Examining the Unified Theory of Acceptance and Use of Technology towards the Application of Collaborative Robots in Garment Factories in Vietnam

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Regarding the robotics and intelligent manufacturing sectors of Industry 4.0 (I4.0), collaborative robots (Cobots), robot models, are a new significant technology of I4.0 and can function together with humans in an uncaged environment to showcase a better performance enhancing safety and productivity (Perez et al., 2019). To the best of the authors' knowledge, academia has not yet explored the garment manufacturers' acceptance intention towards the implication of Cobots in garment factories. Current research on Cobots in garment factories has been limited (Lee et al., 2021). Moreover, Vietnam's textile and garment industry had more than 10,000 enterprises in 2017 and $36.14 billion in 2018 in export turnover as one of the top four Asian countries for garment manufacturing (Nguyen et al., 2019). Hence, Vietnam's textile and garment industry has taken a massive portion of labor and faced enormous challenges and opportunities in the I4.0. Using robots can lose the advantage of cheap worker resources, while it also can improve competitiveness capacities for textile and garment manufacturers (Nhabe Corporation, 2019). Therefore, this study aimed to understand and predict garment employees' cognitive, social, and psychological perspectives as well as behavioral intentions toward Cobot implementations in Vietnam, based on the Unified Theory of Acceptance and Use of Technology of Venkatesh et al. (2003) with three additional variables for Cobot adoption: anxiety, personal innovativeness, and trust. The findings of this study shed some light on academia in understanding influential factors shaping garment employees' intentions towards Cobots adoption and professionals in building up manufacturing strategies utilizing the advantages of Cobots to meet business expectations in the context of garment manufacturing.

The data were collected from a sample of 198 garment employees recruited using a snowball sampling approach based on the network of the researcher's previous working experience in Vietnam. Using an online survey, the participants answered a questionnaire measuring the relationship between variables: performance expectancy, effort expectancy, social influence, facilitating conditions, trust, anxiety, personal innovativeness, and behavioral intentions associated with Cobots, which were measured on a 7-point Likert scale from 1 (Strongly disagree) to 7 (Strongly agree). In addition, participants' previous knowledge of I4.0, Cobots, and demographic characteristics were assessed. Regarding the respondent's characteristics, the data were collected from those who were garment workers in the garment factories (26.77%), followed by engineers (18.69%), and the majority of them have had working experience within ten years (89.41%). Overall, there were 71.72% female and 26.26% male. More than two-thirds of the respondents worked in factories with fewer than 100 production lines (87.94%) and could produce over 1,000,000 garments per month (97.47%). The majority of

participants had heard about the I4.0 (74.75%). Meanwhile, about half of the respondents had not know about the term "Cobots" (55.56%). The data were further analyzed using SPSS 28.0, including normality, internal reliability assessment, exploratory factor analysis, Pearson correlation, and simple regression.

All items of each variable were identified as one factor, and Cronbach's *alpha* reliability values were over .70. All correlations among research variables were significant for the hypothesized relationships ($p < .001$). Based on the simple regression analysis, performance expectancy ($\beta = .53, p < .001$) and effort expectancy ($\beta = .70, p < .001$) positively affect behavioral intention toward the acceptance of Cobots in garment factories. The higher performance expectancy towards the application of Cobots the garment workers had, the better the acceptance of Cobots was. The respondents believed that Cobots could bring higher productivity to the factories and help workers spend less time on job tasks by completing those tasks quicker. In addition, they agreed that it is possible to let Cobots take over workers' positions if Cobots are more effective than workers. Besides, the garment employees will plan or intend to use Cobots in the near future if they feel that Cobots are easy to use, understandable, and clear. Similarly, social influence positively affects behavioral intention ($\beta = .74, p < .001$). This means that when coworkers, factories, or someone important to garment employees suggested that they use Cobots, their intentions will increase. The findings of this study indicated that facilitating conditions positively influence behavioral intention ($\beta = .69, p < .001$). Suppose the garment employees can get resources, opportunities, and the knowledge necessary to use Cobots. They will have a greater intention to use Cobots because they will have fewer difficulties and will overcome any challenges that they might face while working with Cobots.

Trust, anxiety and personal innovativeness were added as external variables in the proposed model, which were not included in the original UTAUT model. Trust has been examined as a positive impact on behavioral intention ($\beta = .70, p < .001$). When employees have a higher trust in Cobots, their intention to use Cobots will increase because Cobots may reach or exceed their expectations. However, anxiety had a negative impact on performance expectancy ($\beta = -.32, p < .001$) and effort expectancy ($\beta = -.33, p < .001$). When employees have a greater feeling of concern about Cobot's performance, their expectations for Cobots might be decreased. Finally, the higher the personal innovativeness, the better performance expectancy ($\beta = .45, p < .001$) and effort expectancy ($\beta = .58, p < .001$) towards Cobots. If the respondents were innovative and liked to try new things, they believed in the Cobots' performance and the ease of using Cobots. Overall, all three external variables of the proposed model conformed to this study's context.

In conclusion, the results indicated positive employees' intentions toward Cobot applications in the core manufacturing processes of factories. Social influence was the strong predictor of behavioral intention toward Cobots applications, along with effort expectancy and

trust in Cobots. Meanwhile, Vietnam has been left behind in updating new technology compared to other developing countries (Nguyen et al., 2019). Therefore, there is a need for Vietnam apparel industry to push the integration of Cobots in the factories, which might be an excellent opportunity to attract and maintain many fashion brands globally to outsource to Vietnam. Cobot developers, application partners, technology programmers, and garment manufacturers should analyze the current situations in the garment factories thoroughly because each factory has a different layout, infrastructure, main garment styles, and budget. This joint effort can update Cobot functions as a highlight to attract the garment employees' intentions because the garment employees are critical laborers working with Cobots up front in the factories. Besides, this research also offered some significant contributions to the academic literature. It proposed a a conceptual model to predict the garment employees' intention to use Cobots based on the theory of UTAUT. To the best knowledge of the researcher, this is the first extended UTAUT model for the prediction of using Cobots in the context of the garment industry. The findings in this study also added the predictive power of the UTAUT theory of Venkatesh et al. (2003) because those additional variables improved understanding and predicting user intention toward new technology, specifically Cobots.

Boer, W. D. & Astrom, J. (2017, June 5). Robots of the future are coming. Are you ready? *School of Business, Society and Engineering, Malardalen University*. http://www.divaportal.org/smash/get/diva2:1134108/FULLTEXT01.pdf

Lee, S., Rho, S. H., Lee, J., Lee, S. W., Lim, D. & Jeong, W. (2021, February 2). Implementation of an automated manufacturing process for smart clothing: The case study of a smart sports bra. *Processes*, *9*(2), 289. https://doi.org/10.3390/pr9020289

Nguyen, T. C., Tran, A. V. T & Nikolaeva, E. (2019). Textile and garment enterprises in Vietnam under the context of Industrial Revolution 4.0. Вестник Челябинского государственного университета, 7(429), 186-194. https://doi.org/10.24411/1994-2796-2019-10721

Nhabe Corporation (2019, October 24). *Textile industry in the trend of Industrial Revolution 4.0.* https://www.nhabe.com.vn/eng/news-events/read-newspapers-for-you/textile-industry-inthe-trend-of-industrial-revolution-4.0-1203.html

Perez, L., Rodriguez-Jimenez, S., Rodriguez, N., Usamentiaga, R., Garcia, D. F., & Wang, L. (2019, November 29). Symbiotic human-robot collaborative approach for increased productivity and enhanced safety in the aerospace manufacturing factory. *The International Journal of Advanced Manufacturing Technology*, 106, 851-863. https://doi.org/10.1007/s00170-019-04638-6

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003, September). User acceptance of information technology: Toward a unified view. *MIS Quarterly,* 27(3), 425-478. https://doi.org/10.2307/30036540