

The Development of an Optimal Wetsuit

Avaree VandeKerkhoff and Mentor Dr. Changhyon(Lyon) Nam

ABSTRACT

This study aimed to subjectively evaluate wetsuits for scuba divers and identify areas for improvement in future product development. Wetsuits are a very important piece of protective gear for people with varying water-related hobbies and professions. However, there are some issues with current wetsuits being too thick or too tight. A qualitative approach was used with 42 participants ($n = 19$ females, $n = 20$ males, $n = 3$ others), who regularly engage in water sports. Semi-structured interviews were conducted and analyzed using NVivo software to identify the main themes. Results revealed four key areas of concern: fit, comfort, materials, and function. Common discomforts highlighted by consumers included tightness around the back of the knees, elbows, ankles, and shoulders. Participants also noted that wetsuits did not accommodate individuals with longer torsos or larger chests. Despite these challenges, participants preferred higher-quality wetsuits with thermal liners to enhance comfort and safety. These findings suggest that improvements in wetsuit design should focus on mobility, fit, and material adaptability to enhance the user experience and safety in water sports.

INTRODUCTION

- As a protective clothing item for water sports and underwater occupations, a wetsuit is a garment typically made from foamed plastic materials such as neoprene, rubber, or polyvinyl chloride, designed to provide thermal insulation for activities like diving (Rainey, 1998).
- The wetsuit is a crucial gear that shields the human body during immersion in cold water, reducing overall heat loss and maintaining body temperature (Martin, 2020).
- Hazards associated with cold environments can lead to serious tissue damage or even death in humans. Environmental factors, like low temperatures, high winds, and cold water, encourage exposed skin and extremities to cool quickly and increase hypothermia and other cold-related illnesses.
- To prevent such issues, scuba divers wear a wetsuit commonly made of neoprene, a synthetic rubber that allows functional aspects such as buoyancy, abrasion resistance, and thermal insulation (Naebe et al., 2013).
- Over the past several decades, many studies have investigated the compression effect of wetsuits (Castagna et al., 2013; Martin, 2020; Moon, 2018) and neoprene properties (Naebe et al., 2013; Oh et al., 2019).
- However, wetsuit users have voiced issues about the neoprene compression, comfort and fit, and environmental concerns.

ACKNOWLEDGMENTS

I would like to thank Professor Lyon Nam for allowing me to participate in this research project and learn more about it, as well as helping me along the way. I would also like to thank my UROP leader Kaylee Parizo, along with UROP Senior Associate Director Alicia Batailles, for providing guidance and support throughout this process.

RESEARCH QUESTIONS

- RQ1.** What key factors influence scuba divers' decisions when choosing a wetsuit?
- RQ2.** What are the primary comfort and fit issues experienced by scuba divers when using current wetsuit designs?
- RQ3.** How do environmental factors like water temperature and depth affect wetsuit's thermal performance and material properties?



Figure 1. Rescue divers- Cold stress and accident situation.



Figure 2. Types of wetsuits.

Figure 3. The issues of the wetsuit.

METHODS

- Based on the literature review and research questions, 26 interview and demographic questions were developed. A qualitative approach was employed through in-depth interviews with 42 participants ($n = 19$ females, $n = 20$ males, and $n = 3$ others), with an average age of 34.
- All participants frequently wear wetsuits, averaging twice a month, and have experience in water sports (e.g., scuba diving, surfing, snorkeling).
- Each interview was conducted via Zoom or in person and lasted approximately 25 minutes.
- The interview reports were thoroughly reviewed multiple times, and qualitative content analysis was employed to inductively organize the data into codes, following the taxonomy developed (William Ramaprasad, 1996).
- A content analysis guided by the research questions was also conducted using NVivo software to identify the main themes.

RESULTS

- Participants' responses emerged across four key wetsuit themes: fit, comfort, materials, and function.
- Regarding comfort and fit issues, they identified the main problem areas on the body as the back of the knees (71%), followed by the elbows (64%), ankles (60%), and shoulders (55%)
- These findings emphasize that improvements in wetsuit design are closely linked to mobility and comfort during water activities.
- Participants pointed out that the material did not sufficiently accommodate individuals with longer torsos or larger chests and felt too tight in certain areas.
- Although they had not experienced extreme heat or cold spots in their wetsuits, they preferred purchasing higher-quality designs and materials (e.g., thermal liners) to enhance comfort and safety, ensuring a more enjoyable experience during leisure water sports.

CONCLUSION

- Wetsuits are vital for protecting individuals from cold water hazards during water sports and underwater activities by providing thermal insulation and buoyancy.
- These insights will provide valuable guidance for wetsuit designers and manufacturers to develop products that enhance mobility, comfort, and sustainability, ultimately improving the user experience and performance in water sports and underwater activities.
- Further research is needed to interview professional divers, including rescuers, marine divers, and deep divers.
- A future study will offer deeper and more measurable insights into wetsuit design—focusing on fit, comfort, and function—as well as consumer preferences and environmental concerns.
- Future studies should also focus on user-centered design to ensure wetsuits accommodate diverse body types, maximizing both performance and comfort during water activities.
- This is particularly important given the growing shift in consumer preferences toward sustainable alternatives due to the environmental impact of neoprene wetsuits.

REFERENCES

- Martin, S. L. (2020). Building and Testing an Incompressible Thermally Insulating Cold Temperature Diving Wetsuit. *Swimming Magazine*; Nadar. <https://revistanadar.com.br/index.php/Swimming-Magazine/Building-and-Testing-an-Incompressible-T>
- Naebe, M., Robins, N., Wang, X., & Collins, P. (2013). Assessment of performance properties of wetsuits. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 227(4), 255-264.
- Oh, H., Oh, K. W., & Park, S. (2019). A study of the improvement of foam material sealing technology for wetsuits. *Fashion and Textiles*, 6, 1-15.
- Rainey, C. (1998). Wet suit pursuit: Hugh Bradner's development of the first wet suit. <https://escholarship.org/uc/item/7353g3dj>
- Williams, J. J., & Ramaprasad, A. (1996). A taxonomy of critical success factors. *European Journal of Information Systems*, 5(4), 250-260.