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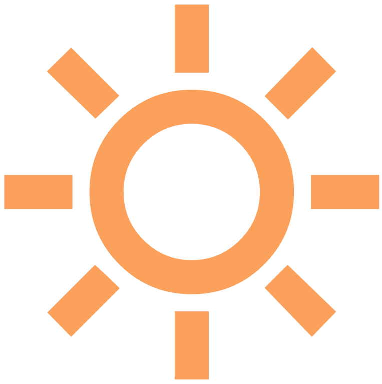
TRADES UNDER HEAT



UNDERSTANDING THE IMPACTS OF HEAT STRESS IN TRADE ENVIRONMENTS

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EXECUTIVE SUMMARY

OVER 70% OF THE GLOBAL WORKFORCE WILL BE EXPOSED TO EXCESSIVE HEAT DURING THEIR CAREERS DUE TO CLIMATE CHANGE. - UNITED NATIONS

This report investigates how trade and construction workers experience heat stress, why existing cooling solutions are underutilised, and where opportunities exist for new design interventions. Heat stress has become a significant occupational health issue as climate change drives hotter summers and more frequent heatwaves. While Work Health and Safety (WHS) legislation mandates rest breaks, hydration, and monitoring, workers remain vulnerable due to strict personal protective equipment (PPE) requirements, heavy physical workloads, and workplace culture.

A review of current literature highlights that existing consumer cooling products such as fans, cooling vests, and neck wraps rarely meet the durability, compatibility, and cultural acceptance demanded by trade environments. Benchmarking of products revealed that while many offer measurable cooling, but none balance effectiveness with PPE integration, mobility, and ruggedness.

Primary research was conducted through surveys (n=12) and interviews with an apprentice, tradesperson, and supervisor. Findings show that nearly all workers experience heat-related discomfort, commonly reporting fatigue, dizziness, and reduced focus. Hydration and shade remain the primary coping strategies, while cooling devices are often dismissed as “gimmicky” or impractical. Cultural factors also play a strong role: some workers hesitate to raise concerns due to peer pressure, while others described supportive site cultures shaped by WHS compliance.

THE INTERVENTION

INTEGRATE
- SEAMLESSLY WITH EXISTING PPE.

PROVIDE
- UNOBTRUSIVE, HANDS-FREE COOLING TARGETED AT EFFECTIVE BODY REGIONS (UPPER BACK, FACE, NECK).

ADAPT
- BE COMPATIBLE WITH EXISTING USER TOOL BRAND AND WORK ENVIRONMENT
- ALLOW FOR MODULAR UPDATES OR ATTACHMENTS AS TOOLS, PPE, OR WORKFLOW CHANGE.

MATCH
- TRADE EXPECTATIONS OF DURABILITY, LONGEVITY, AND RELIABILITY.
- FUNCTION WITHOUT INTERFERING WITH MOVEMENT, TOOLS, OR TASKS.

RESPECT
- MINIMISE DISRUPTION TO TEAM WORKFLOWS WHILE SUPPORTING SAFTEY AND COMFORT.

SUPPORT
- CULTURAL ACCEPTANCE THROUGH TEAM-BASED OR DISCREET SYSTEMS.
- REINFORCE WORKER RESILIENCE UNDER EXTREME HEAT AND PHYSICALLY DEMANDING CONDITIONS.

INTRODUCTION

Trade industries such as construction, electrical, and plumbing are highly exposed to outdoor environments where heat stress is an increasingly critical occupational health issue (Safe Work Australia, 2021). Rising average temperatures, intensifying summer heatwaves, and the physical demands of manual work mean that workers are regularly placed in conditions where fatigue, dehydration, and even heatstroke can occur (Safe Work Australia, 2021). While industry standards and the Work Health and Safety Act (2011) have introduced stricter obligations around rest breaks, hydration, and jobsite monitoring, the physical burden of heat remains a persistent challenge that directly impacts productivity, worker safety, and long-term wellbeing (Safe Work Australia, 2021).

The importance of this project lies in addressing the gap of existing procedural and legislative frameworks, there is a lack of trade-specific tools and interventions that actively reduce heat strain in real time. Current consumer cooling products (e.g., personal fans, neck wraps) are either too fragile, too generic, or incompatible with personal protective equipment (PPE) and jobsite demands. This creates a significant opportunity for design interventions that are durable, trade-focused, and integrated into everyday workflows rather than being disruptive add-ons.

The aim of this report is to identify the key issues trade and construction workers face in managing heat stress, and to understand why effective cooling measures are not being used to protect against heat-related illness and performance decline.

PROJECT STRUCTURE

- PROBLEM IDENTIFICATION
- BACKGROUND LITERATURE RESEARCH
- BENCHMARKING
- PRIMARY RESEARCH
- THEMATIC & TREND ANALYSIS
- GAPS & OPPORTUNITIES FOR DESIGN INTERVENTION
- CONCEPT DEVELOPMENT
- TESTING & VALIDATION
- PRESENTATION

BACKGROUND

Heat stress has emerged as a significant occupational health concern, particularly within physically demanding industries such as construction, fabrication, and other trade-based work. Workers in these sectors are often required to operate in uncontrolled outdoor environments where high ambient temperatures, direct sun exposure, and heavy, restrictive personal protective equipment (PPE) amplify the risk of overheating (Kjellstrom et al., 2016). Unlike office-based professions, trade work provides limited access to air-conditioned environments, rest breaks, or shade, leaving workers vulnerable to both the physiological and cognitive impacts of excessive heat (WorkSafe Queensland, 2023).

Current research highlights several interrelated factors driving this issue:

Firstly, climate change has intensified the frequency and severity of extreme heat events across Australia and globally, increasing the risks faced by workers (IPCC, 2022; Safe Work Australia, 2021). Rising maximum temperatures, combined with urban heat island effects, result in worksites not only becoming hotter but also staying hotter for longer periods (CSIRO & Bureau of Meteorology, 2020).

Secondly, the physical demands of trade work — lifting, carrying, repetitive movements, and PPE use place elevated strain on the body and reduce the ability to shed heat effectively (Kjellstrom et al., 2016). This combination exposes workers to dehydration, heat exhaustion, and in severe cases, heat stroke (Work Health and Safety Queensland, 2019).

The impacts of heat stress extend beyond medical outcomes. Literature links heat exposure to reduced concentration, slower reaction times, and higher rates of mistakes or accidents (Kjellstrom et al., 2009; Xiang et al., 2014). In industries where precision and safety are critical, these impairments can have significant consequences for both individuals and teams.

Importantly, workplace culture plays a strong role in how heat stress is managed. Many tradespeople, particularly apprentices, feel pressure to "push through" rather than slow down, as resilience is often valued over self-care (Rowlinson et al., 2014). Devices such as personal fans or cooling wraps can also attract ridicule or stigma, reinforcing the reluctance to adopt new approaches (Lingard & Turner, 2017). Generational differences are evident, with younger workers more likely to prioritise hydration but less likely to speak up about discomfort (Brown et al., 2020).

Wearable or product-based cooling solutions are available on the consumer market, but adoption in trade environments remains extremely low. Barriers include practicality (devices interfering with movement or tools), durability (fragility in rough site conditions), weight or bulk, and cultural acceptance (Jay & Brotherhood, 2016). If a product requires frequent charging, cleaning, or maintenance, workers are unlikely to use it (WorkSafe Victoria, 2022). These barriers highlight a disconnect between the solutions currently available and the realities of trade and construction work.

In summary, background research establishes heat stress as a growing occupational challenge, intensified by climate change and reinforced by the cultural expectations of trade work. While the physiological risks are well understood, the persistent gap lies in the effective implementation of cooling strategies that workers will actually use. This gap frames the focus of the present project: understanding the barriers that prevent adoption of cooling measures in trade environments and identifying opportunities for design-led interventions that align with trade culture, PPE use, and site conditions.

BENCHMARKING

This section will benchmark a range of current products designed to reduce heat stress, with a focus on on-body cooling solutions and supportive systems. Performance was analysed across six criteria – compatibility with PPE, durability, mobility, cooling effectiveness, cost, and cultural acceptance. A benchmarking table was developed with these products, and values were translated into a radar chart to better visualise trends across product categories.

Products currently available span from evaporative and phase change vests to neck coolers, wearable fans, hydration systems, and environmental interventions such as shade shelters. These span from inexpensive consumer-grade items intended for leisure use, to more specialised but costly industrial solutions.

The benchmarking table (APPENDIX A) highlights the trade-offs between cooling effectiveness, ease of use, and compatibility with PPE. For example, evaporative and phase change vests provide a measurable cooling benefit but introduce bulk, weight, and mobility issues. Neck coolers and waist-mounted fans scored higher on mobility but are less rugged, with limited durability in demanding trade environments. Hydration packs and environmental controls are highly compatible and durable, but their indirect or intermittent nature means they do not provide immediate or continuous cooling.

When plotted into a radar chart, these products cluster around mid-range performance, with no category excelling across all dimensions. Most deliver moderate cooling but sacrifice either usability or compatibility with trade workflows.

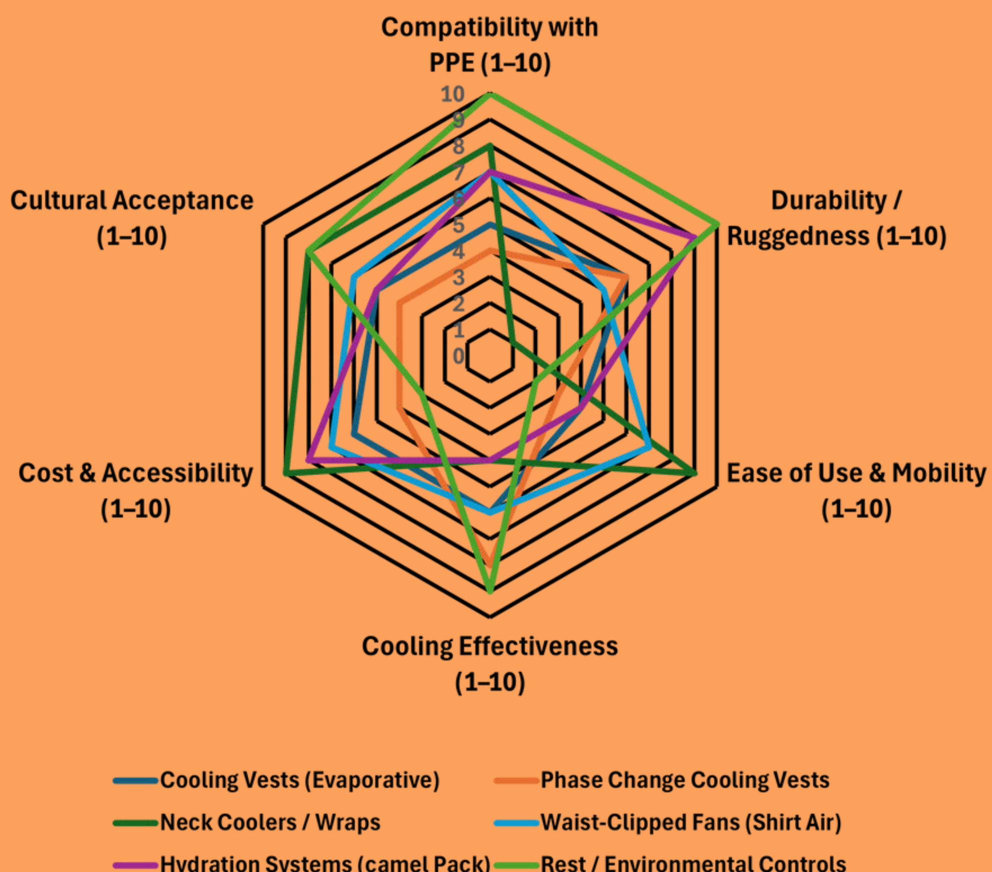

Figure 1: Radar Chart Of Benchmarked Categories

IDENTIFIED GAPS AND OPPORTUNITIES

Phase change technology demonstrates particular shortcomings. While phase change materials (PCM) can maintain a steady cooling temperature, they are often packaged into large rigid packs that concentrate cooling on the torso front; an area identified by research as the least effective torso zone for thermal relief. Literature indicates that the upper back, neck, and to a lesser degree the lower back are far more effective cooling regions. This highlights both a misuse of PCM technology and a clear opportunity for design interventions guided by human factors and ergonomic evidence.

Another common issue identified was the low durability and service quality of many mass-produced products. Cheap axial fans, for instance, are widely used because they are inexpensive and easy to manufacture, but they provide low-pressure airflow and underperform in demanding worksite conditions compared to centrifugal or blower fans. Similarly, consumer-grade neck wraps and waist fans often lack the ruggedness needed for trade environments, reducing their cultural acceptance among workers who value reliability and toughness in gear.

Benchmarking shows that while a wide variety of cooling products exist, none adequately balance cooling performance, PPE compatibility, mobility, and ruggedness in a trade context. Existing solutions either excel in narrow markets or are designed for non-industrial users, leaving clear gaps for new designs. These gaps present opportunities for trade-specific wearable cooling systems that:

- **Target effective cooling regions** identified in literature (upper back, neck, lower back).
- **Integrate seamlessly with PPE** without restricting movement.
- Employ more **efficient technologies** (e.g. centrifugal airflow, modular PCM placement).
- **Prioritise durability and serviceability** for trade environments.

This analysis underscores that the current market leaves trade workers underserved, not because cooling is unavailable, but because available products are misaligned with the realities of heavy, PPE-intensive work.

SECTION TWO

PRIMARY RESEARCH

To understand how trade and construction workers experience and manage heat stress, primary research was conducted to complement the secondary literature reviewed earlier. While existing studies highlight the physiological dangers of heat and generic mitigation strategies, they rarely capture the day-to-day reality of tradespeople: how site culture, personal experience, and practical constraints shape their responses to heat. This research therefore sought to gather first-hand accounts from workers across different trades, climates, and experience levels. Using, a mixed-methods approach surveys and interviews was adopted, allowing both quantitative data on trends and qualitative insights into individual experiences.

12 SURVEY RESPONSES

3 SEMI-STRUCTURED INTERVIEWS

METHODOLOGY

The quantitative component consisted of a structured survey distributed online, which received 12 valid responses from participants working in trades including mining, scaffolding, boiler making, precast concrete fabrication, plasterboard, construction, landscaping, and land surveying with most representing construction, fabrication, and outdoor industrial contexts.

The survey included both multiple-choice and scaled responses (e.g. discomfort rated 1–10), as well as open-text prompts to allow workers to describe experiences in their own words. While the sample size is modest, the responses provide indicative trends suitable for informing early-stage design directions.

Interviews were conducted with an apprentice, recently qualified tradesman and, supervisor and senior tradesperson with over 2 decades of experience. Questions covered working environments, PPE, hydration practices, symptoms of heat stress, site culture, and attitudes toward cooling solutions.

This combined approach was chosen deliberately as surveys provided quantitative breadth, revealing common trends across occupations, while interviews offered qualitative depth, highlighting personal stories, cultural insights, and nuanced reflections on how heat is managed day to day.

PROCEDURE

The survey link was distributed directly to workers and shared within small trade groups. Participation was voluntary and anonymous, with respondents providing informed consent. Interviews were conducted in a conversational format, recorded with permission, and later transcribed for coding.

ANALYSIS

Data was analysed through thematic analysis. Quantitative results (e.g., reported symptoms, hydration patterns) were summarised descriptively, while qualitative responses were coded into themes. This dual approach allowed for comparison between statistical trends and individual narratives.

LIMITATIONS

The study should be considered an exploratory pilot. The small sample size (n=15) limits generalisability, and participants may not represent the full diversity of trade sectors. Nonetheless, the findings highlight important patterns and cultural barriers that can guide subsequent design development.

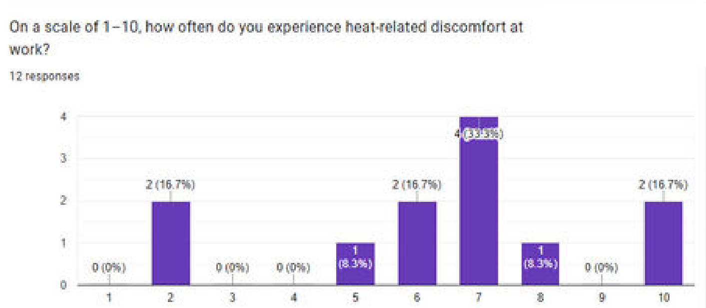

Figure 2: Example of Likert Scale

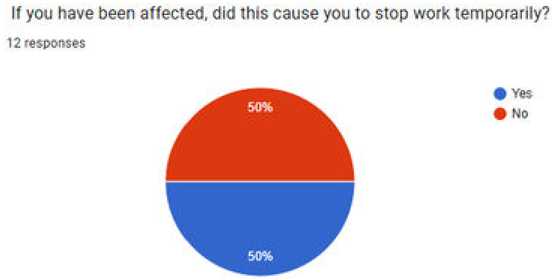

Figure 3: Example of Binary Scale

ANALYSIS & FINDINGS

This section presents an analysis of survey and interview data collected from trade workers regarding heat stress, PPE use, and cooling strategies. The aim was to identify key patterns in workers' experiences, self-management practices, and barriers to adopting heat mitigation devices.

Thematic analysis was applied to both qualitative and quantitative data to group responses into coherent categories. Survey Likert-scale and binary responses were manually coded, while short-answer responses and interview transcripts were coded for recurring themes. Consolidated these codes into concise categories allowed for clear comparison between survey and interview findings. These categories were then transferred into a treemap diagram to illustrate the frequency and distribution of themes across the methods

Survey Highlights:

- On a scale of 1–10, most respondents rated their heat-related discomfort between 6 and 10, indicating moderate to high levels of heat stress.
- PPE such as long sleeves, long pants, hi-vis clothing, and hard hats were commonly reported as increasing heat and discomfort.
- Respondents relied primarily on hydration (water) and rest to manage heat.
- Several respondents indicated that heat sometimes caused them to take breaks or slow down work, though not all reported stopping work entirely.

Few respondents reported using specialised cooling devices; barriers included cost, interference with work or PPE, and impracticality.

QUANTATIVE ANALYSIS

Table 1 - Example Survey Coding Table

Short Response	Code	Theme
"Long Sleeve 100% cotton drill industry"	PPE discomfort	Heat + PPE
"Sometimes" (re: hydration)	Hydration	Self Regulation
"Depends who's around" (re: feeling comfortable speaking up)	Peer pressure	Site Culture
"Water Fountain on site / Water Station, rest room fridge and freezer / Refuge chambers"	Access to cooling	Workplace Support
"Looks too gimicky / Gets in the way / Too expensive / Uncomfortable / Too noisy / Nil"	Device impracticality	Barriers to Adoption

Analysis:

These results demonstrate that heat stress is strongly influenced by PPE and environmental conditions, while individual strategies such as hydration and shade breaks are the primary means of mitigation. Workplace culture and peer perceptions also affect whether workers feel able to act on discomfort. The survey highlights key barriers to device use, suggesting a need for practical cooling solutions compatible with PPE and workflow.

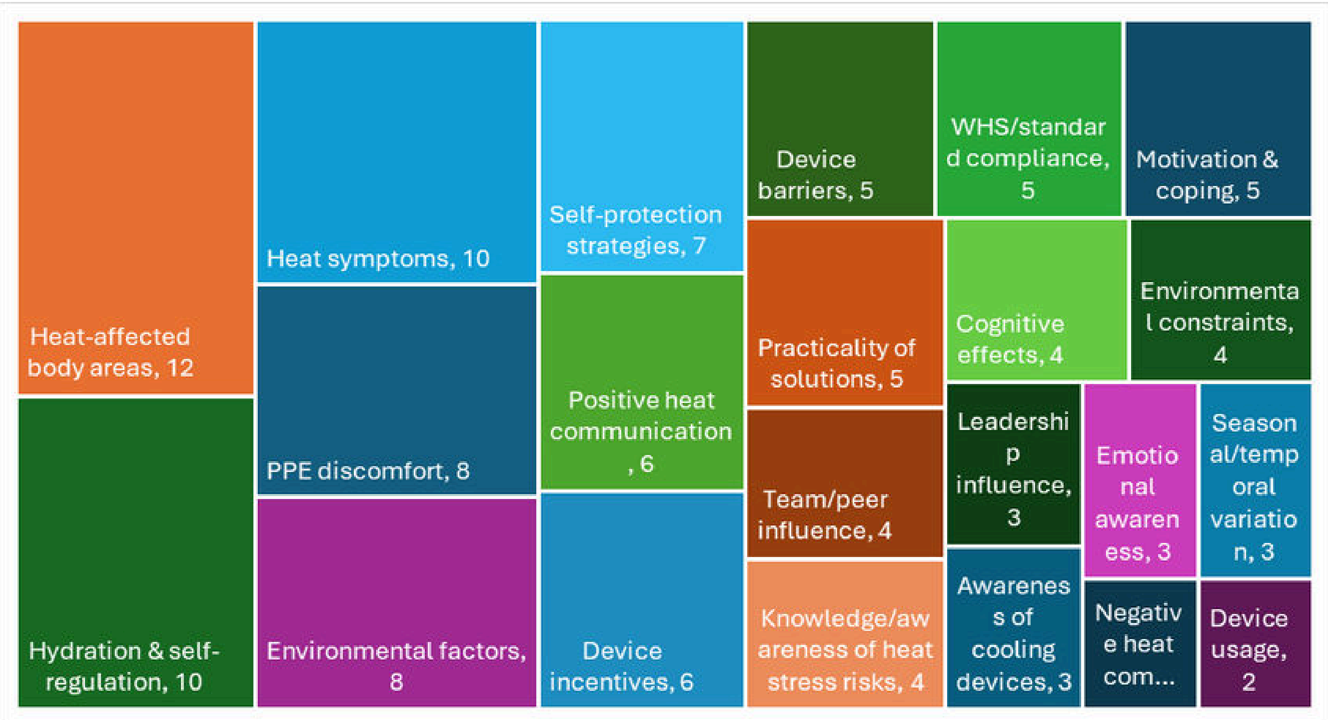

Figure 4 - Coded Survey THemes

QUALITATIVE ANALYSIS

The three interviews captured a range of trades, including carpentry, electrical, and plumbing/TAFE teaching, with experience ranging from apprentices to fully qualified tradespeople. Responses highlighted the pervasiveness of heat stress in outdoor and mixed environments, as well as how PPE and jobsite culture influence management strategies.

Interview Highlights:

- Participants consistently reported feeling heat most acutely in the upper back, face, hands, and head, often exacerbated by PPE such as long sleeves, pants, and hard hats.
- Workers generally self-regulate via hydration and breaks, with some using shade or positioning themselves away from direct sun.
- Heat stress occasionally leads to slowing down work or taking extra breaks, but participants expressed that workplace culture and peer perception can influence whether this occurs.
- Participants had little prior experience with purpose-built cooling devices, citing potential bulk, interference with tools or PPE, and cost as barriers.
- When asked about ideal cooling solutions, participants suggested long-lasting, compact devices that don't interfere with work, and some imagined "floating" or hands-free cooling concepts.

Table 2 - Example Interview Coding Table

Short Response	Code	Theme
"Personally, I wear long clothes, so long pants, long sleeves and a hat. So it's usually very hot."	PPE discomfort	Heat + PPE
"I would have to take breaks every now and then just because it's too hot."	Hydration	Self Regulation
"Depends who's around"	Peer pressure	Site Culture
"If it's too bulky, because on top of that I gotta wear a tool belt, and if it's getting in the way, then it's useless."	Device Impracticality	Barriers to Adoption
"Probably my head...top and back."	Body Focus	Heat Concentration
"I take frequent breaks for like water, like rehydrating and just getting out of the sun's rays every so often."	Hydration + shade	Self-regulation

Analysis:

These results demonstrate that heat stress is strongly influenced by PPE and environmental conditions, while individual strategies such as hydration and shade breaks are the primary means of mitigation. Workplace culture and peer perceptions also affect whether workers feel able to act on discomfort. The survey highlights key barriers to device use, suggesting a need for practical cooling solutions compatible with PPE and workflow.

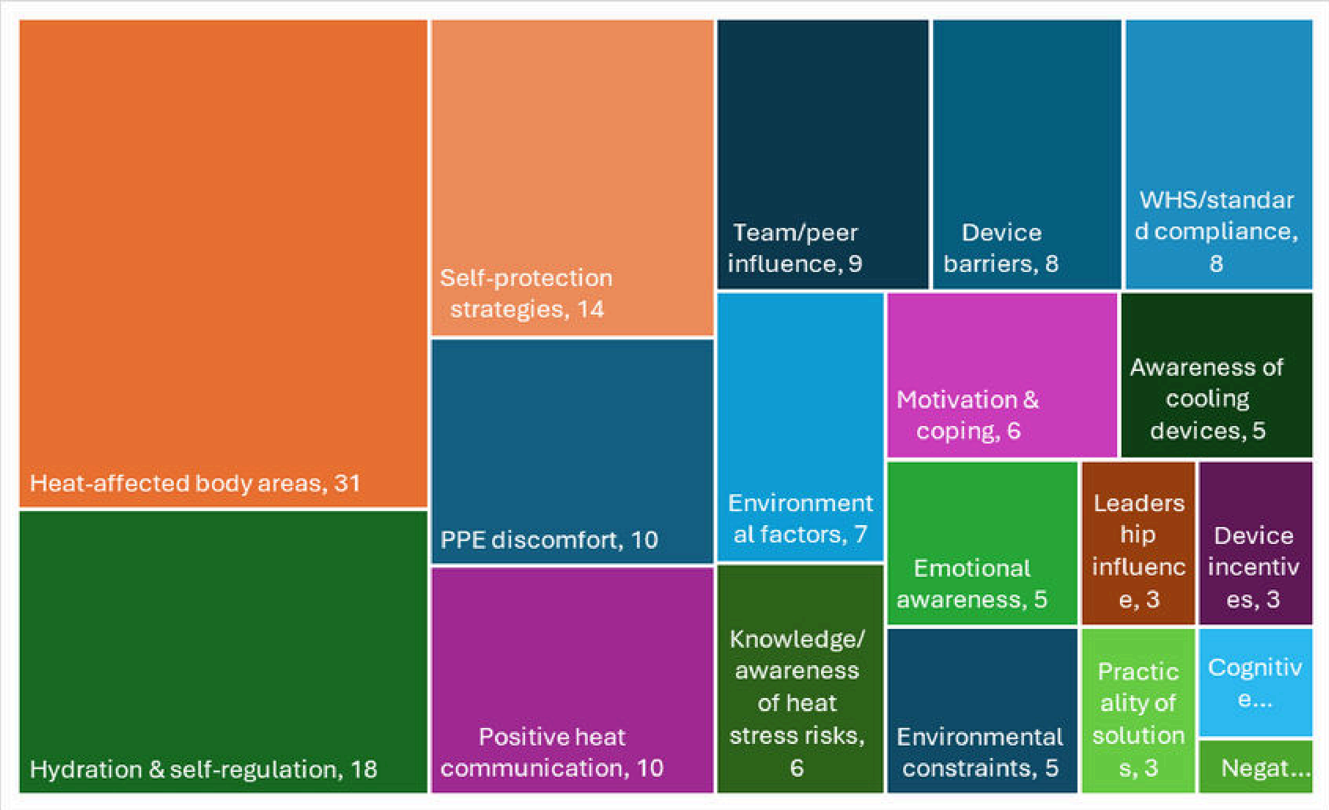

Figure 5 - Coded Survey THemes

SYNTHESIS OF THEMATIC FINDINGS

From both surveys and interviews, four major themes emerged:

1. **PPE & Heat Load**
   - PPE was consistently the largest contributor to heat stress, particularly helmets, long sleeves, pants, and high-vis gear.
   - High-exposure areas include the head, upper back, and hands.
2. **Self-Management & Environmental Strategies**
   - Workers rely on hydration, pacing, and shade breaks to mitigate heat.
   - Environmental factors (sun exposure, indoor/outdoor work, seasonal variation) strongly influence effectiveness.
3. **Cultural, Social, and Organizational Influence**
   - Positive communication from peers and leadership encourages protective behaviour.
   - Negative communication or perceived peer pressure can discourage breaks.
   - Device adoption is influenced by workplace culture, peer use, and perceived integration with work tasks.
4. **Barriers & Incentives for Device Use**
   - Awareness of cooling devices exists, but usage is extremely low.
   - Practicality, cost, and interference with PPE/tools and WHS standards are key deterrents.
   - Workers would prefer compact, long-lasting, hands-free solutions compatible with PPE and workflow.

Overall, both surveys and interviews confirm that heat stress is a frequent challenge, mitigated primarily by self-regulation rather than systemic interventions. The data also highlight opportunities for practical, integrated cooling solutions that align with PPE requirements and daily workflow.

DISCUSSION

The findings highlight a complex interaction between workplace safety regulations, cultural expectations, and individual strategies for coping with heat stress. A recurring theme was the influence of **strict PPE requirements**, which workers cannot alter without breaching WHS compliance. This aligns with literature noting that mandated long-sleeve cotton uniforms, high-visibility clothing, and hard hats contribute substantially to heat burden (Xiang et al., 2015). Primary research extends this understanding by showing how PPE also creates personal barriers to the adoption of external cooling devices. For example, roof tilers reported that carrying additional equipment conflicted with safety protocols requiring minimal load on elevated working surfaces / platforms.

PROBLEMS IDENTIFIED

A major challenge is the **non-negotiable** role of PPE in trade work. The 100% cotton drill long-sleeve uniform, high-visibility clothing, and hard hats are legally mandated under WHS standards, leaving workers with limited flexibility to adapt their clothing for comfort. Devices that require modification, replacement, or removal of PPE are unlikely to be adopted. This is consistent with both survey and interview responses, where workers described PPE as a major contributor to heat stress but also a requirement they cannot compromise.

Another problem is **worker scepticism** toward cooling technologies. Interviews revealed that devices were often dismissed as “gimmicky,” too bulky, or impractical. This reflects a cultural expectation within trades: tools and equipment must be durable, multipurpose, and unobtrusive. Devices that interfere with workflow, restrict mobility, or require significant maintenance will be rejected, regardless of their technical ability to reduce heat stress.

The **cultural dynamics of communication** also represent a barrier. Some workers were reluctant to speak about heat stress in front of peers, suggesting that workplace culture can inhibit open discussion. As a result, devices that draw attention or make workers feel singled out may be resisted, particularly if they visibly mark someone as struggling with heat.

Finally, there are **practical barriers** related to cost, durability, and maintenance. Several respondents indicated that clothing already wears out quickly; an additional device that requires frequent replacement or adds expense may be considered unsustainable.

Figure 6 - Worker in 100% Drill Industry Standard Clothing

OPPORTUNITIES FOR DESIGN

Despite these barriers, the findings also highlight opportunities for innovative design. First, there is clear scope for **integration with existing PPE.** Rather than developing standalone devices, solutions could be embedded into the clothing and equipment workers are already required to wear. For example, modular cooling inserts, ventilated collars, or add-on components that clip seamlessly to hard hats or high-visibility vests would align with WHS compliance while avoiding the burden of carrying extra gear.

Secondly, design should **prioritise non-intrusiveness and mobility.** Workers consistently indicated that they would avoid devices that restrict movement or interfere with tasks. Therefore, lightweight, low-profile systems that workers can "forget" they are wearing will have higher adoption potential. This may include passive cooling solutions, textile-based innovations, or slimline active cooling elements that do not obstruct tools, harnesses, or body posture.

Third, there is an opportunity to **leverage jobsite culture positively.** While some workers hesitated to speak up about heat stress, there were also examples of supportive leadership and site-level communication. Designing devices that can integrate into **team-based systems**, such as shared rest indicators, site-wide temperature alerts, or collective hydration prompts, could reduce the stigma of individual use.

Fourth, findings suggest that devices must **match trade expectations of reliability**. Just as tools are expected to be durable and versatile, cooling solutions must withstand heavy use, weather exposure, and long shifts without frequent replacement. Designing for longevity and low maintenance would help address the perception of gimmickry.

Finally, there is an opportunity for **educational integration**. Workers demonstrated variable awareness of heat stress symptoms and risks. Devices that not only cool but also **provide feedback or cues about heat exposure** could contribute to greater self-awareness and compliance with WHS standards. For example, wearable systems that subtly indicate when hydration or rest is needed could support decision-making without relying on worker initiative alone.

The design implications highlight the need for solutions that work **with, not against**, the constraints of PPE and workplace culture. The key is integration, subtlety, durability, and team-level functionality. Addressing these areas transforms the challenges identified in the research into opportunities for innovation, ensuring that any heat mitigation solution has the potential to be adopted in real trade environments.

CONCLUSION

FUTURE PLAN

This research confirms that heat stress is a pervasive and persistent challenge for trade workers, exacerbated by environmental exposure, heavy PPE, and physically demanding tasks. While awareness of the risks is high, effective mitigation strategies are uneven and largely dependent on workplace culture, peer behaviour, and environmental conditions. Hydration, pacing, and shade remain the primary methods for managing heat, but these strategies have clear limitations under extreme conditions.

Importantly, both survey and interview data indicate a significant opportunity for design-led interventions: solutions that are durable, hands-free, PPE-compatible, and unobtrusive, while also respecting workplace norms and cultural expectations. Addressing these gaps could enhance worker safety, comfort, and productivity, supporting both individual wellbeing and broader occupational health outcomes.

Ultimately, mitigating heat stress in trades requires a combination of technological innovation and cultural change, highlighting the value of human-centred design approaches that integrate seamlessly into everyday workflows.

HOW THIS INFORMS THE CONCEPT DIRECTION?

These insights directly inform the direction of the proposed intervention. This project aims to develop a **trade-worker-centric** cooling solution that addresses the limitations of current strategies and devices. The solution is intended to be **practical, integrated, and unobtrusive.** Enabling workers to manage heat in real time and enhances comfort, safety, and productivity without disrupting workflow or requiring complex setup or maintenance.

INTEGRATE WITH EXISTING PPE

- EMBED SOLUTIONS INTO CLOTHING AND EQUIPMENT ALREADY WORN (E.G., MODULAR COOLING INSERTS, VENTILATED COLLARS, CLIP-ON COMPONENTS FOR HARD HATS OR HIGH-VISIBILITY VESTS)
- ALIGNS WITH WHS COMPLIANCE AND AVOIDS EXTRA GEAR

PRIORITISE NON-INTRUSIVENESS AND MOBILITY

- LIGHTWEIGHT, LOW-PROFILE SYSTEMS THAT DON'T RESTRICT MOVEMENT OR INTERFERE WITH TASKS
- OPTIONS INCLUDE PASSIVE COOLING, TEXTILE-BASED SOLUTIONS, OR SLIMLINE ACTIVE ELEMENTS THAT DON'T OBSTRUCT TOOLS OR BODY POSTURE

LEVERAGE POSITIVE JOBSITE CULTURE

- TEAM-BASED / COLLECTIVE SOLUTIONS
- REDUCES STIGMA OF INDIVIDUAL DEVICE USE

MATCH TRADE EXPECTATIONS OF RELIABILITY

- DURABLE, VERSATILE, WEATHER-RESISTANT, AND LOW-MAINTENANCE DESIGNS
- OVERCOMES PERCEPTION OF GIMMICKRY

SUPPORT EDUCATIONAL INTEGRATION

- DEVICES PROVIDE FEEDBACK OR CUES ABOUT HEAT EXPOSURE
- HELPS WORKERS MONITOR HYDRATION, REST, AND OVERALL HEAT STRESS WITHOUT RELYING SOLELY ON INITIATIVE

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APPENDIX A

BENCHMARKING TABLE

Product	Compatibility with PPE	Durability / Ruggedness	Ease of Use & Mobility	Cooling Effectiveness	Cost & Accessibility
TechKewl Hybrid Cooling Vest	Medium – worn over PPE, adds bulk (**4**)	Moderate – fabric, PCM inserts fragile (**6**)	Medium – mobility somewhat restricted (**5**)	High – good cooling duration (**8**)	Low – expensive (~$300+) (**3**)
Ergodyne Chill-Its Evaporative Vest	Medium – requires layering (**5**)	Moderate – soakable fabrics, wear over time (**6**)	Medium – damp weight impacts comfort (**5**)	Medium – relies on evaporation (**6**)	Medium – ~$60–$120 (**6**)
Mission Cooling Neck Gaiter	High – fits under collars, non-intrusive (**9**)	Low – lightweight, tears easily (**3**)	High – flexible and mobile (**9**)	Low–Medium – needs re-wetting (**4**)	High – cheap (~$20–$30) (**9**)
Klein Tools Hard Hat Fan	Low – adds bulk, PPE interference (**3**)	Low – exposed electronics (**4**)	Low – cumbersome, snag risk (**3**)	Medium – airflow helps head (**5**)	Medium – ~$50 (**5**)
ToughBuilt Hydration Backpack	High – external, no PPE conflict (**9**)	High – rugged, site-ready (**9**)	High – mobile, hands-free (**8**)	indirect cooling only (3)	Medium – ~$70–$120 (**6**)
Cool Flow Fan Vest (OEM)	Medium–High – fits under PPE shirts (**6**)	Moderate – battery + plastics, not rugged (**5**)	High – mobile, hands-free (**7**)	Medium – airflow under clothing (**6**)	Medium – ~$50–$100 (**5**)
Honeywell Cool 50 PCM Vest	Medium – bulky, limited under PPE (**4**)	High – rugged PCM packs (**8**)	Low – heavy, rigid inserts (**3**)	High – steady cooling (**8**)	Low – ~$350+ (**3**)
Oztrail Pop-Up Shade Shelter	High – no PPE conflict (**10**)	High – durable outdoor fabric, frame (**8**)	Low – requires setup, interrupts work (**2**)	High – immediate shade relief (**9**)	Medium – ~$100–$200 (**6**)
CAT Cool-Ring Neck Cooler	High – small, wearable under PPE (**8**)	Low–Medium – gel packs, moderate life (**4**)	High – very mobile (**9**)	Medium – short duration cooling (**5**)	High – ~$30–$40 (**9**)
Arctic Heat Cooling Vest	Medium – under PPE possible (**5**)	Moderate – gel packs, washable fabric (**6**)	Medium–High – lighter than PCM vests (**6**)	Medium–High – decent relief (**7**)	Medium – ~$150 (**6**)
Ergoflix Portable Desk Fan (Battery)	Very Low – not PPE compatible (**2**)	Low – fragile consumer product (**3**)	Low – requires hand use, not mobile (**3**)	Medium – airflow, but limited (**5**)	High – ~$20–$40 (**7**)