CASE STUDY

Forecasting Adoption of Telepresence Robot Technology

ARVIND RANGASWAMY

Background

In 2014, Satya Nadella took over as CEO of Microsoft following the resignation of Steve Ballmer. Under the new CEO, Microsoft has sought to distance itself from the "family of devices" mantra of the former CEO[1]. Instead of the device-centered approach, Nadella issued the following mission statement for Microsoft moving forward: "[T]o empower every person and every organization on the planet to achieve more"[2]. In pursuit of this mission, Nadella advocates for a mobile-first, cloud-first focus, where mobile-first refers to not just the mobility of devices, but also the mobility of experiences[3]. To reinforce this new focus, in 2016 Microsoft spent $26.2 billion to acquire LinkedIn, its largest acquisition ever[4]. Exhibit 1 summarizes important Microsoft acquisitions since the year 2000 to support its growth. In recent years, its acquisitions reflect its growing presence in enterprise collaboration, communications, and networks (e.g., Yammer, Skype, and Sunrise[5]). Microsoft is now attempting to build a growing presence in the area of Unified Communications (UC), a field traditionally dominated by companies such as Cisco, Avaya, and ShoreTel[6]. As summarized in Exhibit 2, Microsoft now only trails Cisco within the Enterprise UC market space and aims to overtake Cisco[7].

Microsoft's corporate strategy and planning department is now assessing how to further the company's emphasis on mobile experiences within the enterprise arena. Surveys of customer preference for enterprise UC indicate a relatively even split between Microsoft and Cisco. Several executives within Microsoft noted Cisco's partnership with iRobot, the creator of the robotic telepresence unit (RTU) iRobot Ava 500, and were wondering what benefits robotic telepresence technology would offer enterprises, and what applications of this technology would be most relevant within enterprises. One group within the company advocated a "watch and wait" approach to learn from the experiences of Cisco and others while being prepared to be a fast follower if the technology takes off. Yet others advocated a "lead the world" approach that would require the company to take an active role in developing and promoting the telepresence robot technology, and working closely with lead users to identify profitable applications. As a first step to resolving these two conflicting approaches, the company decided to undertake a forecasting analysis of mobile robotic telepresence technology (MRTT). The company hoped that such an analysis would provide guidance for deciding whether to make major investments and/or acquisitions related to this technology to further its corporate mission.

Mobile Robotic Telepresence Technology (MRTT)

MRTT enables the operation of semi-autonomous robots from a distance, and represents a combination of (1) teleoperation and (2) telepresence. The robot is operated by a remote user, and those in presence of the robot are called local users, and the location of the robot is the local environment[8] [10]. Telepresence gives the remote user the ability to be present at a distant location (e.g., at a meeting) even when not physically there. Depending upon the maker and the product version, an RTU either comes equipped with a screen or allows connection to individual devices with screens (e.g. a mobile phone or tablet). In addition to the ambulatory capabilities, the equipment incorporates a microphone, video camera, and wireless transmitter to communicate via an Internet connection. The potential benefits of robotic telepresence use within the office include decreased traveling, immediate access to others, decreased business expenses, and perhaps most importantly, past research suggests that robotic telepresence enables collaboration similar to physical interaction that does not happen with a smartphone or tablet alone[8]. Figure 2 shows some examples of RTU products currently available for enterprise use. These types of models for office use (and, possibly for home use) are generally easy to use with little learning involved (once they are properly installed within an enterprise).

In 2015, the RTU market was valued at $825 million and one forecast suggests it will become a $7 billion market by 2022[9] with a CAGR of 53.62% through 2020[10]. The growth in global RTU shipments is due in part to more companies introducing products into the market[11].

Exhibit 3 lists five different RTUs that are currently available. Notably, Double 2, Beam+, and PadBot rely on a "bring-your-own-device" business model, which enables the product to be sold at lower price points. The end-user supplies the device (e.g. an Apple iPad). Other RTU's such as VGo, Ava 500 and BeamPro, are marketed as "all-in-one" products that are sold at higher price points. The higher prices can be attributed to the more extensive autonomous capabilities of these products. In particular, iRobot's Ava 500 offers functionalities such as automatic office mapping, thereby requiring less end-user involvement and seamless enterprise integration.

Microsoft has had some experience in using an RTU product developed by Suitable Technologies, the creator of Beam+ Smart Presence System (BSPS): https://www.youtube.com/watch?v=L2c_ieRPFP4.

Forecasting considerations

There are a number of uncertainties surrounding the market acceptance of telepresence robot technologies, especially for gaining border acceptance beyond enthusiastic lead users.

Technological Uncertainties

While telepresence robot technology seems to have a promising future, market success depends on the ability of the technology to deliver distinct benefits in well-defined applications. The early adopters have experimented with different applications in several different industries, such as enterprise management, hospital/medical services, education, home care, military/defense, exploration, disaster recovery, and events. If any of these areas show great promise, then research and development are likely to shift to those areas. Here are some potential areas for the application of RTUs (Source: Jeffrey Funk, National University of Singapore).

Global organizations/businesses

- Meetings, collaboration, sales & marketing
- Auditing, inspection & maintenance

Hospital/Medical Centers

- Provide interface to doctors and specialists to communicate with patients remotely
- Tele-operation

Education

- Enable educational institutes to engage the best experts and educators around the world to provide teaching
- Mobility will enhance classroom interactions

Home Care

- Companion for elderly living alone
- Situation-specific intelligent–reminding (e.g. taking medication)

- Alert message when emergency detected

Military Police Security

- Area monitoring by military, police, and security personnel
- Fire detection applications
- Allowing users to patrol and examine remote areas
- Perform precision observations and data collection without experiencing the hazard

Exploration

- Deployment in underwater environments to produce interactive webcasts
- Navigate to areas that are difficult and impossible to reach by humans (e.g. natural resource exploration)

Disaster Recovery

- Deployment for use in disaster recovery in earthquake, nuclear disaster e.g. Fukushima

Events/Conferences

- Presenting paper, attending presentation, participating in panel discussions, and co-chairing a technical session
- A "telepresence hall" for presentations and/or professional networking
- Museums could arrange tele-presence visiting to examine exhibits from different angles in a museum. (Australian National Museum, 2012)

The year 2012 was expected to be a landmark for the adoption of RTU technology. Although sales did grow in 2012, it was far from being a landmark year partly because of the reliability of Internet and WiFi communications (for example in medical applications). Another factor was the high total cost of acquiring and using the technology[12]. Even though these barriers should decrease in the future, the extent to which these barriers can be overcome depends on such factors such as the geographical area where the users and the RTUs are located, availability of resources, and importantly, the enterprise culture.

There is also substantial uncertainty due to lack of software and technology standardization, especially in the location where the units are deployed. Most systems currently use freemium software such as Skype, but more diverse platforms are needed to accommodate the diversity of technologies used within enterprises[12]. For example, some enterprises use both Cisco and Microsoft UC products, depending upon which technology fits the individual needs within the enterprise. If Microsoft pursues the MRTT market aggressively, it needs to not only integrate its own technologies into an RTU, but it also needs to integrate, or support, technologies offered by other UC companies.

Market Uncertainties – the value of "being there"

Several quantitative and qualitative assessments have generated mixed results for the added value of robotic telepresence. In one survey that compared communications of face-to-face (FTF), audio only (AO), video conferencing (VMC), telepresence robot (TPR), and instant messaging/chat (IM), TPR only outperformed IM[13] (see Exhibit 5).

Other studies have reported more favorable findings[14], suggesting that TPR allowed for increased participation from users and recipients and increasing their affinity towards the user.

Perhaps these discrepancies in findings can partially be explained by the diversity of contexts in which TPR has been tested. Robotic telepresence is highly domain dependent, and while generalizations may be able to be drawn between certain areas of domain-specific use, broad generalizations cannot be drawn given the variety of factors that influence different domains[15]. There are some similarities in findings reported between home and office settings, particularly with respect to increased number of unplanned (i.e. spontaneous) interactions. More in-depth research is needed to better understand context-specific requirements and appropriately tailor TPR to the needs of the users[15]. For instance, privacy studies are lacking in regards to robotic telepresence and is an area that generalizations cannot be yet be drawn[12] because small-scale studies may not necessarily raise privacy as an issue[14], but it may influence enterprise market adoption.

Despite the potential incremental value of telepresence over face-to-face, the ROI of telepresence seems to be low. For example, if you invest $250,000 to equip one room with telepresence technology, but it is used only a few times a week, it will take several years to recover that investment, much less show a positive ROI. Thus, ROI is highly dependent on the extent to which the technology is used on a continuous basis.

In sum, while empirical evidence suggests potential value-add of robotic telepresence within the workplace, there are still many uncertainties to be resolved.

Forecasting Robotic Telepresence Sales

One company that follows this industry has reported that 6,500 units of RTU were shipped worldwide in 2016, with a projection that 32,000 units will be shipped in 2020[16] (See Exhibit 6).

Independent forecasts of RTU adoptions using the Bass model[17]

Unlike forecasting sales or shipments, the Bass model forecasts the long-term adoptions (first-time purchase) of a new technology. There are two aspects to developing forecasts of RTU using the Bass model: (1) Forecasting the total eventual market for the technology – this is the eventual number of customers who would adopt the technology. (2) Forecasting the diffusion process describing how adoptions spread among potential customers of the technology.

Forecasting total market potential

At this stage in the evolution of the technology, it is difficult to define the total potential adopters of this technology. Even if the market and technological uncertainties are resolved, not every enterprise may need MRTT products. At the same time, a study by McKinsey research shows that a new class of company is emerging — one that uses collaborative Web 2.0 technologies intensively to connect the internal efforts of employees and to extend the organization's reach to customers, partners, and suppliers[18]. As a result, there is growing use of telepresence technology (i.e. room-based videoconferencing, not just desktop-based videoconferencing) to facilitate enterprise work, and an RTU which combines telepresence with teleoperation will participate in that growth. As enterprises gain experience and value using telepresence technologies, they are more likely to explore ways to enhance some of those applications with RTUs. Exhibit 7 summarizes the adoption patterns for various enterprise technologies from 2006-2016 based on adoptions across companies worldwide in a wide range of industries. For example, Blogs and Social Networks have been adopted by 70% of these companies.

Here are some statistics that may help frame the total eventual market for telepresence:

- According to American Community Survey (US Census Bureau), at least 50% of the US workforce has a job with partial telework, and 20-25% of the workforce teleworks with some frequency.[19]
- In Fortune 1000 companies, many employees are not at their desk 50-60% of the time.
- The average attention span of a conference participant increases to 35 minutes for video conferencing, as opposed to audio only. This is probably because they are less likely to multitask during a videoconference.

Forecasting the diffusion process

A key consideration in developing forecasts of the diffusion process for a new technology is an understanding of the diffusion process of analogous products. Several different past technologies may provide suitable analogs based on the similarities in market behaviors between a focal technology and a previous technology. One aspect of market behavior is whether the new technology is expected to substitute for an existing technology. Under this criterion, a potential analogous technology could be fax machines (also called telecopying machines) because it is also a communication technology that substituted for teletype machines within enterprises, gradually gaining adopters as it became more affordable.

Another approach would be to view robotic telepresence as an enterprise technology that enables enterprises to enhance collaborations in entirely new ways, delivering remote mobility and more in-person-like interactions, despite distance barriers. Under this perspective, potential market behavior analogs could be the LinkedIn business-networking site. LinkedIn provides a new way for professionals and companies to find each other for employment, business leads, and freelance engagements, thereby enhancing enterprise collaborations.

3D printing could also be an analog technology because it improves business productivity just as MRTT improves business productivity. 3-D printing offers enhances productivity by allowing companies to make quick prototypes, small lot production such as spare parts, difficult to machine products, etc. Also, similar to MRTT, growth of 3D printing has been inhibited by relatively high cost. In the coming years, however, the cost of 3D printing is expected to decrease by 50%, spurring increased adoption rates[20], and MRT price points are also expected to decrease in a similar manner.

Case study questions

Take the perspective that you are helping Microsoft to forecast the diffusion of robotic telepresence units, and then assess whether a partnership with Suitable Technologies, or an outright acquisition, would be appropriate given Microsoft's stated mission and growth strategy. Specifically, complete the following tasks:

Question 1
Summarize and justify alternative scenarios (i.e., compelling stories about the future) ranging from pessimistic to optimistic regarding the market performance of remote telepresence robots (RTU).

Question 2
Develop forecasts of robotic telepresence penetration in the U.S. market from 2017 to 2026 along with a justification and explanation for your forecasts based on one or more scenarios you developed. (In applying the Bass model, note that market penetration data for the three analog products mentioned in the case, namely, fax machines, LinkedIn, and 3D printers, were all reckoned in terms of the percentage of the target market that adopted the product. Thus, the maximum market potential can be set to 100 for developing the forecasts).

Question 3
Recommend short-term and long-term strategies that Microsoft should pursue based on the forecasts that you develop.

This case describes a business situation using a mix of real and hypothetical data. Information sources have been listed as endnotes and include annual reports, industry reports, and media and press accounts. It does not purport to represent the actual situation facing Microsoft or the decisions made by the company. This case was developed by Professor Arvind Rangaswamy with the assistance of Alex Brown and Jake Thompson.

Exhibits

No	Company	Business	Date	Value
1	Visio Corporation	Wholesale drawing software	Jan 7, 2000	1.375 billion
2	Titus Communications	Cable television	Apr 20 2000	945 million
3	Great Plains Software	Business management software	Apr 5, 2001	940 million
4	Navision	Software programming	Jul 11, 2002	1.45 billion
5	Rare	Software and video games	Sep 24 2002	375 million
6	Tellme Networks	Mobile phone software	Mar 14, 2007	800 million
7	aQuantive	Digital Marketing	Aug 13 2007	6.3 billion
8	Danger	Mobile Internet software	Apr 15, 2008	500 million
9	Fast Search & Transfer	Enterprise search	Apr 25, 2008	1.2 billion
10	Greenfield Online	Search and e-commerce services	Sep 28, 2008	486 million
11	Skype Technologies	Telecommunications	May 10, 2011	8.5 billion
12	Yammer	Social networking	Jun 25, 2013	1.2 billion
13	Nokia mobile unit	Mobile phones smartphones	Sep 2, 2013	7.2 billion
14	Mojang	Video games	Nov 6, 2014	2.5 billion
15	Adallom	Cloud security	Jul 19, 2015	320 million
16	LinkedIn	Professional networking service	Jun 13, 2016	26.2 billion

Exhibit 1: Acquisitions made by Microsoft since 2000 where the value of the acquisition was >$300 million[7].

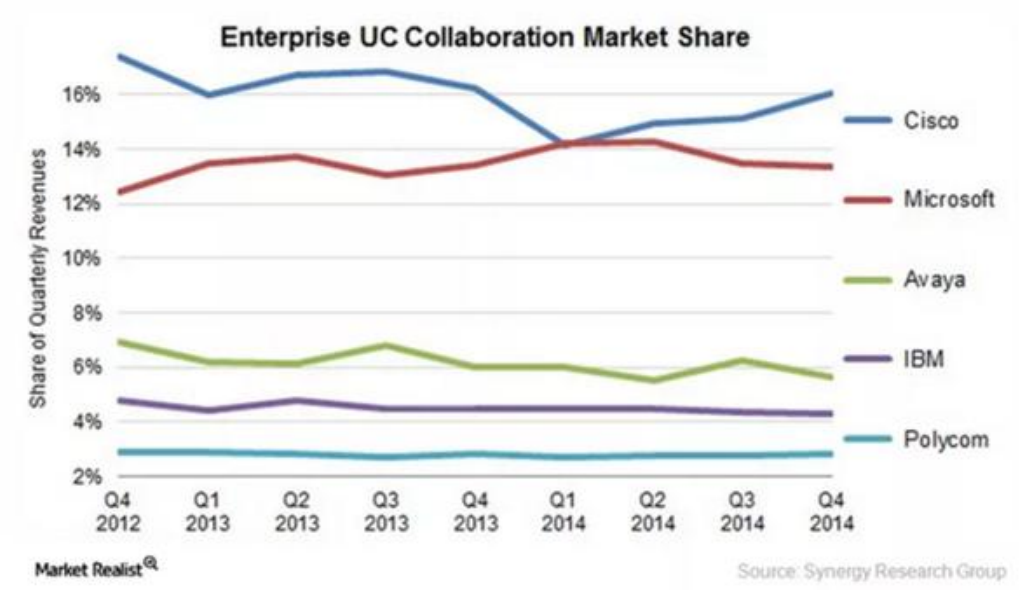

Exhibit 2. An overview of the major players within the UC market space and their respective market shares.

Brand	Model	Price	Interface Included	Recommended Interface Product(s)
Double Robotics	Double 2	$2,500	No	Apple
Suitable Technologies	BeamPro	$13,995	No	Android, Apple, or Microsoft
Inbot Technology Ltd.	PadBot	$449	No	Apple
Verizon	VGo	$5,995	Yes	N/A
iRobot (Cisco)	Ava 500	$69,500	Yes	N/A

Exhibit 3. An overview of different RTUs currently available.

Exhibit 4: Two examples of RTU products for enterprise use. The one on the left is Suitable Technologies BeamPro, and the one on the right is Cisco's iRobot.

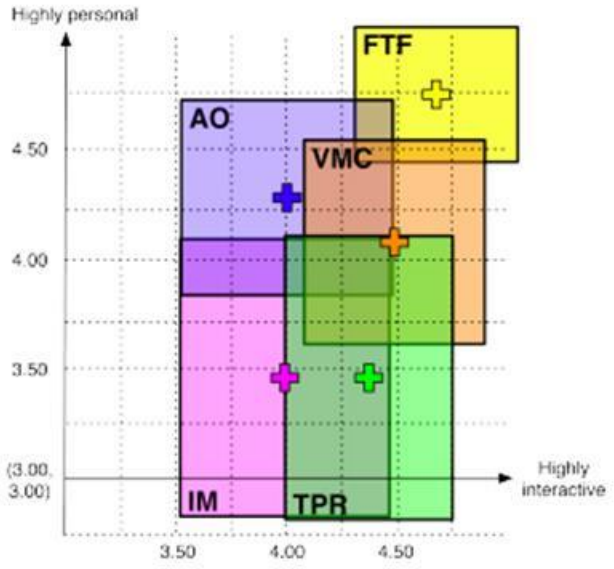

Exhibit 5. Averages and standard deviations for face to face (FTF), phone call (audio only, AO), video conferencing (video-mediated communication, VMC), telepresence robot (TPR), and instant messaging/chat (IM). Plus signs denote averages (for interactivity and personalness), and rectangles denote ± 1 Standard Deviation. The interactivity metric varied from 1 (not at all interactive) to 5 (highly interactive) and personal axis varied from 1 (not at all personal) to 5 (highly personal).

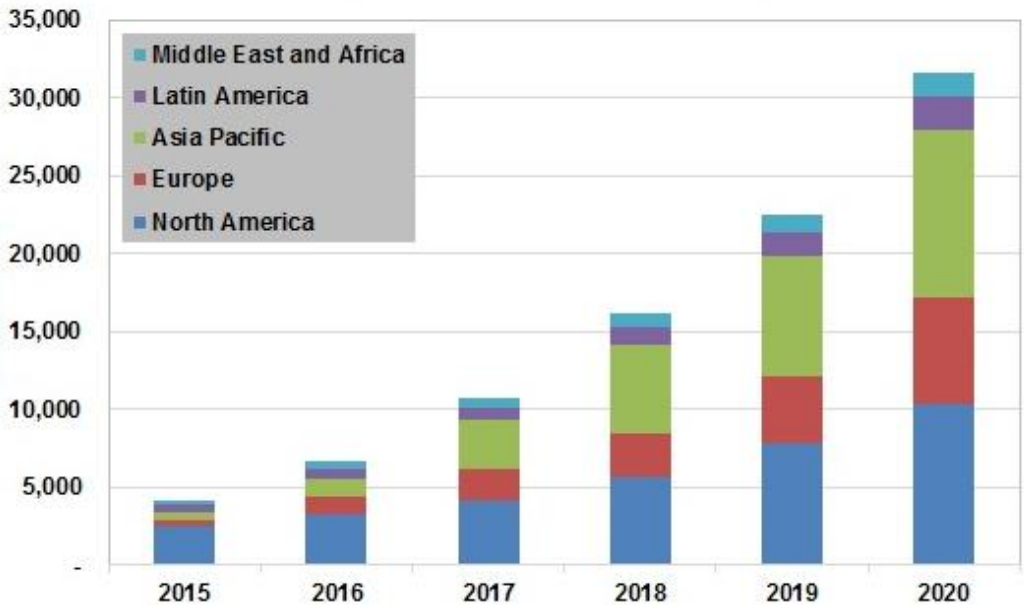

Exhibit 6: Telepresence robot unit shipments forecasts by worldwide regions (2015-2020). (Source: Tractica[16])

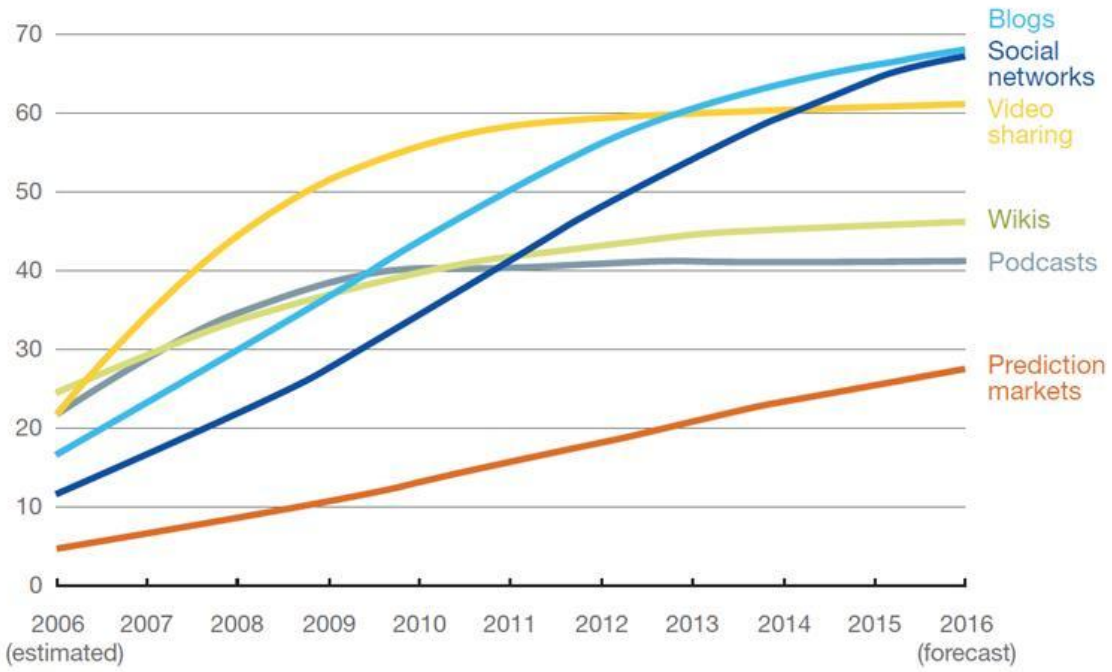

Exhibit 7: Corporate adoption of Enterprise 2.0 technologies. The chart shows the pattern of adoption as a percentage of a representative set of 1,500 companies out of 11,000 tracked by McKinsey & Company[21]. 35% of the companies had adopted these technologies in response to their adoption by competitors.

Acronyms

BSPS: Beam+ Smart Presence System
MRTT: Mobile Robotic Telepresence Technology
RTUs: Robotic Telepresence Units
UC: Unified Communication

---

[1] http://www.bizjournals.com/seattle/blog/techflash/2016/05/microsofts-next-act-satya-nadella-lays-out-vision.html
[2] http://fortune.com/2016/03/30/microsoft-cortana-chat-bot/
[3] http://www.geekwire.com/2015/exclusive-satya-nadella-reveals-microsofts-new-mission-statement-sees-more-tough-choices-ahead/
[4] http://theweek.com/articles/629803/microsoft-wants-monopolize workplace
[5] http://www.fastcompany.com/3060886/why-microsoft-buying-linkedin-for-26b-is-a-smart-move
[6] http://www.computerweekly.com/feature/Microsoft-Lync-opens-up-unified-communications-market
[7] http://marketrealist.com/2016/01/microsoft-keen-moving-unified-communications-space/
[8] http://www.hindawi.com/journals/ahci/2013/902316/
[9] http://www.telepresenceoptions.com/robotic-telepresence/
[10] http://www.businesswire.com/news/home/20160705005547/en/Global-Telepresence-Robots-Market-Growth-53.62-CAGR
[11] http://www.businessinsider.com/growth-statistics-for-robots-market-2015-2
[12] Kristoffersson, A., Coradeschi, S., & Loutfi, A. (2013). A review of mobile robotic telepresence. Advances in Human-Computer Interaction, 2013, 3.
[13] Tsui, K. M., Desai, M., & Yanco, H. A. (2012, March). Towards measuring the quality of interaction: communication through telepresence robots. In Proceedings of the Workshop on Performance Metrics for Intelligent Systems (pp. 101-108). ACM.
[14] Venolia, G., Tang, J., Cervantes, R., Bly, S., Robertson, G., Lee, B., & Inkpen, K. (2010, April). Embodied social proxy: mediating interpersonal connection in hub-and-satellite teams. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 1049-1058). ACM.
[15] Rae, I., Venolia, G., Tang, J. C., & Molnar, D. (2015, February). A framework for understanding and designing telepresence. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (p. 1552-1566). ACM.
[16] https://tractica.omdia.com/newsroom/press-releases/telepresence-robot-shipments-to-total-nearly-100000-units-by-2020/
[17] Bass, F. (1969) "A New Product Growth Model for Consumer Durables" Management Science, Vol. 15 No. 1 p. 215-227.
[18] Bughin J. and M. Chui (2011). The rise of the networked enterprise: Web 2.0 finds its payday. McKinsey Quarterly (Spring).
[19] http://globalworkplaceanalytics.com/telecommuting-statistics.
[20] Siemens. *3D Printing: Facts & Forecasts.* 2013.
[21] Bughin, J. (2015). Taking the measure of the networked enterprise. McKinsey Quarterly (October).