The Quantified Workplace:

How the Internet of Things will Impact Work in the Future

Nancy L. Russo, Northern Illinois University and Malmö University, nrusso@niu.edu

The Internet of Things and the Quantified Self

The Internet of Things refers to "objects that are readable, recognizable, locatable, addressable, and controllable via the Internet – whether via RFID, wireless LAN, wide-area network, or other means" (National Intelligence Council, 2008). Technologies such as near-field communications, real-time localization, and embedded sensors turn "everyday object into smarts objects that can understand and react to their environment" (Kortuem et al., 2010, p. 30). This implies that almost any object, from a thermostat to a running shoe, can become part of the Internet of Things. The true power of IOT comes from the ability to combine data from several heterogeneous sources and share that data with other systems (Kranz et al., 2010).

Today there are three main market segments where there is significant IOT activity: smart homes and buildings, transportation, and personal health tracking (Atzori, 2010; Swan, 2012). In homes and buildings sensors, thermostats, and heating and cooling systems are connected with applications to manage energy usage based on occupancy patterns. Trucks, trains, and airplanes may contain components that monitor usage levels and behaviors to determine when maintenance is needed, and communicate that information to both the operator and the manufacturer. "One of the biggest IOT growth areas is measuring individual health metrics through self-tracking gadgets, clinical remote monitoring, wearable sensor patches, Wi-Fi scales, and a myriad of other biosensing applications" (Swan, 2012, p. 218).

Representative of the growing interest in personal health monitoring IOT applications is the Quantified Self movement. The Quantified Self (QS) refers to the ability to capture and track large amounts of data about oneself, typically with the objective of improved health or performance. Simple devices and applications can record data on the number of steps taken or miles run, the number of calories burned, and the amount and quality of sleep. There are also wearable devices that can measure blood pressure, heart rate, body temperature and blood oxygen levels. Specialized patches can measure blood chemistry and headbands monitor brain activity via EEG to identify seizures and mood changes. This data, as well as other data measured and recorded by the QS participant, can be tracked over time and compared to data from the QS population.

The Internet of Things and the Quantified Workplace

In the workplace, IOT technologies were initially used in a manner analogous to their use in smart homes, controlling lighting, heating and cooling and monitoring energy

usage. Location-based sensors, including RFID, are used to track the movements of employees, and can interact with the lighting, heating and cooling controls. Traditional electronic performance monitoring data (computer use, audio and video monitoring) can be used in conjunction with other data captured by IOT devices. IOT technologies are being tested for use in training (McGowan, 2015), injury prevention (Kortuem et al., 2010), promoting cohesion (Kirkham et al., 2013), space utilization and employee interactions (Mathur et al., 2015a) and security and surveillance (Miorandi et al., 2012).

The consumerization of workplace technology (Harris et al., 2012), wherein employees bring their personal smart phones and health monitors into the workplace, has made it very easy to monitor employee's locations and activities. Already in 2011, over 40% of the devices used to access business applications were the users' personally owned devices (Gens, et al., 2011). The driver of this trend is the workers themselves, possibly because increased accessibility gives workers a sense of autonomy and flexibility that outweighs the downside of increased work demands outside of work hours (Cavazotte et al., 2014).

In some organizations such as BP and Autodesk, fitness tracking devices are provided to employees as part of the corporate wellness program (Nield, 2014). These programs focus on helping people to prevent illnesses or improve health through their behavior, and may also monitor stress levels to manage mental health (Mirarchi et al., 2015). "The potential economic benefits to an organization such as reduced absenteeism, increased productivity, increased stress tolerance and improved decision-making, as well as the physical and mental health benefits for employees, means that there is a strong business case for using the workplace as a vehicle for health promotion efforts of this kind" (Kries & Brodeker, 2004, as cited in McEachan, et al., 2011, p.1)

While the use of IOT technologies in the workplace may appear benign, concerns have been raised regarding the potential for abuse. Having one's location and personal interactions and communications tracked by a Quantified Workplace system may be considered a breach of both work-environment privacy and solitude privacy as defined by Ball et al. (2012). Monitoring and routinization of work processes may have a negative impact on employee work life (Carter et al., 2011). "At a minimum, we can speak of declining welfare for workers and the associated regime of total mobilisation and surveillance corrode workers' health and safety, creating anxiety, burnout and overwork" (Moore & Robinson, 2015, p. 8). The accessibility of data from multiple sources, such as GPS, email, social media and personal devices, allows employers to combine data on behavior at work with other information, search for patterns, and draw conclusions which reflect information that the employee chose not to share her employer (Holtgrewe, 2014).

Designing Quantified Workplace IOT Systems of the Future

Our understanding of IOT systems in the Quantified Workplace (QW) is in its infancy. Early work has focused on creating platforms, standards, and devices. Little work has been done to provide guidance on how organizations should design QW systems that

address the conflicting needs of employees and the organization. A preliminary set of issues that may be used to guide research and development of QW systems, termed the "VALUES" framework, has been developed from an examination of extant IOT/QW research. Concerns related to each of these issues are briefly described below.

Visibility: Relevant data should be presented in a simple, intuitive, actionable format (Mathur, et al., 2015). What data is visible to the employee and to others, and in what format on what platform? Employees prefer to have QW systems running either unobtrusively in the background or to have complete transparency (Kirkham et al., 2013). Is data identified/reported at the individual, group, or organizational level, or controlled by the context (Kortuem et al., 2010)? Is the data visible to other systems or external organizations?

Autonomy: Autonomy is critical to motivation and job satisfaction (Janz et al., 1997). Employees want to have some control over what data is captured and when and what is done with that data. Active monitoring in which employees enter data themselves or opt in to data collection provide more autonomy than passive systems which collect data about employees without their interaction (Jeske & Santuzzi, 2015).

Localization: The context of the employee's movements may be used to determine what data to track or what information to provide to employees (Kortuem et al., 2010). Whereas it is possible to use GPS to continuously track an employee's location, that level of detail may not be appropriate or necessary. Does tracking stop at the end of the workday? Are relationships between employees' location data correlated? Is location data combined with other types of data?

Utilization: How is the data generated by IOT/QW systems used? Some workplace IOT systems run in the background, monitoring and adjusting environmental conditions such as lighting and temperature or providing alerts when air quality is low, for example. Data from individual devices may be used for self-monitoring, where an employee can track her own activity and mood, or can serve as a basis for gamification to encourage desired actions. Using data for employee development purposes versus performance evaluation reduces negative reactions to monitoring (Jeske & Santuzzi, 2015).

Exploration: IOT/QW systems offer the potential for learning and can include a capacity for tailoring by employees (Kirkham et al, 2013). How does the system change over time in response to measures of how it is used? Can employees customize the interface or the particular data collected or the way in which it is reported?

Security: Very often the data captured by IOT/QW systems are personally identifiable, raising issues of authentication, data integrity, and privacy (Atzori et al., 2010). New security techniques are required to control the diffusion of this data inside and outside of the organization. This data must be protected from unauthorized use and risk should be reduced by not storing the data indefinitely.

Conclusion

The IOT/QW issues identified above have implications for individuals, organizations, and society. We can expect these systems to become more pervasive and connected, and it therefore is in our best interest to establish guidelines, policies and standards to protect the rights of tomorrow's workforce while allowing organizations and society to benefit from the opportunities provided by these systems.

References

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. Computer networks, 54(15), 2787-2805.

Ball, K., E. M. Daniel, and C. Stride. (2012) Dimensions of employee privacy: an empirical study. Information Technology & People, 25(4), 376–394.

Carter, B., A. Danford, D. Howcroft, H. Richardson, A. Smith and P. Taylor (2011), ' "All They Lack Is a Chain": Lean and the New Performance Management in the British Civil Service', New Technology, Work and Employment 26, 2, 83–97.

Cavazotte, F., Heloisa Lemos, A. and Villadsen, K. (2014). Corporate smart phones: professionals' conscious engagement in escalating work connectivity. New Technology, Work and Employment, 29: 72–87. doi: 10.1111/ntwe.12022

Gens, F., Levitas, D., & Segal, R. (2011). 2011 Consumerization of IT Study: Closing the "Consumerization Gap". Framingham: International Data Corporation (IDC).

Harris, J., Ives, B., & Junglas, I. (2012). IT consumerization: when gadgets turn into enterprise IT tools. MIS Quarterly Executive, 11(3), 99-112.

Holtgrewe, U. (2014), New new technologies: the future and the present of work in information and communication technology. New Technology, Work and Employment, 29: 9–24. doi: 10.1111/ntwe.12025

Janz, B.D., Colquitt, J.A., & Noe, R. A. (1997). Knowledge Worker Team Effectiveness: The Role of Autonomy, Interdependence, Team Development, and Contextual Support Variables. Personnel Psychology, 50, 877-904.

Jeske, D. & Santuzzi, A.M. (2015). Monitoring What and How: Psychological Implications of Electronic Performance Monitoring. New Technology, Work and Employ ment, 30:1, 62-78,

Kirkham, R., Mellor, S., Green, D., Lin, J. S., Ladha, K., Ladha, C., Jackson, D., Olivier, P., Wright, P. & Ploetz, T. (2013, September). The break-time barometer: an exploratory system for workplace break-time social awareness. In Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing (pp. 73-82). ACM.

Kortuem, G., Kawsar, F., Fitton, D., & Sundramoorthy, V. (2010). Smart objects as building blocks for the internet of things. Internet Computing, IEEE, 14(1), 44-51.

Kranz, M., Roalter, L., & Michahelles, F. (2010, May). Things that twitter: social networks and the internet of things. In What can the Internet of Things do for the Citizen (CIoT) Workshop at The Eighth International Conference on Pervasive Computing (Pervasive 2010) (pp. 1-10).

Kreis J, Bodeker W (2004). Health-related and economic benefits of workplace health promotion and prevention: Summary of the scientific evidence. BKK Bundesverband; Hauptverband der gewerblichen Berufsgenossenschaften -HVBG; Berufsgenossenschaftliches Institut Arebeit und Gesundheit - BGAG.

Mathur, A., Van den Broeck, M., Vanderhulst, G., Mashhadi, A., & Kawsar, F. (2015). Tiny habits in the giant enterprise: understanding the dynamics of a quantified workplace. In Proceedings of the 2015 ACM Int'l Joint Conf. on Pervasive and Ubiquitous Computing (pp. 577-588).

McEachan, R. R., Lawton, R. J., Jackson, C., Conner, M., Meads, D. M., & West, R. M. (2011). Testing a workplace physical activity intervention: a cluster randomized controlled trial. Int J Behav Nutr Phys Act, 8(29), 1-12.

McGowan, M. (October 8, 2015). One Eye on the Future: NIU professors harness an empowering potential of Google Glass. Accessed at http://newsroom.niu.edu/2015/10/08/one-eye-on-the-future/

Miorandi, D., Sicari, S., De Pellegrini, F., & Chlamtac, I. (2012). Internet of things: Vision, applications and research challenges. Ad Hoc Networks, 10(7), 1497-1516.

Mirarchi, D., Vizza, P., Cannataro, M., Guzzi, P. H., Tradigo, G., & Veltri, P. (2015, June). ICT Solutions for Health Education Model. In Computer-Based Medical Systems (CBMS), 2015 IEEE 28th International Symposium on (pp. 31-32). IEEE.

Moore, P., & Robinson, A. (2015). The quantified self: What counts in the neoliberal workplace. New Media & Society. [Accessed September 17, 2015 at http://nms.sagepub.com/content/early/2015/09/10/1461444815604328.abstract]

National Intelligence Council (2008). Disruptive Technologies Global Trends 2025: Six Technologies with Potential Impacts on US Interests out to 2025. Available online: http://www.fas.org.irp/nic/disruptive.pdf (accessed 12 October 2015).

Nield, D (2014) 'In corporate wellness programs, wearables take a step forward' Fortune.com. 15/4/2014 Available at: http://fortune.com/2014/04/15/in-corporate-wellness-programs-wearables-take-a-step-forward/ (accessed 8 August 2015).

Rogers, Y., Hazlewood, W. R., Marshall, P., Dalton, N., & Hertrich, S. (2010). Ambient influence: Can twinkly lights lure and abstract representations trigger behavioral change? In Proceedings of the 12th ACM international conference on Ubiquitous computing (pp. 261-270). ACM.

Swan, M. (2012). Sensor mania! the internet of things, wearable computing, objective metrics, and the quantified self 2.0. Journal of Sensor and Actuator Networks, 1(3), 217-253.