CYBORG AS A SURGEON: A THEORETICAL FRAMEWORK FOR CYBORG ACCEPTANCE IN HEALTHCARE SERVICE

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ABSTRACT

The interest in cyborg technology keeps growing as the human desire to improve their mental and physical capabilities becomes a common dream. Even though this technology is still under development, it has received the attention of many researchers to study the extent of human acceptance to become a cyborg. On the other hand, this research finds that it is important to investigate the possibility of human acceptance to deal with the cyborg, especially in healthcare services encounter. Accordingly, the research has developed a theoretical model for accepting healthcare services provided by the cyborg. The model has been developed based on previous studies related to models and theories of social robot acceptance, being a cyborg acceptance, and new technology acceptance in general. The proposed model assumes that Perceived Usefulness, Perceived Ease of Use, Social influence, Perceived Risk, Empathy, Trust, and Emotions (Positive and Negative emotions and Anxiety) could be the key drivers of the intention to use the proposed services.

KEYWORDS: Cyborg, Nanotechnology, Robot, Technology Acceptance, Healthcare Services.

1. INTRODUCTION

Besides cultural assumptions of what may be considered "incomplete," "normal," or "improved", a belief in the ability of technology to enhance body's natural capabilities has led to a variety of body-altering techniques that doesn't only restore functions but may exceed what is typically considered therapeutic medical intervention. In fact, it raised a strong argument about the ability to enhance the human body according to particular needs or desires (Hogle, 2005). These body-altering techniques are used to produce the "Cyborg", which could be defined as a cognitively or bodily enhancement of humans to form a concept called "Transhumanism". The transhumanism and technology convergence is directing the scientists' efforts toward enhancing human social skills, health, happiness, and intelligence with higher performance than before. Technological implants, brain-computer interfaces, extension and externalization of cognitive functions, and neuronal prosthesis are some examples of Cyborg technologies (Romportl, 2015).

Greguric (2014) pointed out four research areas affecting the development of human enhancement technologies: cognitive sciences, nanotechnologies, information technologies, and biotechnologies. As well, the enhancements could be categorized into the following types:

A. Cognitive abilities enhancement: such as infrared vision, memory enhancement, decision making, and sensory perception, by using technological implants or wearable technologies.

B. Physical capabilities enhancement: such as strength, stamina, and accuracy, by using bionic technology, genetic engineering, and pharmacology.

The technological implants are defined as electronic devices that can be implanted into the human body to improve one's capabilities or for the restoration of lost functions (Pelegrín-Borondo et al., 2017). Moreover, there are different implantable devices in use for different purposes. Researchers and scientists claim that brain-machine interactions will enable humans to log onto the Internet, access different databases, talk new languages fluently and help people with failing memories. It promises to make humans fundamentally different by radically changing their capabilities. Furthermore, humans could be able to control devices remotely using their thoughts (McGee & Maguire, 2007).

The boundaries between what considered human and what considered machine is getting unclear, as technology becomes close to being embedded within the human body (Britton & Semaan, 2017). Meanwhile, human interests in reinforcing one's emotional, cognitive and physical abilities are seen as a common dream among human-being individuals, which is associated with improving the quality of human life. Some types of enhancements are already available through surgeries, wearables, pharmaceutical compounds and technological implants (Gauttier, 2018). For instance, the implanted Radio Frequency Identification Device (RFID) can transmit data numbers as pulses to be used for credit cards and door access control (Warwick, 2016). Based on their use, some of these enhancements are already accepted by society, such as cosmetic surgeries, wearables, and pharmaceuticals. However, the acceptance of technological implants is still under investigation. The innovation in biomedicine, genetics, robotics, and nanotechnology is making it possible to produce hybrid bodies that combine biological and technological parts (Kostrica, 2018; Triviño, 2015). Additionally, reducing the size of the electronic components has introduced the Nanotechnology (Nanoimplants), which are small devices that can be implanted inside the human body, to improve human physical and cognitive capabilities (Pelegrín-Borondo et al., 2016; Reinares-Lara et al., 2016). It had been seen as science fiction for using insideable technologies for healthy people to increase their innate capabilities. Nowadays, the market has accepted different types of such technologies which proves that technology keeps progressing. The expectations regarding the cyborg market are promising for a reputable business with a potentially significant impact on future technologies and human societies (Pelegrín-Borondo et al., 2018). As per Pelegrín-Borondo et al. (2017), the use of physical and technological implants to compensate physical disabilities and increase attractive power is already accepted by society. Moreover, the technological implants to increase innate human capacity are partially accepted and further investigations have been established to formulate a complete picture of users' acceptance of these technologies. In other words, the acceptance of creating cyborgs is still under investigation, as the technology itself is under development (Reinares-Lara et al., 2018). Nevertheless, the aim of this research is to investigate the acceptance of cyborg as an entity in society, its development as a technology, and how humans will perceive cyborg individuals once they become a reality. In addtion, the research is investigating the acceptance of cyborg services compared to human services, especially in the healthcare sector, and proposing a theoretical model that can identify the choice criteria of cyborg services.

2. LITERATURE

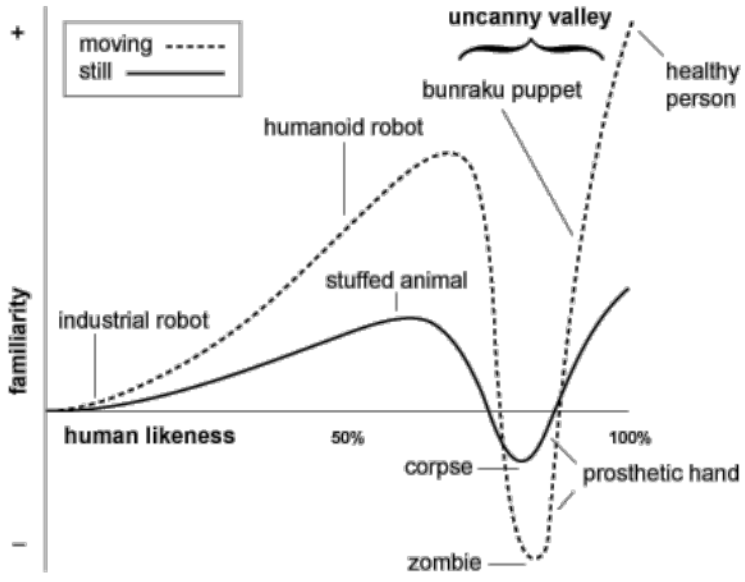
When cyborg technology will be established, people's understanding of technology design and use must be shifted to perceive the differences between traditional technology and new technology applications (Britton & Semaan, 2017). Also, the development of these technologies is important for the future of neural prosthetic inventions. No much is known about the moral attitude of people toward the ratio between risk and benefits of using such technology and about their preferences,

expectations, and needs. Furthermore, the ethical issues related to the associated risk with these technologies is an important topic that should be discussed. As well as the acceptance, which could be shifted from positive to negative state, as the use will be shifted from therapy to enhancement. For instance, the cochlear Implant could be considered a therapy device if the user has deafness. If the user has no hearing issues, then it could be considered as an enhancement. The successes of these technologies could depend on the offered benefits and people's perception of these benefits (Schicktanz et al., 2015).

The technological implants to restore physical functions and physical implants to increase seductive strength are already accepted by society (Pelegrín-Borondo et al., 2017). However, few studies have been conducted to investigate the acceptance of implants for enhancement applications and to create cyborgs (e.g. Olarte- Pascual et al., 2015; Pelegrín-Borondo et al., 2018; Pelegrin-Borondo et al., 2017; Pelegrín-Borondo, Reinares-Lara, et al., 2017; Pelegrín-Borondo et al., 2016; Reinares-Lara el al., 2018; Reinares-Lara et al, 2016). Whereas, this research is about investigating the acceptance of cyborg as an entity.

In general, humans will start to use the perceptual cues and former experiences to classify an object (e.g. Human and Cyborg) and to effectively expect their behavior. In this stage, human already recognizes the abnormality of the other human, from the physical structure (e.g. wearables) or through the behavior (e.g. implants). This stage is very important to avoid falling in “Uncanny Valley”, in which the human will feel with unfamiliarity while interacting with human-like objects (Stein & Ohler, 2017). Originally, uncanny valley theory (Fig.1) was introduced by Mori (1970) to propose the relation between human-likeness and familiarity while dealing with industrial robots. The theory proposed that, at some point (First Peak), maximum familiarity would be achieved once the robots become human-like in terms of behavior and appearance. Furthermore, the motion will enhance familiarity perception. However, the author pointed out the feel of strangeness that could drop familiarity to the negative portion, which is representing the “Uncanny Valley”. The author has mentioned an important point regarding the prosthetic hand, which is representing one of the cyborg shapes. He believed that, as the enhanced prosthetic hand looks like normal ones, humans would perceive familiarity. However, once humans figure out the abnormality of this hand, the familiarity curve will drop to the uncanny valley and humans could feel with eeriness.

Figure 1. Uncanny valley theory (Mori, 1970, p.33).



Some authors refer to the problem of trust when humans meet strangers. They mentioned the role of facial expressions in affecting trust behavior. Scharlemann et al. (2001) investigated the relationship between facial characteristics and trust while interacting with others. Their study claimed that facial expressions (e.g. smile) can stimulate trust behavior. Additionally, for life-like agents, trustworthiness could be achieved by enhancing their competence (Mulken et al., 1999). In the same context, empathy and emotions can overcome the uncanny valley's negative outcomes. Emotions have been considered as a way to distinguish humans from objects and machines. Also, the ability to express basic emotions is proof of humanity (Heisele et al., 2002). In fact, the idea is about the mismatch between human expectations and perception to avoid uncanniness. For instance, the ability of robots to express emotions will fall into "Uncanny Valley" if humans expect that a robot will not be able to do that, which in turn could produce eeriness feeling. However, their ability to experience and detect emotions without expressing them could keep them in the same area at the First Peak (Koschate et al., 2016). Moreover, as the proposed relation between humans and cyborgs will include direct interaction, it is essential to investigate the impact of anxiety on the interaction. Indeed, the expected anxiety is a reflection of the abnormality and superpower associated with cyborg technology. Factually, anxiety problem could not be related to the technology itself, rather than it could be an emergence of this negative feeling while interacting with it (Oh et al., 2017). Nevertheless, changing the attention to be toward the technology benefits could help in reducing anxiety associated with using it (Reinares-Lara et al., 2016). Meanwhile, some studies claimed that anxiety is not a significant determinant of the intention toward new technologies (Pelegrín-Borondo et al., 2017; Venkatesh et al., 2003).

As cyborg is still an outcome of technological innovations, it could be worthy to stimulate the acceptance of a cyborg throughout the acceptance of new technologies, such as robots and the acceptance to become a cyborg. In this context, different models and theories have been utilized in studying the acceptance of such technologies. The research will consider the following theories and models in studying the acceptance of Cyborg:

1. Technology Acceptance Model (TAM1) for Davis (1985) and its extensions TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008).
2. The Unified Theory of Acceptance and Use of Technology (UTAUT1) for Venkatesh et al. (2003) and its extension UTAUT2 for Venkatesh et al. (2012).
3. The Cognitive-Affective-Normative Model (CAN) for Pelegrín-Borondo et al. (2016), which has been developed to study the acceptance of being a cyborg.

The Perceived Ease of Use (PEU) is one of TAM constructs that represents the effort needed to use a specific system. The second construct of the TAM model is the Perceived Usefulness (PU), which is related to the benefits associated with the use of any technology (Davis, 1985; Heijden, 2004). Humans need to perceive the usefulness of cyborg in terms of its superiority in performance if compared to human performance. Furthermore, Performance Expectancy, which corresponds to Perceived Usefulness, is related to the individual's beliefs about the system's ability to improve their job performance. And Effort expectancy, which corresponds to Perceived Ease of Use, is related to the simplicity of using the system (Venkatesh et al., 2003). It could stimulate the acceptance of dealing with cyborgs if humans find them better than the other options or stimulate the rejections if there are no differences in terms of performance and outcomes. But it is important also to consider the possibility of the low effects of these two constructs in the initial investigation of cyborg acceptance since the technology is still in its novelty stage (Pelegrín-Borondo et al., 2017).

Individuals are members of their social entity. Therefore, other members' opinions and advice toward any behavior or decision could make a difference and could direct that behavior or decision. Social influence was introduced by the Theory of Reasoned Action (TRA) for Fishbein and Ajzen (1975) and the Theory of Planned Behavior (TPB) for Ajzen (1991). And it has been used in the technology acceptance models (Davis, 1989; Venkatesh, 2000). As well, it showed a significant impact on the acceptance of Nanoimplants (Pelegrín-Borondo et al.,2015; Pelegrín-Borondo et al., 2017, 2016; Reinares-Lara et al., 2018, 2016), breast augmentation for young women (Moser & Aiken, 2011), and the acceptance of virtual customer integration (Füller et al., 2010).

In Cognitive-Affective-Normative (CAN) model, which was developed by Pelegrín-Borondo et al. (2016) to study the intention behavior toward being a cyborg, the authors used the emotional dimensions: Positive and Negative emotions. While using a specific service, customers may develop positive or negative emotions. The positive ones could be considered important for the future behavior of the customers (Pappas et al., 2013). Likewise, they could be considered important in directing the attitude of customers toward new technologies, and they could enhance the predictive power of technology acceptance models (Kulviwat et al., 2007).

In the healthcare services sector, different studies have been investigating the acceptance of new technologies among the customers and by applying the abovementioned models and theories, such as the acceptance of electronic health systems (e-health), mobile health services (m-health) and health information systems. Some studies found the PEU as the dominant influencer on the intention behavior toward these technologies, as a direct impact (Aggelidis & Chatzoglou, 2009; Keikhosrokiani et al., 2018; Pai & Huang, 2011) or through PU and Attitude dimensions (Chow et al., 2013). However, literature is supporting the PU as the most significant determinant of the intention toward these technologies if compared to PEU (Alsharo et al., 2018; Chang et al., 2015; Chen et al., 2013; Dünnebeil et al., 2012; Hendrikx et al., 2013; Kijsanayotin et al., 2009; Lai, 2014; Dhanar et al., 2017; Phichitchaisopa & Naenna, 2013; Sezgin et al., 2017; Sun et al., 2013) and the Social Influence as well (Bawack & Kamdjoug, 2018; Chu et al., 2018; Guo et al., 2012; Hossainet al., 2019; Jaebeom Lee & Rho, 2013). Also, they have been used in studying the acceptance of wearable technologies for healthcare applications (Li et al.,2016; Nasir & Yurder, 2015; Yang et al., 2016) and in the electronic exchange of information across the healthcare sector too (Ahadzadeh et al.,2015; Chu et al., 2018; Hsieh, 2014).

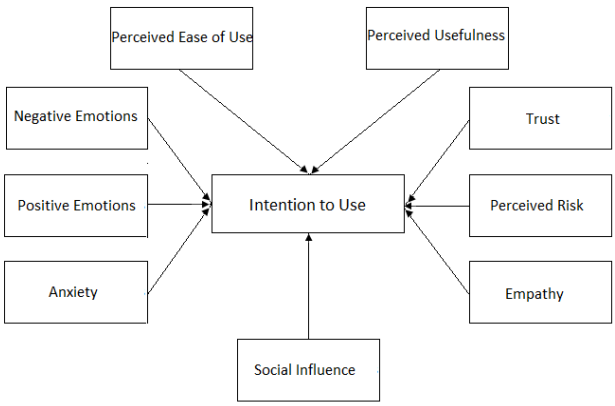
Some authors have pointed out the importance of Perceived Risk in human-robot interactions. They claimed that, once users perceive risk more than benefits, they could avoid the use of robots at all (Hancock et al., 2011). However, the risk impact has been assessed through other dimensions (e.g. trust). But the need is to investigate the impact of this construct by itself and through extending the conceptual models to include Perceived Risk in assessing the intention toward such technologies (Blutet al., 2018). Because the previous studies had pointed out to risk as an outcome (or side effect) of using the new technologies, not as users' perception, and without integrating it into their research models (e.g. Destephe et al., 2015; Lilley, 2012; Matsui et al., 2018; Wirtz et al., 2018; Young et al., 2009). The same issue is also found in studying new technology acceptance in healthcare applications (e.g. Kates et al., 2015; McColl et al., 2013; Moro, 2018; Young et al., 2009).

As for cyborg technology, the term itself is immature and technology is still in the development stage, especially for human enhancement purposes. Besides, nothing is much known about its acceptance in society. However, society already accepted the use of this technology (e.g. technological and physical implants) for restoring physical functions, such as in Cochlear Implants (CI), and for increasing seductive capacities, such as in breast implants (Moser & Aiken, 2011; Pelegrín-Borondo et al., 2017). For instance, CI is seen as a hearing aid for helping deaf people to restore their hearing ability. Whereas, it could be used as an enhancement tool to increase human hearing capacity to beyond the

normality. Therefore, this shift in the use of therapy to enhancement could change people's perception of these technologies (Joseph Lee, 2016). As well, some CI users for therapy purposes are introducing themselves as cyborg entities (Christie & Bloustien, 2010). In the same context, Gao et al. (2015) studied the acceptance of healthcare wearable technologies. The authors pointed out three significant factors related to the intention to use wearable technologies in terms of privacy, healthcare and technology perspectives. Their results suggested that the importance of these factors is depending on their applications (Medical or Fitness). For example, social influence is significantly important for fitness wearables. However, PU is one of the important determinants of medical wearable technology acceptance. On the other side, the ethical issues related to the associated risk with these technologies and their limits are an important topic that should be discussed in future researches. The successes of cyborg technologies could depend on the offered benefits and on people's perception of these benefits (Schicktanz et al., 2015). Ethically speaking, technological implants for therapy use are acceptable. While, it is still unclear for enhancement applications, despite what some authors mentioned the critical need for reformulating the meaning of ethics, in terms of moral judgments, to be applicable to this type of technology (Schermer, 2009). Reinares-Lara et al. (2018) studied the effect of ethics on the acceptance of technological implants. The authors mentioned the ethical problem, which is covering different areas, such as personal security and privacy, and its effect on personal identity. In fact, the study implemented the ethical construct into the CAN model, to investigate its moderating influence on the acceptance of brain implants for increasing capacities. The model is consisting of Performance Expectancy, Effort Expectancy, Emotions (Negative Emotions, Positive Emotions, and Anxiety) and Subjective Norms as the determinants of the intention to use technological implants. Even though results did not prove the moderating effect of the ethical side of the implant's acceptance, it explained the intention differences in using them. Meanwhile, the same results confirmed the impact of performance expectancy, effort expectancy, negative emotions, positive emotions and social influence on the intended behavior, where the last two constructs had the strongest impact. This is consistent with the results of Pelegrín-Borondo et al. (2017) and Pelegrín-Borondo et al. (2016) studies. Consequently, studying the acceptance of cyborg technology should consider the cultural differences during the investigations. For instance, the CAN model could be employed in different countries and integrated with the ethical dimension, to be able to generalize the results, as ethical aspects are inherently cultural (Reinares-Lara et al., 2018).

After all, these studies have been investigating the acceptance of being a cyborg. Whilst, the research purpose is to study the acceptance of cyborg as an entity in the healthcare service encounter, and if compared to the services offered by the human-being. Moreover, since cyborg represents a combination of technology and humanity, both aspects will be considered, to investigate cyborg acceptance. Accordingly, the research proposed the theoretical model, which is shown in figure 2.

Figure 2. Theoretical Model.



3. CONCLUSION

Human body enhancements to create cyborgs are increasing widely and they could reduce the fears of human being extinction because of robots. Hence, human enhancement could be more efficient than producing robots to obtain multilateral embodied intelligence. Because the natural motion skills of human-being require complex structural elasticity and massive computational resources. Nevertheless, the technology is still under development and it could be seen as a futuristic technology that will be able to produce an enhanced human body as imagined in science fiction novels and movies. In fact, it has received the attention of many researchers to study human acceptance to become a cyborg. However, this research was interested in developing a theoretical framework that can be used to investigate the acceptance of the services that could be offered by cyborg, especially in the healthcare service encounter. The research integrated different constructs from previous studies that have been interested in studying new technology acceptance, such as robot and being cyborg acceptance.

The early investigation of the potential acceptance of such technologies could direct the future efforts of technology developers and service providers toward meeting customers' expectations. Meanwhile, the investigation of the service acceptance itself could require future researches to draw more attention to customer expectations of such services. Also, the ethical impact of the proposed service could be required in future investigations, since the cyborg is representing an advance technology that could have the ability to imitate and exceed human abilities. If these futuristic cyborgs become a reality, they could compete with humans and replace them, thereby increasing the professional and social gap between humans and enhanced humans. Another ethical concern is related to the cyborg services availability for high-income customers, which could create a new social class that can buy the proposed superior services, and this could increase the equity gap too.

REFERENCES

Aggelidis, V. P., & Chatzoglou, P. D. (2009). Using a Modified Technology Acceptance Model in Hospitals. *International Journal of Medical Informatics*, *78*(2), 115–126. https://doi.org/10.1016/j.ijmedinf.2008.06.006

Ahadzadeh, A. S., Pahlevan Sharif, S., Ong, F. S., & Khong, K. W. (2015). Integrating Health Belief Model and Technology Acceptance Model: An Investigation of Health-Related Internet Use. *Journal of Medical Internet Research*, *17*(2), 1–27. https://doi.org/10.2196/jmir.3564

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Alsharo, M., Alnsour, Y., & Alabdallah, M. (2018). How Habit Affects continuous Use: Evidence from Jordan's National Health Information System. *Informatics for Health & Social Care*, 14. https://doi.org/10.1080/17538157.2018.1540423

Bawack, R. E., & Kamdjoug, J. R. K. (2018). Adequacy of UTAUT in Clinician Adoption of Health Information Systems in Developing Countries: The Case of Cameroon. *International Journal of Medical Informatics*, *109*, 15–22. https://doi.org/10.1016/j.ijmedinf.2017.10.016

Blut, M., Wünderlich, N. V, & Brock, C. (2018). Innovative Technologies in Branded-Service Encounters: How Robot Characteristics Affect Brand Trust and Experience. In *Thirty Ninth International Conference on Information Systems*. San Francisco. Retrieved from https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1126&context=icis2018

Britton, L. M., & Semaan, B. (2017). Manifesting the Cyborg via Techno-Body Modification : From Human Computer Interaction to Integration. In *CSCW '17 Companion* (pp. 2499–2510). Portland, Oregon: ACM. https://doi.org/10.1145/3025453.3025629

Chang, M. Y., Pang, C., Michael Tarn, J., Liu, T. S., & Yen, D. C. (2015). Exploring User Acceptance of an E-hospital Service: An Empirical Study in Taiwan. *Computer Standards and Interfaces*, *38*, 35–43. https://doi.org/10.1016/j.csi.2014.08.004

Chen, S.-C., Liu, S.-C., Li, S.-H., & Yen, D. C. (2013). Understanding the Mediating Effects of Relationship Quality on Technology Acceptance: An Empirical Study of E-Appointment System. *Journal of Medical Systems*, *37:9981*, 1–13. https://doi.org/10.1007/s10916-013-9981-0

Chow, M., Chan, L., Lo, B., Chu, W. P., Chan, T., & Lai, Y. M. (2013). Exploring the Intention to Use a Clinical Imaging Portal for Enhancing Healthcare Education. *Nurse Education Today*, *33*(6), 655-662. https://doi.org/10.1016/j.nedt.2012.01.009

Christie, E., & Bloustien, G. (2010). I-cyborg: Disability, affect and public pedagogy. *Discourse: Studies in the Cultural Politics of Education*, *31*(4), 483-498. https://doi.org/10.1080/01596306.2010.504364

Chu, X., Lei, R., Liu, T., Li, L., Yang, C., & Feng, Y. (2018). An Empirical Study on the Intention to Use Online Medical Service. In *2018 15Th International Conference on Service Systems and Service Management (Icsssm)*. https://doi.org/10.1109/ICSSSM.2018.8464965

Davis, F. D. (1985). *A technology acceptance model for empirically testing new end-user information systems: Theory and results*. *Doctoral dissertation*. Massachusetts Institute of Technology.

Davis, F. D. (1989). Perceived Usefulness , Perceived Ease Of Use , And User Acceptance. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

Destephe, M., Brandao, M., Kishi, T., Zecca, M., Hashimoto, K., & Takanishi, A. (2015). Walking in the Uncanny Valley: Importance of the Attractiveness on the Acceptance of a Robot as a Working Partner. *Frontiers in Psychology*, *6*, *204*. https://doi.org/10.3389/fpsyg.2015.00204

Dünnebeil, S., Sunyaev, A., Blohm, I., Leimeister, J. M., & Krcmar, H. (2012). Determinants of Physicians' Technology Acceptance for E-Health in Ambulatory Care. *International Journal of Medical Informatics*, *81*(11), 746–760. https://doi.org/10.1016/j.ijmedinf.2012.02.002

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Füller, J., Faullant, R., & Matzler, K. (2010). Triggers for Virtual Customer Integration in the Development of Medical Equipment - From a Manufacturer and a User's Perspective. *Industrial Marketing Management*, *39*, 1376–1383. https://doi.org/10.1016/j.indmarman.2010.04.003

Gao, Y., Li, H., & Luo, Y. (2015). An Empirical Study of Wearable Technology Acceptance in Healthcare. *Industrial Management and Data Systems*, *115*(9), 1704–1723. https://doi.org/10.1108/IMDS-03-2015-0087

Gauttier, S. (2018). 'I've got you under my skin' – The Role of Ethical Consideration in the (non-) Acceptance of Insideables in the Workplace. *Technology in Society*, *56*, 93–108. https://doi.org/10.1016/j.techsoc.2018.09.008

Greguric, I. (2014). Ethical issues of human enhancement technologies: Cyborg technology as the extension of human biology. *Journal of Information, Communication and Ethics in Society*, *12*(2), 133–148. https://doi.org/10.1108/JICES-10-2013-0040

Guo, X. T., Yuan, J. Q., Cao, X. F., & Chen, X. D. (2012). Understanding the acceptance of mobile health services: A service participants analysis. In *International Conference on Management Science and Engineering - Annual Conference Proceedings* (pp. 1868–1873). IEEE. https://doi.org/10.1109/ICMSE.2012.6414426

Hancock, P. A., Billings, D. R., Schaefer, K. E., Chen, J. Y. C., De Visser, E. J., & Parasuraman, R. (2011). A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction. *Human Factors*, *53*(5), 517–527. https://doi.org/10.1177/0018720811417254

Heisele, B., Serre, T., Pontil, M., Vetter, T., & Poggio, T. (2002). Categorization by Learning and Combining Object Parts. *Advances in Neural Information Processing Systems*, *14*(2), 1239–1245.

Hendrikx, H. C. A. A., Pippel, S., van de Wetering, R., & Batenburg, R. S. (2013). Expectations and Attitudes in eHealth: A Survey Among Patients of Dutch Private Healthcare Organizations. *International Journal of Healthcare Management*, *6*(4), 263–268. https://doi.org/10.1179/2047971913Y.0000000050

Hogle, L. F. (2005). Enhancement Technologies and the Body. *Annual Review of Anthropology*, *34*, 695–716. https://doi.org/10.1146/annurev.anthro.33.070203.144020

Hossain, A., Quaresma, R., & Rahman, H. (2019). Investigating Factors Influencing the Physicians' Adoption of Electronic Health Record (EHR) in Healthcare System of Bangladesh: An Empirical Study. *International Journal of Information Management*, *44*, 76–87. https://doi.org/10.1016/j.ijinfomgt.2018.09.016

Hsieh, P. (2014). Physicians ' Acceptance of Electronic Medical Records Exchange : An Extension of the Decomposed TPB Model with Institutional Trust and Perceived Risk. *International Journal of Medical Informatics*, *84*(1), 1–14. https://doi.org/10.1016/j.ijmedinf.2014.08.008

Kates, M., Ball, M. W., Patel, H. D., Gorin, M. a, Pierorazio, P. M., & Allaf, M. E. (2015). The Financial Impact of Robotic Technology for Partial and Radical Nephrectomy. *Journal of Endourology*, *29*(3), 6. https://doi.org/10.1089/end.2014.0559

Keikhosrokiani, P., Mustaffa, N., Zakaria, N., & Baharudin, A. S. (2018). User Behavioral Intention Toward Using Mobile Healthcare System. In *Consumer-Driven Technologies in Healthcare* (pp. 128–143). Pennsylvania, USA: Information Resources Management Association. https://doi.org/10.4018/978-1-5225-6198-9.ch022

Kijsanayotin, B., Pannarunothai, S., & Speedie, S. M. (2009). Factors Influencing Health Information Technology Adoption in Thailand's Community Health Centers: Applying the UTAUT Model. *International Journal of Medical Informatics*, *78*(6), 404–416. https://doi.org/10.1016/j.ijmedinf.2008.12.005

Koschate, M., Potter, R., Bremner, P., & Levine, M. (2016). Overcoming the Uncanny Valley: Displays of Emotions Reduce the Uncanniness of Humanlike Robots. In *The Eleventh ACM/IEEE International Conference on Human Robot Interaction* (pp. 359–365). Christchurch, New Zealand: IEEE.

Kostrica, D. (2018). Medical Approach of Transhumanism. *HUMANUM*, *28*(1), 67–74. Retrieved from http://www.humanum.org.pl/images/2018/humanum_28_1_2018.pdf#page=67

Kulviwat, S., Bruner, G. C., Kumar, A., Nasco, S. A., & Clark, T. (2007). Toward a Unified Theory of Consumer Acceptance Technology. *Psychology & Marketing*, *24*(12), 1059–1084. https://doi.org/10.1002/mar.20196

Lai, Y.-H. (2014). A study on the attitude of use the mobile clinic registration system in Taiwan. *International Journal of Computer and Information Technology*, *3*(4), 750–754.

Lee, Jaebeom, & Rho, M. J. (2013). Perception of Influencing Factors on Acceptance of Mobile Health Monitoring Service: A Comparison between Users and Non-users. *Healthcare Informatics Research*, *19*(3), 167–176. https://doi.org/10.4258/hir.2013.19.3.167

Lee, Joseph. (2016). Cochlear Implantation, Enhancements, Transhumanism and Posthumanism: Some Human Questions. *Science and Engineering Ethics*, *22*(1), 67–92. https://doi.org/10.1007/s11948-015-9640-6

Li, H., Wu, J., Gao, Y., & Shi, Y. (2016). Examining Individuals' Adoption of Healthcare Wearable Devices: An Empirical Study from Privacy Calculus Perspective. *International Journal of Medical Informatics*, *88*, 8–17. https://doi.org/10.1016/j.ijmedinf.2015.12.010

Lilley, S. (2013). *Transhumanism and Society: The Social Debate Over Human Enhancement*. Fairfield, CT, USA: Springer. https://doi.org/10.1007/978-94-007-4981-8

Matsui, D., Minato, T., Macdorman, K. F., & Ishiguro, H. (2018). Generating Natural Motion in an Android by Mapping Human Motion. In *Geminoid Studies* (pp. 57–73). Springer Singapore. https://doi.org/10.1007/978-981-10-8702-8

McColl, D., Louie, W. Y. G., & Nejat, G. (2013). Brian 2.1: A Socially Assistive Robot for the Elderly and Cognitively Impaired. *IEEE Robotics and Automation Magazine*, *20*(1), 74–83. https://doi.org/10.1109/MRA.2012.2229939

McGee, E. M., & Maguire, G. Q. (2007). Becoming borg to become immortal: Regulating brain implant technologies. *Cambridge Quarterly of Healthcare Ethics*, *16*(3), 291–302. https://doi.org/10.1017/S0963180107070326

Mori, M. (1970). The Uncanny Valley. *Energy*, *7*(4), 33–35.

Moro, C. (2018). *Learning Socially Assistive Robot Behaviors for Personalized Human-Robot Interaction*. *Master Thesis*. University of Toronto. Retrieved from http://hdl.handle.net/1807/82909

Moser, S. E., & Aiken, L. S. (2011). Cognitive and Emotional Factors Associated with Elective Breast Augmentation among Young Women. *Psychology & Health*, *26*(1), 41–60. https://doi.org/10.1080/08870440903207635

Mulken, S. van, André, E., & Müller, J. (1999). An Empirical Study on the Trustworthiness of Life-Like Interface Agents. In *The 8th International Conference on Human-Computer Interaction* (Vol. 2, pp. 152–156). Munich, Germany: DBLP.

Nasir, S., & Yurder, Y. (2015). Consumers' and Physicians' Perceptions about High Tech Wearable Health Products. *Procedia - Social and Behavioral Sciences*, *195*, 1261–1267. https://doi.org/10.1016/j.sbspro.2015.06.279

Oh, C., Lee, T., Kim, Y., Park, S., Kwon, S. bom, & Suh, B. (2017). Us vs. Them: Understanding Artificial Intelligence Technophobia over the Google DeepMind Challenge Match. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17* (pp. 2523–2534). Denver, CO, USA. https://doi.org/10.1145/3025453.3025539

Olarte-Pascual, C., Pelegrín-Borondo, J., & Reinares-Lara, E. (2015). Implants to increase innate capacities: Integrated vs. apocalyptic attitudes. Is there a new market? *Universia Business Review*, *2015*(48), 86–117. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84949637861&partnerID=40&md5=e412b5a12f21962f95d3abfe4bb18e04

Olarte, C., Pelegrín, J., & Reinares, E. (2017). Model of acceptance of a new type of beverage: Application to natural sparkling red wine. *Spanish Journal of Agricultural Research*, *15*(1), 1–11. https://doi.org/10.5424/sjar/2017151-10064

Pai, F. Y., & Huang, K. I. (2011). Applying the Technology Acceptance Model to the introduction of healthcare information systems. *Technological Forecasting and Social Change*, *78*(4), 650–660. https://doi.org/10.1016/j.techfore.2010.11.007

Pappas, I. O., Giannakos, M. N., & Chrissikopoulos, V. (2013). Do Privacy and Enjoyment Matter in Personalized Services? *International Journal of Digital Society*, *4*(1), 705–713. https://doi.org/10.20533/ijds.2040.2570.2013.0091

Pelegrín-Borondo, J., Arias-Oliva, M., Murata, K., & Souto-Romero, M. (2018). Does Ethical Judgment Determine the Decision to Become a Cyborg? *Journal of Business Ethics*, 1–13. https://doi.org/10.1007/s10551-018-3970-7

Pelegrín-Borondo, J., Juaneda-Ayensa, E., González-Menorca, L., & González-Menorca, C. (2015). Dimensions and basic emotions: A complementary approach to the emotions produced to tourists by the hotel. *Journal of Vacation Marketing*, *21*(4), 351–365. https://doi.org/10.1177/1356766715580869

Pelegrin-Borondo, J., Orito, Y., Fukuta, Y., Murata, K., Arias-Oliva, M., & Adams, A. A. (2017). From a Science Fiction to the Reality: Cyborg Ethics in Japan. *ORBIT Journal*, *1*(2), 1–15. https://doi.org/10.29297/orbit.v1i2.42

Pelegrín-Borondo, J., Reinares-Lara, E., & Olarte-Pascual, C. (2017). Assessing the acceptance of technological implants (the cyborg): Evidences and challenges. *Computers in Human Behavior*, *70*, 104–112. https://doi.org/10.1016/j.chb.2016.12.063

Pelegrín-Borondo, J., Reinares-Lara, E., Olarte-Pascual, C., & Garcia-Sierra, M. (2016). Assessing the moderating effect of the end user in consumer behavior: The acceptance of technological implants to increase innate human capacities. *Frontiers in Psychology*, *7:132*, 1–13. https://doi.org/10.3389/fpsyg.2016.00132

Phichitchaisopa, N., & Naenna, T. (2013). Factors Affecting the Adoption of Healthcare Information Technology. *EXCLI Journal*, *12*, 413–436. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4566918/

Reinares-Lara, E., Olarte-Pascual, C., & Pelegrín-Borondo, J. (2018). Do you Want to be a Cyborg? The Moderating Effect of Ethics on Neural Implant Acceptance. *Computers in Human Behavior*, *85*, 43–53. https://doi.org/10.1016/j.chb.2018.03.032

Reinares-Lara, E., Olarte-Pascual, C., Pelegrin-borondo, J., & Pino, G. (2016). Nanoimplants that Enhance Human Capabilities: A Cognitive-Affective Approach to Assess Individuals' Acceptance of this Controversial Technology. *Psychology & Marketing*, *33*(9), 704–712. https://doi.org/10.1002/mar.20911

Romportl, J. (2015). *Beyond Artificial Intelligence: The Disappearing Human-Machine Divide*. https://doi.org/10.1007/978-3-319-09668-1

Scharlemann, J. P. W., Eckel, C. C., Kacelnik, A., & Wilson, R. K. (2001). The value of a smile: Game theory with a human face. *Journal of Economic Psychology*, *22*, 617–640. https://doi.org/10.1016/S0167-4870(01)00059-9

Schermer, M. (2009). The Mind and the Machine. On the Conceptual and Moral Implications of Brain-Machine Interaction. *NanoEthics*, *3*, 217–230. https://doi.org/10.1007/s11569-009-0076-9

Schicktanz, S., Amelung, T., & Rieger, J. W. (2015). Qualitative assessment of patients' attitudes and expectations toward BCIs and implications for future technology development. *Frontiers in Systems Neuroscience*, *9:64*. https://doi.org/10.3389/fnsys.2015.00064

Schifter, D. E., & Ajzen, I. (1985). Intention, Perceived Control, and Weight Loss: An Application of the Theory of Planned Behavior. *Journal of Personality and Social Psychology*, *49*(3), 843–851. https://doi.org/10.1037/0022-3514.49.3.843

Sezgin, E., Özkan-Yildirim, S., & Yildirim, S. (2017). Investigation of Physicians' Awareness and Use of M-Health Apps: A Mixed Method Study. *Health Policy and Technology*, *6*(3), 251–267. https://doi.org/10.1016/j.hlpt.2017.07.007

Stein, J. P., & Ohler, P. (2017). Venturing into the uncanny valley of mind—The influence of mind attribution on the acceptance of human-like characters in a virtual reality setting. *Cognition*, *160*, 43–50. https://doi.org/10.1016/j.cognition.2016.12.010

Sun, Y., Wang, N., Guo, X., & Peng, Z. (2013). Understanding the Acceptance of Mobile Health Services : A Comparison and integration of alternative models. *Journal of Electronic Commerce Research*, *14*(2), 183–200. Retrieved from http://web.csulb.edu/journals/jecr/issues/20132/paper4.pdf

Triviño, J. L. P. (2015). Equality of Access to Enhancement Technology in a Posthumanist Society. *Dilemata*, *7*(19), 53-63. Retrieved from https://www.dilemata.net/revista/index.php/dilemata/article/view/400

van der Heijden. (2004). User Acceptance of Hedonic Information Systems. *MIS Quarterly*, *28*(4), 695. https://doi.org/10.2307/25148660

Venkatesh, V. (2000). Determinants of Perceived Ease of Use : Integrating Control , Intrinsic Motivation , and Emotion into the Technology Acceptance Model. *Information System Research*, *11*(4), 342–365. https://doi.org/10.1287/isre.11.4.342.11872

Venkatesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences*, *39*(2), 273–315. https://doi.org/10.1111/j.1540-5915.2008.00192.x

Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology : Extending the Unified Theory od Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157–178. https://doi.org/10.2307/41410412

Warwick, K. (2016). Transhumanism: Some Practical Possibilities. *FIfF-Kommunikation. Zeitschrift Für Informatik Und Gesellschaft*, (2), 24–27. Retrieved from http://www.fiff.de/publikationen/fiff-kommunikation/fk-2016/fk-2016-2/fk-2016-2- content/fk-2-16-p24.pdf

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. https://doi.org/10.1108/JOSM-04-2018-0119

Y, M. D. I., Reza, M., Meyliana, Widjaja, H. A. ., & Hidayanto, A. N. (2017). Acceptance of HIS Usage Level in Hospital with SEM-PLS as Analysis Methodology: Case Study of a Private Hospital in Indonesia. In

2016 International Conference on Information Management and Technology (ICIMTech) (pp. 112–117). Bandung, Indonesia: IEEE. https://doi.org/10.1109/ICIMTech.2016.7930313

Yang, H., Yu, J., Zo, H., & Choi, M. (2016). User Acceptance of Wearable Devices: An Extended Perspective of Perceived Value. *Telematics and Informatics*, *33*(2), 256–269. https://doi.org/10.1016/j.tele.2015.08.007

Young, J. E., Hawkins, R., Sharlin, E., & Igarashi, T. (2009). Toward acceptable domestic robots: Applying insights from social psychology. *International Journal of Social Robotics*, *1*(1), 95–108. https://doi.org/10.1007/s12369-008-0006-y