

Smart technologies reveal what impacts workers' productivity the most

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Innovative technologies of Industry 4.0 are in every part of nowadays business processes. Automated guided vehicles, robots, smart tools, augmented and virtual reality—only a shortlist of tools used in small,

medium, and large enterprises around the world. However, the researchers of Kaunas University of Technology, Lithuania mark that employees remain the key factor in every part of the business chain and raise a question—how can contemporary technologies be used to investigate their performance?

Many would agree that warehouse management is a fundamental aspect of the efficiency and effectiveness of every trade or manufacturing company. However, despite all the innovative solutions in the logistics market, warehouses still heavily rely on human operators and their performance. According to Business Wire, more than 80 percent of warehouses today still have no form of automation, meaning all the operations depends only on the employees.

Therefore, the researchers of Kaunas University of Technology (KTU), Lithuania decided to dig deeper into this field and with the help of smart tools to reveal what are the most important factors on logistics workers' productivity.

"Human workers guarantee the flexibility required by material handling processes thanks to their cognitive and physical abilities, which are still hard to replicate with automated systems in a cost-effective way. Therefore, we see a need to consider human and work environment factors to increase business performance, employees' safety, and their well-being," says Alessandro Stefanini, researcher at the Kaunas University of Technology School of Economics and Business in the ERA Chair Industry 4.0 Impact on Management Practices and Economics (IN4ACT) project.

A new approach in the operations management sphere

Study of IN4ACT researchers proposed a new angle to investigate the performance of the employees. While observing the opportunities that

wearable sensors and similar smart tools, like smartphones, or smartwatches are providing to the different types of research, scholars of IN4ACT raised a question—how can wearable sensor tools support the investigation of individual, collaborative, and environmental factors in the operations management sphere?

"The key problem which we aimed to cope with was related to the investigation of individual, collaborative, and environmental factors affecting workers' well-being and productivity during logistics activities. The first point was related to the assessment of whether these aspects were important or neglectable. Secondly, it was interesting to evaluate which factors have the most relevant impacts. In addition, a second motivation for this research is related to the investigation of how smart tools can support the investigation of individual, collaborative, and environmental factors in business management," says Stefanini.

The investigation took place in a logistics hub of one of the largest producers of tissue paper in Europe. The warehouse, located in Lucca, Italy, extends for 24,000 square meters and is dedicated to the storage of paper for hygienic and domestic uses. Monitoring was carried out for three months, and during this time five workers were observed for a total of about 1600 hours.

"Smartwatches were employed to systematically measure operators' behavior-related variables—such as body movement, heart rate, voice, and operators' interactions—during working activities. As regards the environmental aspects, thermo-hygrometer and lux-meter systems—with datalogger function—were synchronized and placed in the warehouse area to constantly monitor and collect data on working conditions. It allowed us to study the behaviors of logistics employees and their environmental conditions in deeper and more efficient ways, directly and without compromising their operational activities," says Stefanini.

Smartwatches reveal the importance of relationships and the environment

This data-driven methodology and tech tools allowed researchers to reach strong qualitative results. Data from heart rate, movement, and voice monitoring revealed that employees' performance is remarkably influenced by human attitudes, interactions, emotions, and environmental conditions, though showing different relationships depending on the individual characteristics of each employee.

"While analyzing the data received from the smartwatches, we concluded that the interactions with the team leader and with the colleagues have different effects on the employee performance based on the time of the day and the individual traits. Although some relationships are theoretically predicted by past researches, analysis of both human and working environmental factors in real settings is almost absent," says the researcher.

When talking about the main findings, it is interesting to notice that the level of interaction with some individuals, according to the researchers, seemed to have more impact on productivity than others. While it is not surprising that productivity of employees decreased in the second half of the shift, with the steepest declining trend in the last two hours. The investigation also showed that the effect of human interaction on performance is dependent on the time of the day: a higher level of interaction seems to be beneficial in the morning, whereas many interactions in the afternoon seem to lower productivity. Similarly, with the help of smart tools researchers were able to notice that some operators were considerably more productive during specific days of the observation.

"Digging deeper into the information provided by the analysis of body

signals, we found that heart rate monitoring in beats per minute (BPM) was the third most important predictor. When BPM is too high, the productivity tends to slightly shrink. Similar evidence also emerges from the analysis of [heart rate](#) peaks, which are usually associated with lower predicted performance—they seem to represent cases of overexertion or altered emotional states. Similarly to BPM, productivity seemed to be greater when the minimum value of [body movement](#) is higher," says Stefanini.

Finally, according to the research, environmental conditions also appeared to have a relevant impact on productivity.

"Specifically, luminosity had a positive effect on performance: the more intense the illumination, the higher the predicted productivity was. The size of this effect changed depending on the individual, with some employees being more affected by this environmental condition than others. Humidity and temperature seemed not to affect performance, except when they were particularly low or high. In particular, high temperature appears to predict lower performance," explains the researcher.

The possibilities of smart tools

The study made by IN4ACT scholars addresses the issue of investigating behavioral factors in business management. The study showed how it is possible and relatively simple to in-depth explore the human and [environmental factors](#) during work activities using body-worn sensors, which record individual, collaborative, and environmental data in real-time.

"This research opens up new avenues for profiling employees and adopting individualized human resource management, providing managers with indications for implementing an operational system

capable of potentially checking and improving workers' well-being and performance. Our findings are promising and encourage further similar studies exploring human and environmental aspects during human-intensive activities," says Stefanini.

More information: Davide Aloini et al, Enhancing operations management through smart sensors: measuring and improving well-being, interaction and performance of logistics workers, *The TQM Journal* (2021). [DOI: 10.1108/TQM-06-2021-0195](https://doi.org/10.1108/TQM-06-2021-0195)

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