms, big-data and inexpensive computation systems (Jordan & Mitchell, 2015). For example, in medical sector, machine learning is flexible and powerful instrument that can be used to resolve and predict results from clinical and biological information. Its models have the power to improve the efficiency of the healthcare in different ways, such asdiagnostic models, which can be used in risk stratification, and in recommending the required lab tests and appropriate therapies (Gui & Chan, 2017).

The integration between robotics technologies and machine learning produced the robotic learning, which is related to:

1. **Reinforcement learning:**it is a machine learning model presuming the world as a set of environments and agents states "S", the agent can execute a set of actions "A", roles to explain what the agent observes, and the time, which is represented by discrete steps (Smart & Kaelbling, 2002). The agent will be given a reward for each performed action as shown in Fig 1.
2. **Developmental robotics:** it is concerned in studying the development of lifelong cognitive behaviors and focus on robot autonomous mental development (AMD), such as, artificial emotions, self-organization and self-motivation (Xu, Min, & Xiao, 2014). AMD is using robot sensors and effectors to develop mental capabilitiesby the autonomous interaction with its environment (Weng et al., 2001).
3. **Evolutionary robotics (ER):** is the application of an artificial peer of natural Darwinian evolution, in order to develop robots artificial brains, sensors and bodies (Arvey, Paolo, Wood, Quinn, & Tuci, 2005). It implements population-based artificial evolution to improve autonomous robot controllers.The process of controller evolution contains repeating cycles of controller appropriateness evaluation and selection which are almost similar to a generation in natural evolution. For each cycle, every controller from a population of candidate controllers is set to perform a specific task, and to be involved then in evaluation period. The evaluation is based on fitness function, which is a function used to measure if the design is fulfilling its targets, and a modification is repeatedly performed based on the fitness function evaluation. Then a genetic algorithm (GA) is applied, based on the information resulted from fitness function, to select and replicate the fittest candidates to the next generation (Nelson & Grant, 2006).

Figure 1Reinforcement Learning framework(Zhou, Zhu, Liu, Fu, & Huang, 2014, p.3)

It is important for therobot to be able to capture the companion person emotions. Realizing the emotional status from physiological cues is an efficient method of achieving potential human-robot interaction. Various machine learning methods have been successfully utilized in emotions recognition to predict the emotional status of an individual, based on a set of physiological features (Changchun Liu, Rani, & Sarkar, 2005).

4. ROBOTS IN BUSINESS

Using robots in business field may be seen as a science fiction vision for future. Nevertheless, the reality indicates a wide use of the robotic technology in different types of business across the globe. The interest in research about business robots increased as robotic technology is progressing (Choi, Song, Jeong, & Jeon, 2011).

Robot could be a simple machine, or a complex mobile and autonomous one. It can get involved in human's daily life and has a social interaction with them (Rogers, 2004). Human Robot Interaction (HRI) is emerged as a scope of research concerned in evaluating, designing and understanding of robotic systems in their interactions with people. This interaction requires a communication between a robot and a person. The communication could be remotely (human and robot are not in the same place) or proximate (both are in the same place). With these types of communication, different interaction-based classifications are used for robots. These classifications are related to social interaction, physical manipulation and mobility. For example, proximate interaction with mobility will produce robot-assistant systems. Additionally, empathy, sociability, and cognitive characteristics are associated with the social interaction. In contrast, remote interaction with mobile robots is available in supervisory and teleoperation control applications (Goodrich, 2008). In the same context, the applications of mobile robots have been growingin bot outdoor and indoor environments in different sectors. Robots are used specially in risky activities and in the places where it is difficult for human to access (Sharifi, Young, Chen, Clucas, & Pretty, 2016). They are used in manufacturing, military applications, healthcare, search and rescue, security, homes, and tourism among many other activities(Shneier & Bostelman, 2015).

For instance, an interactive robot called "RHINO" was used as a museum tour-guide in Germany in 1997 by Burgard et al. (1999) to examine how robot interacted with people in public places and how people will perceived it. The importance of this experiment was related

to the transfer of robot use from closed offices to public environments, where more obstacles, constraints and crowds surrounding and affecting robot tasks. Therefore, the challenge was to implement a robot that has the ability to cope with surrounding environmental obstacles, and at the same time, to design an interface perceived ease for the users, and to include social features that attract the users in terms of human-robot interaction context. Two types of interfaces were associated with the "RHINO": onboard and web interface. In the onboard interface, the robot gives the ability for users to choose a tour and listen to an introduction from the robot. The robot then starts moving while playing a music to add some entertainment to the tour. The direction of the camera is pointed to the direction of the robot motion. For each exhibit, the robot gives a brief audio explanation about the exhibit, and then leave the choice to the user to continue in listening or to move to another exhibit. On the other side, the web interface gives the users four capabilities: control, monitoring, background information and discussion forum. Its ability to react with people by welcoming their presence through its horn sounds, and its ability to slow down its speed to excuse people to make way, were considered the most enjoyable sides of "RHINO". Two years later, a new generation of "RHINO" was developed, called "Minerva". Minerva robot was tested in Smithsonian museum in USA in 1999. RHINO and Minerva used camera images for localization, its motion planner used information acquisition during paths planning and it had the ability to learn maps. They had a face, what was very helpful to attract people attention, showing emotional states (Thrun et al., 1999).

Recently, a human-shaped robot called Prepper (Fig 2) is being used for different applications, such as welcome, guide and inform the visitors. It was used in more than 2000 companies across the world. The robot was designed by SoftBank company in Japan. It has face and basic emotions recognition abilities and it has the ability to interact with people through conversation and touch screen. The company is offering different versions of Prepper for different businesses sectors, such as retail, finance, government, education and research, healthcare and tourism applications (SoftBank, 2018). For instance, Prepper robot was used in Smithsonian Institution in Washington DC as a tour guide in the museums. It is programmed to answer commonly questions, to tell stories, to react with the visitors and to make gestures. It can translate phrases in Swahili language in the National Museum of African Art, it can guide the visitors into Rosa Parks VR experience in the National Museum of African American History and Culture and it can teach visiting students coding and software engineering in the Smithsonian's teen educational space ARTLAB+(Burton, 2018). Furthermore, Prepper becomes the first employee in Jordan by Princess Sumaya University for Technology. Its movement and language were programmed by a group of students in the university. It is offering a support in the scientific research procedures and in teaching students the needed skills to develop and manufacture Prepper itself (PSUT, 2018). Prepper was developed in 2014 for the B2B uses and then involved in the B2C applications. The developers avoided the human-like exact appearance to keep it away from falling in the uncanny valley (Mori, 1970). And they make it as a gender-neutral shape and with childlike and androgynous voice, in order to avoid the stereotyping effects. Furthermore, the safety aspect was perceived well through the design process. The robot was designed in such way that it can ensure the affordability by the needed functions, sensors and components. In fact, the developers showed more attention in the interactivity side of the robot design. They implemented different software components to provide the robot with the necessary abilities, including emotions perception and expression,

gestures expression and liveliness behaviors. These abilities will ensure a proper interaction with people. Moreover, Prepper has the ability to work 12 hours with each charge and it has different modules for various autonomous behaviors(Pandey & Gelin, 2018).

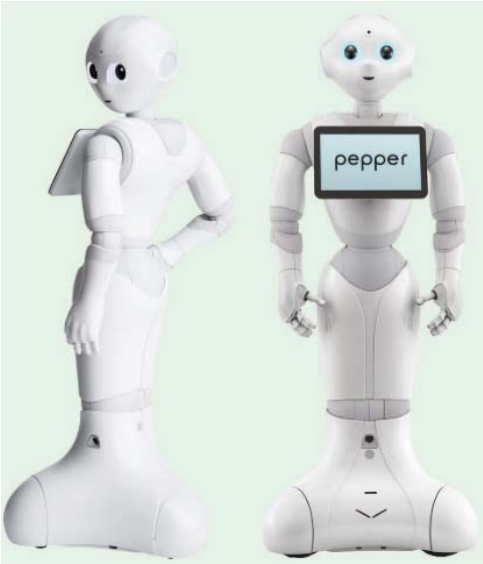

Figure 2 Prepper Humanoid Robot (Pandey & Gelin, 2018, p.41)

Moreover, in the 8th of November 2018, New China News Agency (Xinhua) revealed its first virtual news presenter wearing formal clothes and speaks like a robot. The AI news presenter was designed by Xinhua and Chinese search engine company (Sogou) to simulate human gestures, emotions and voice. The Agency pointed out the expected cutting cost by using it and its usefulness in presenting the breaking news in timely manner. They produced different AI presentation styles for different type of news, trying to avoid boredom feeling of viewers (Baraniuk, 2018). Some experts criticize the limited facial expressions, the artificial voice and the possibility to enter in the “uncanny valley”, it is considered a promising news experience, in which AI, machine learning and robotic research could improve and develop innovative products with higher performance in the close future(Vincent, 2018).

Another attempt to use robots in business application was coined by Choi et al. (2011). They developed a remote video conferencing robot (Fig 3). The robot was designed to enhance the one-to-many communication in a conference call. Robot can be controlled by a smart phone or a PC, and participants can connect their devices (PC, Smartphone or tablet) to the robot via over Wi-Fi or WCDMA. This robot needs further developments in enhancing the physical design and their functionalities, such as autonomous mobility, voice recognition and minimizing the delay associated with the network and synchronization with smart phones.

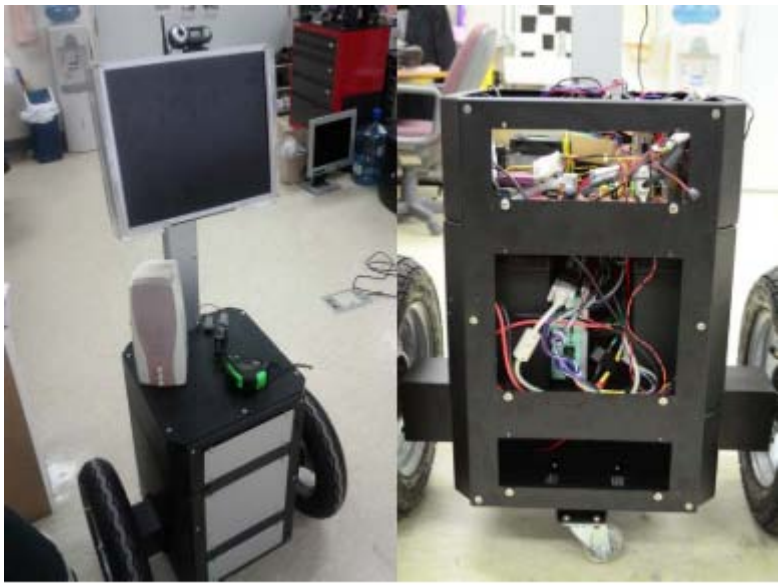

Figure 3Video Conferencing Robot(Choi et al., 2011, p.672)

5. ROBOTS ACCEPTANCE

As a matter of fact, robot's acceptance has been studied in literature in terms of technology acceptance concept, considering the social aspects. Studying the social aspects in robot acceptance is a keystone of their future development, especially when robots will be used to work side by side with people. This importance is due to the expected mutual interaction between humans and robots in such settings (Savela, Turja, & Oksanen, 2018).

The Technology Acceptance model (TAM) developed byDavis (1985) and its extension (TAM2) developed byVenkatesh and Davis (2000) , could be used in the study of the acceptance of robotic technologies by people. TAM is originally basedon the Theory of Reasoned Action (TRA) ofFishbein and Ajzen (1975). TRA hadthe purpose of studying the acceptance of new technology within the ICT context. The model suggests that the system perceived ease of use (PEU) and perceived usefulness (PU) will impact positively the attitude toward that system, which in turn will stimulate the intention behavior and finally the actual use. In the robotic context, the PU can be defined as the expected enhancement of the activates that is associated with the use of robots. PEU can be defined as the mental and physical efforts required to interact with robots (De Graaf & Ben Allouch, 2013).

It is important for the human to perceive PEU and PU constructs positively, to ensure the acceptance of robots. But these functional aspects are not enough. There are other aspects that should be considered, such asthe related with social interaction. For instance, in business filed, such as banks, hotels or hospitals, customer must feel that the offered services by robotsare matching or exceeding human services, in order to get satisfied. Therefore, the robot has to show and behave in a human-like way. Furthermore, it should look like human in terms ofappearance and behavior. This idea was mentioned by Mori (1970), who developed the Uncanny Valley Theory. Mori (1970) analyzed the relation between human-likeness and familiarity when dealing with robots. He claimed that, at some point (First Peak), the maximum

familiarity will be achieved when the robot become a human-like in terms of behavior and appearance. Furthermore, robot with natural motion will enhance the familiarity perception. However, the author pointed outthat the feel of eeriness,whichcan affect in a negative way to familiarity (Uncanny Valley) as shown in Fig 3. This eeriness is a result of making human-like robot more realistic. At some point, the realism will improve human-robot interaction and will impact positively the acceptance of robots. In contrary, it will negatively affect the robot acceptance, if it goes beyond the normality, as perceived as a the human when it is not(Bartneck, Kulić, Croft, & Zoghbi, 2009; De Graaf & Ben Allouch, 2013).

In terms of the appearance, robots' cloud be classified into the following types (Moro, 2018):

1. **Human-Like robot**: the appearance of the robots looks like a human being (e.g. Two legs, two hands, head, face and son on).
2. **Animal-like robot**: here, the robots take an animal look with four legs, tail, etc.
3. **Machine-like**: no human or animal features are included in the appearance design of the robot, such as the industrial robots.
4. **Character-like**: the robot may be designed to look like a famous cartoon character.

It is necessary to point out that, in areas where the direct interaction between human and robot is involved, attractiveness and human-like appearance are being used to evaluate the robots, in order to be accepted or to be rejected (Destephe et al., 2015).

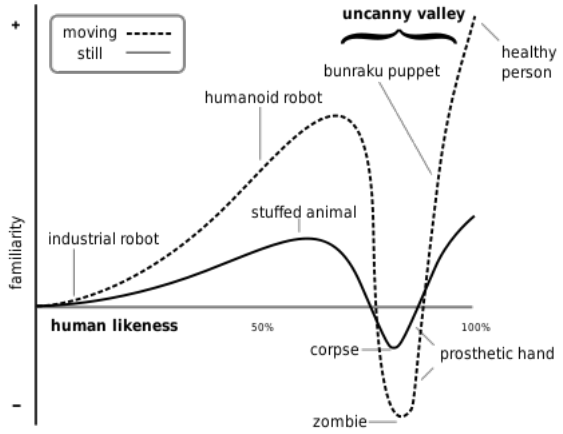

Figure 4 Uncanny Valley Theory (Mori, 1970, p.33)

Some authors in literature referred to the problem of trust when humans meet robots. They pointed out that the role of the facial expressions affects trust and behavior. Scharlemann, Eckel, Kacelnik, and Wilson (2001) investigated the relationship between facial characteristics and trust while interacting with others. Their study claimed that, the facial expressions (e.g. smile) can stimulate a trust behavior. Additionally, for the life-like agents, the trustworthiness could be achieved by enhancing the competence of the them (Van Mulken, André, & Müller, 1999). In the same context, empathy and emotions can overcome the uncanniness (Uncanny Valley) negative outcomes. Furthermore, all of these researches and developments in robotic technology are seeking on producing robots that have the ability to simulate or exceed human capabilities. These developments will threat some existed occupations that could be done in the future by robots, opening a vast number of new opportunities related to the AI, big data, automation and more within in this field(Frey & Osborne, 2017).

Although the social robots are still lacking the ability to imitate human interpersonal skills, researchers still believe with the technology development of robots and social features improvements will enhance robot ability to interact with human. But the improvements of technical features and mechanical capabilities cannot guarantee a successfully acceptance of robots (Kwon, Jung, & Knepper, 2016). Actually, placing robots in social contexts such as work environments, overrides the technical issues. Beyond the technical features, it should consider the emotional response, human expectations and motivations. However, some authors argued that these factors have been ignored while studying the acceptance of the new technologies (Bagozzi, Dholakia, & Pearo, 2007). There is a high probability that people will start to compare between human and robots in case thatthe robot can replace the human worker. The recent researches have pointed out that perceived warmth and perceived competence as adjustments for the social interaction between the humans (Fiske, Cuddy, & Glick, 2007), which can be applied on the interaction between humans and robots, especially when human start comparing between the robot performance and the replaced human performance, such is in frontline jobs for different applications and settings (Wirtz et al., 2018).

Nowadays, developers are designing robots to be good for specific functions. On the other hand, human is tending to apply the anthropomorphism to the human-like objects. Anthropomorphism could be defined as a social state resulted from the interaction between human and robot, which includes for instance, motivations, emotions, intentions of the human toward the robot (Epley, Waytz, Akalis, & Cacioppo, 2008). As well, the initial overestimation applied by the human toward the robot's capabilities is understood, especially when the reference is the human mental model. This is because humans trust other humans, in order to be able to carry out a set of common capabilities, such as motion and speech abilities (Kwon et al., 2016). Thus, the best way to benefit from anthropomorphism is by making a balance between human expectations and robot actual capabilities (DiSalvo, Gemperle, Forlizzi, & Kiesler, 2002). Likewise, in the social settings, human tend to expand more the social capabilities for anthropomorphic robots, and it could be possible to overcome the expected thoughts about the capabilities by employing the behavior.

6. CONCLUSION

This research discussed theoretically the use of robotic technology in different fields of business with the aim to be able to understand how such technology can be implemented and accepted in these fields.The examples mentioned through the research pointed out the different usage of robotic technologies in different business fields for different purposes, beside of their impact on these areas. In general, robotic technology is promising, and with developments in different sciences, such as AI, machine learning and mechatronics engineering is hastening the robotic development process.

The research reviewed some factors that affecting the acceptance of robotic technology. Some of these factors have a positive impact on the robotictechnology acceptance,and it can be generalized, even if the purpose of the use is different, such as the functional factors as PEU and PU. But certainly, there are factors that may vary upon the nature of robots and their use. For example, it does not seem that the appearance of industrial robot is important as much as beingable to perform the entrusted tasks. But other sectors and activities, such as in the

banking sector, the customer cares about the general appearance and the way of cooperation,being important for the acceptation factors as theinteractivity human-robot. Furthermore, it is also difficult to generalize on certain specifications of the robots in any of their potential applications areas. For example, in business sector, the specifications of the robot will differ depending on the purpose of its use, and therefore the factors influencing its acceptance will vary. This could be perceived as normal, because even humans will not be able to perform all type of tasks. Each field and function havepeople who possess specific capabilities, skills and expertise to accomplish these functions. Hence, each case must be studied separately, according to the specificities of the field and thecontext in which the robot will be employed.For instance, to be able to use the robot in business,used as afrontline employee, social cognition factors (warmth and competency) and the psychological ownership factors (attractiveness, receptiveness and manipulability) have a significant impact on customers satisfaction. As customer perceive the frontline robot as too close to a human-being, it will fail into “uncanny valley”, and in could turn their perception as less warm (van Doorn et al., 2017). Also, it is important to investigate the anticipated emotions and behavior desire for the workers when they have to work side by side with robots in work places (Piçarra & Giger, 2018).

In general, these differencesopen up may research questions in social sciencesarea, being critical to integrate all those factors in the study the of robot acceptance. These studies will give the directions to the developers about what are the key aspects that people find important, in order to accept the existence, coexistence and the use of such technologies.To contribute to a more comprehensive understanding of the factors that play a major role in accepting robotics technology,a deeper analysis should be promoted about the efficient and meaningful relationships among human and robot. Long-term exploratory studies should be adopted(De Graaf, Allouch, & Klamer, 2015).

On the other side, there are growing fears by human beings regarding to the robot's access into human jobs and its expected control over the “human world”, which will lead to the end of the humans as we know, at least as in people imaginations. First of all, by pointing out to the main reason behind the development of this technology, which was to improve the level of services provided to human beings in various fields of business. On other words, robots are created for serving people, not for replacing them. Secondly, the feel of fear and anxiety that robots may replace humans in some jobs could be understood, and it is somehow a fact. But recent studies suggest that the use of such technology will open the door to millions of new jobs that must be filled to guarantee the success of the technology deployment.Between 2010 and 2015, US industry employed 135,500 new industrial robot, and for the same period, the number of human vacancies increased by 230,000, which indicates a positive impact associated with the robotic technology utilization in business world (Acemoglu & Restrepo, 2017). Finally, the research has shown the importance of artificial intelligence and machine learning in developing algorithms and programs capable to improverobotsperformance, in a way that makes them able to simulate human behavior in various tasks and jobs. However, AI is still lacking the human intelligence. It is specialized in specific type of tasks and cannot perform the huge number of tasks that human can perform. And even for learning, it is not possible to compare machine learning ability to the human one, at least currently andin theclose future. In addition to that, AI and machine learning are still tools, the fear is not

coming from robots by themselves, they fear comesfromhow humans will use them(Vasilaki, 2018).

Society need to make redouble efforts in the education and the awareness of the new generations about the future trend in the technologies and the associated job opportunities. In the future we will need different skills and abilities to be able to survive. For instance, sectors requiring empathy, social intelligence and creativity are expected to have a high demand in future (Acemoglu & Restrepo, 2017). Moreover, the business sector leaders have to keep watching the new advancements of robotic technology, because the deployment of these technologies into businesses is becoming a necessity, not a choice, in order to survive in the business world.

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