Exploring Expert Opinion Regarding Energy Consumption in Apparel Assembling Process: A Qualitative Approach

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Background: Environmental sustainability practices in the textile and apparel (TA) industry are receiving greater attention as harmful impacts are becoming more evident. However, there has been a lack of research addressing environmental sustainability within the discipline, especially of studies incorporating apparel industry's expert opinion. In order to identify pathways toward greater sustainability in the TA supply chain, this study investigated practical solutions for improving environmental sustainability in the apparel production segment of the industry from the practitioner view point. This study specifically focused on the apparel assembling process, because it is the most energy intensive process with the largest environmental footprint when compared to other apparel production processes such as cutting, finishing, etc. (Sivaramakrishnan, Muthuvelan, Ilango, & Alagarsamy, 2009; Sule, 2012). Burning fossil fuel is still the single most reliable source for generating electric energy, therefore, reducing energy consumption is an essential approach for minimizing the environmental footprint of apparel sewing process. **Purpose:** The purpose of this exploratory study was to investigate sewing process contributors to energy consumption (EC) as revealed by apparel assembling experts. The objectives were to (a) identify the most influential EC factors from the apparel assembling process and (b) identify steps to reduce EC. **Method:** Qualitative method was employed, using semi-structured, open-ended interview questions to collect data via teleconferencing. A pre-interview task was assigned to interviewees in order to categorized the EC factor through Q-sort (i.e., dragging and dropping)**.** The Q-sort task was distributed via the Qualtrics software platform. The interviews were audio recorded (upon IRB approval and participants' consent) and then transcribed (verbatim and denaturalized) using NVivo version 11.0. This study utilized a realist approach, focusing on experts' lived experience with the apparel manufacturing process. Data analyzed using content and comparative analysis through word-based techniques— word repetitions and key-words-in-contexts (KWIC). This realist approach allows the researcher to search for current facts (i.e., energy consumption phenomenon) from the real world (i.e., apparel production process) (Patton, 2002). A total of nine experts (through saturation technique) were selected through purposeful intensity and snowball sampling technique. There were six males and three females, and they were all US citizens between the ages of 31 and 63 years. They had noteworthy apparel industry expertise ranging from 4-40 years with the production process along with 4-35 years of direct involvement with management and/or production. Their current designations included Managing Director for Production, Apparel Industry Production Consultant, Senior Vice President of Supply Chain, and Lecturer and Associate Professor in Apparel and Textiles. The Q-sort consisted of an initial list of energy consumption factors, developed from literature review (Islam, 2016) and researcher experience. **Finding:** Results

revealed five most influential EC factors in apparel assembling process: number of sewing operations; standard allowed minute (SAM); sewing machine motor capacity and speed; operator production efficiency; and percent of sewing machine utilization. Almost every expert interviewed supported speeding up production, gaining efficiency, and shortening the sewing process to reduce EC. Experts were concerned about EC of the apparel manufacturing and its contribution to greenhouse gas emissions and climate change. They discussed diverse issues including supporting alternative means of supplying energy (expert 5), finding solutions to reduce carbon footprints and attaining sustainability (expert 3), knowing environmental impacts on logistics to get raw materials from one place to another (expert 9), and balancing costs and environmental components within apparel products (expert 7). Both experts 1 and 6 mentioned labor cost has a priority over energy cost. Expert 6 explained this situation by stating:

> I think we are still in a situation where people are able to move product around the world from more expensive to less expensive locations basically because of labor rates rather than the energy rates. I think we are almost reaching the point of saturation where simple movement of product from one region to another is not going to really start making significant cost differences. So, I think once that happens then they are gonna look for other areas of efficiency and energy certainly could be a consideration.

The importance of turning off machines was equally articulated by experts 3 and 4. The recommendation of expert 3 was,

> [W]hen operators go on break or lunch they should shut down their machines, they should turn them off. And then, obviously at the end of the shift it's important that all the machines get turned off …if you move to another machine to do another operation and you're not going to be using the machine for a while it should be turned off.

Conclusions and Implications: This study set out to identify the most influential EC factors of apparel sewing processes. Industry practitioners would make changes in practices once they understand the most influential EC factors and consequently, the environmental sustainability could be achieved in the apparel industry. Designers and industrial engineers need to work together to restyle the apparel product through reengineering product construction, finding simpler ways of sewing, and adopting consequential standard operating procedures. Experts provided factual solutions (with examples) to produce energy efficient apparel and battled between environmental gains versus incurred cost. However, a summary of their concerns can be expressed as "I don't think people are going to be willing to pay more for energy efficient products."

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