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Women Workforces' Satisfaction with Personal Protective Equipment: A Case of the Australian Construction Industry

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Abstract: Despite the anecdotal evidence that construction women workforces have faced difficulties in accessing adequate and properly fitting personal protective equipment (PPE), there have been very few studies addressing their experiences and satisfaction with PPE. This study aimed to provide an overview of women workforces' satisfaction with PPE in the Australian construction industry. The specific research objectives were to: (i) examine their satisfaction regarding the functional, expressive and aesthetic (FEA) need attributes of PPE and (ii) investigate factors affecting their overall satisfaction with PPE. Data were collected using an online questionnaire survey. The results indicated a rather low satisfaction level among the respondents for all the thirteen FEA need attributes of their PPE. A regression model showed that their overall satisfaction with PPE was significantly affected by their experiences of PPE use (i.e., the need for alterations or adjustments to PPE, adequacy of training for PPE use, the perceived impact of ill-fitting PPE on work productivity) and satisfaction with FEA need attributes but not their demographical factors. The research findings call for action among construction training organizations, PPE designers and manufacturers and construction employers to recognise and address the low satisfaction level for PPE use among women workforces in the industry.

Keywords: Australia; construction; personal protective equipment; satisfaction; women

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1. Introduction

The global shortage of adequate personal protective equipment (PPE) for health care workforces during the COVID-19 pandemic made news headlines around the world. Likewise, PPE applications during the pandemic drew considerable attention among researchers. Based on a search on the Google Scholar search engine using the keywords "adequate" and "access", it was noted that one of the key focuses of the literature (i.e., about 40%) on COVID and PPE was accessibility to adequate PPE during the pandemic (as of the fourth quarter of 2022). While access to adequate PPE is certainly of great importance, properly fitting PPE is just as important in protecting health care workforces [1–3]. Sadly, but unavoidably, the recent PPE shortages in the health care industry turned out to be pandemic-driven. However, the provision of adequate and properly fitting PPE should not be crisis-driven, and the same should apply to every industry, be it agriculture, health care, construction, mining, transportation, manufacturing or the automotive industry.

The construction industry is one of the most hazardous industries due to its dynamic, temporary and decentralized work organization [4]. For example, the latest statistics in Australia show that construction was the industry with the most work-related injuries and illnesses at a rate of 59 per 1000 employed persons [5]. In Singapore, the construction sector remained the top contributor to workplace fatal injuries between 2018 and 2022, and it was also one of the top contributing industries for major and minor workplace injuries and dangerous occurrences for the same time period [6]. While PPE should be used in combination with other effective engineering and administrative control measures in the hierarchy for controlling hazardous exposures in workplaces [7], it is usually understood to

be one of the most repetitive types of equipment in the daily routine of any construction site worker [8]. Unfortunately, the reported use of PPE among construction workers in recent studies from different countries is worrying low (e.g., [9–11]). The lack of availability of adequate PPE has been identified as a key factor associated with workers' non-use of PPE in these studies. Adding to the problem is the issue of improperly fitting PPE described by construction workforces (e.g., [12–14]). Improperly fitting PPE could cause serious injuries or death and productivity losses at construction workplaces [13,15,16].

Despite the increased workforce diversity in the construction industry, there is anecdotal evidence that women workforces have faced difficulties in accessing adequate and properly fitting PPE for their job tasks (e.g., [14,15,17,18]). While the root causes of the difficulties that women workforces experienced remain unclear, a possible way to solve the issues relating to access to adequate and properly fitting PPE for female construction workforces would be to promote awareness of their PPE needs within the construction industry [13,18–20]. This calls for studies providing insights into their concerns, experiences, needs and satisfaction regarding PPE, and how these have transformed their job tasks and work experiences are important to raise awareness within the construction industry [13,21]. Additionally, among the very limited number of studies on women workforces' PPE satisfaction, the only empirical evidence to date in the work of Wagner et al. [22] indicates that PPE satisfaction (i.e., access to properly fitting PPE) would contribute positively to tradeswomen's job satisfaction, thus enhancing retention of tradeswomen in the industry from a long-term perspective. In contributing to this research area, this study aimed to provide an overview of women workforces' satisfaction with PPE in the Australian construction industry. The specific objectives were to: (i) examine their satisfaction regarding the functional, expressive and aesthetic need attributes of PPE and (ii) investigate factors affecting their overall satisfaction with PPE. The research findings clearly have implications for different stakeholders involved in the design, manufacturing, purchase and supply of PPE for women in construction. In particular, construction employers who purchase and supply PPE to their employees could consider reassessing their PPE purchasing and training protocols in addressing the PPE needs of their female employees.

2. Literature Review

2.1. PPE Research in the Construction Industry

Previous studies on PPE in the construction industry are commonly covered under the umbrella of construction safety research. A systematic review of the literature related to PPE and safety in construction between 2009 and July 2020 revealed a rising concern among researchers in the construction management field [8]. The key themes emerging from Ahmad et al.'s [8] review included: (i) the roles of PPE in construction safety, (ii) safety education and training, (iii) PPE safety management, (iv) PPE quality and usage, (v) safety accident prevention and (vi) smart PPE and technologies. While there has been significant progress in the development of smart materials, wearable devices and Internet of Things technologies for smart PPE applications, the technology readiness level is relatively low, which prevents their mass introduction and use in practice [23]. In examining smart commercial wearables and connected worker solutions for occupational safety, health and productivity management, the authors pointed out a long list of challenges for large-scale technology adoption at construction workplaces. The fact that practical applications of smart PPE in construction sites remain scarce may partly explain why the literature on PPE has been dominated by behavioural studies, closely surrounding the other five key themes in Ahmad et al.'s [8] review. Researchers have examined the relationship between a combination of different aspects and PPE applications in construction. These aspects include safety attitudes, safety consciousness, safety citizenship behaviour, safety knowledge, safety commitment, attitudes towards PPE, safety incentives and safety supervision (e.g., [9,24–28]).

There is another collection of behavioural studies on PPE that have specifically examined the factors affecting the use (or non-use) of PPE among construction work-

ers in different countries; for example, in Egypt [11], Hong Kong [16], Sri Lanka [10], Trinidad [26], Uganda [27] and Malaysia [29]. The identified factors can be broadly classified into: (i) demographical factors (e.g., age, gender, educational level, type of employment); (ii) individual factors (e.g., safety knowledge, risk perception, perceived usefulness, perceived ease of use, social influence); and (iii) organizational factors (e.g., safety incentives, safety supervision, supply of adequate PPE, provision of safety training). As expected, the results regarding the significance of the identified factors affecting the use (or non-use) of PPE in these studies were mixed since there are institutional and social differences across the respective construction industries. Nonetheless, a common and concerning issue highlighted in these studies is the lack of access to adequate PPE among construction workers, which is probably the most fundamental issue that needs to be addressed to enhance the use of PPE among construction workers. It may be expected that this PPE accessibility issue has impacted the different cohorts of construction workforces to varying degrees, including transforming their job tasks and work experiences. The present study focussed on construction women workforces and their experiences and satisfaction with PPE.

2.2. PPE and Women Workforces in Construction

While there have been very few studies on the PPE needs of women workforces in construction [13], there is anecdotal evidence from short reports by different organizations regarding women's difficulties in accessing adequate and properly fitting PPE (e.g., [14,15,17,18]). Oo and Lim [21] classified the possible reasons for the lack of accessibility identified in the literature according to the industry stakeholders (namely, the employing organizations, PPE designers and manufacturers). These reasons included: (i) the "one-size-fits-all" purchasing habits of employing organizations, where women workforces are expected to have the smaller sizes of PPE designed for men [12,13,18,30]; (ii) the absence of recent women's anthropometric data that could be used by PPE designers and manufacturers [13,17,31]; and (iii) the marketing strategies of manufacturers, which hardly promote or label alternative-sized PPE, and their use of white male models of average sizes to display PPE [32]. Above all, at the industry level, authors opined that the male-dominated culture of the industry contributed to the lack of access to properly fitting PPE among women workforces (e.g., [13,18–20]). This collection of studies asserts that it is critical to promote awareness of women workforces' PPE needs and the difficulties they face in meeting their needs and accessing adequate and properly fitting PPE. The difficulties identified in the literature include: (i) the need to purchase their own PPE; (ii) the need to make alterations or adjustments to ill-fitting PPE; and (iii) the lack of adequate training for or proper use of PPE in their job tasks [12,13,18,21]. It could be expected that these difficulties might have negative impacts on PPE users' satisfaction, which is the focus of the present study. Nonetheless, there is a need for more studies on many other aspects related to PPE for construction women to promote awareness in the construction industry [13,21].

The closest study to the present study with respect to women workforces' PPE satisfaction is that by Wagner et al. [22]. They examined the relationship between PPE satisfaction, self-efficacy and job satisfaction based on their sample of small groups of construction tradeswomen in the US. Their results showed that users' PPE satisfaction had a statistically significant positive effect on self-efficacy and job satisfaction, supporting the importance of positive experiences with PPE use in creating more satisfied workers. This present study concentrated on a more specific scope, focusing on construction women workforces' PPE satisfaction, and aimed for a large sample size, which helped in providing insight into their satisfaction regarding the functional, expressive and aesthetic need attributes of PPE and the factors affecting their overall PPE satisfaction.

3. Research Method

This study adopted a survey research design that allowed data collection from the targeted population in an efficient way and generalization of research findings based on the sample involved. Data were collected via an online questionnaire to gather information

from a large cohort of construction women workforces based in different states and territories in Australia. The targeted respondents were those who were at least 18 years old and were using PPE in their job tasks at the time of the survey. A purposive sampling method was adopted to reach the targeted population and achieve the research aim and objectives. While this sampling method is prone to research bias arising from the selection of sampling units [33], the authors attempted to seek support from multiple women's networks and professional bodies in the construction industry in the recruitment process to enhance the representativeness of the sample. The online questionnaire link was distributed via emails and social media by women's networks and professional bodies supporting this study.

There were two sections in the online questionnaire. In the first section, the respondents were asked about their demographic background and experiences of PPE use. The measurement items for the latter were developed from the limited collection of studies on PPE for women in the construction industry (e.g., [13,15,22]). Responses were measured using both categorial and five-point Likert scales, as appropriate for each question. Next, they were asked about their satisfaction with PPE. The measurement consisted of 13 attributes for the evaluation of functional (9), expressive (2) and aesthetic (2) needs related to PPE and was adapted from Wagner et al. 22] and Bye and Hakala [34]. It should be noted that these two studies applied Lamb and Kallal's [35] functional, expressive and aesthetic (FEA) consumer needs model in the development of their measurement items. Respondents' overall satisfaction with PPE was measured using a single-item measure. This single-item measure was considered sufficient as it was unambiguous to the respondents, and Wagner et al. [22] used a similar approach in their work. The questionnaire was pilot tested with experienced women working in the industry, and there were some minor changes to wordings based on their feedback.

While it was not possible to keep track of the number of questionnaires sent out by the supporting organizations because of the use of social media and the fact that the authors had no access to their email address books, it was fortunate that a relatively large sample size (n = 635) was obtained in the present study. Both descriptive and inferential statistical analyses were performed on the dataset. A one-sample t-test was used to identify statistically significant variables by testing the mean values of the examined variables based on a test value = 3 (i.e., the mid-point or neutral score in a five-point Likert scale). Next, regression analysis was performed to determine if the respondents' demographic aspects, their experiences of PPE use and their satisfaction with the functional, expressive and aesthetic attributes of PPE (the independent variables) were predictors of their overall satisfaction with PPE (the dependent variable). Table 1 shows the variables, their associated survey items and codes applied in the regression analysis. In preparing the independent variables with multiple measurement items (i.e., variables regarding satisfaction with functional, expressive and aesthetic needs), an overall score was calculated for these variables by averaging the scores of the respective items. It should be noted that the four attributes of expressive and aesthetic needs were combined in the regression analysis. This was undertaken since the distinction between these two groups of variables may have been vague due to the respondents' social and cultural contexts [36]. A stepwise regression method was adopted to identify the best-fit model, and tests were performed to ensure there were no violations of regression analysis assumptions. A HC3 test showed that the statistical inferences of the best-fit model were not compromised by heteroscedasticity (see [37]), and there was insignificant autocorrelation as revealed by the Durbin–Watson statistic (2.016). Furthermore, the removal of an outlier of a standardized residual larger than three corrected the problem of normality, and the predictor variables were not highly correlated with each other (i.e., the highest VIF value = 2.313).

Table 1. The variables in the regression analysis.

Variables	Survey Items	Scales/Codes
Age (*Age*)	What is your current age?	1 = 18–25; 2 = 26–35; 3 = 36–45; 4 = 46–55; 5 = 56 and above
Years of experience in the CI (*YrsExp*)	How many years of work experience have you had in the construction industry?	1 = less than 1; 2 = 1–5; 3 = 6–10; 4 = 11–15; 5 = 16–20; 6 = 21–25; 7 = 25 and above
Employment status (*Empl*)	Which of the following best describe your current employment status (please select the most relevant one)?	1 = Self-employed; 2 = Employed; 3 = Family business; 4 = Others
Education level (*Edu*)	What is the highest level of education you have completed?	1 = Primary and secondary; 2 = Cert.; 3 = Dip/Adv. Dip; 4 = Undergrad.; 5 = Postgrad.
Frequency of PPE use (*Fq*)	On average, how often do you have to work on a construction job site?	0 = Others; 1 = Weekly basis
Purchase own PPE (*Pu*)	Do (did) you have to purchase your own personal protective clothing and equipment (PPE) required for your job?	0 = No; 1 = Yes
Alterations or adjustments to PPE (*Al*)	Do (did) you have to make alterations or adjustments to the PPE provided by your employer or from your own purchase before using them?	0 = No; 1 = Yes
Training for PPE use (*Trng*)	How would rate the information, instruction and/or training you received for proper use of PPE (including its storage and maintenance) in your job tasks?	0 = No information or training; 1 = Very inadequate; 2 = Inadequate; 3 = Fair; 4 = Adequate; 5 = Very adequate
Work productivity and PPE (*Prod*)	To what extent has ill-fitting PPE hampered your work productivity?	1 = Not at all; 2 = Slightly; 3 = Moderately; 4 = Considerably; 5 = A great deal
Satisfaction with functional attributes (*S_Func*)	How satisfied are you with the following attributes of your PPE? Functional need attributes SF1 to SF9 (see Table 3)	1 = Strongly dissatisfied; 2 = Somewhat dissatisfied; 3 = Neither dissatisfied nor satisfied; 4 = Somewhat satisfied; 5 = Strongly satisfied
Satisfaction with expressive and aesthetic attributes (*S_ExpAes*)	How satisfied are you with the following attributes of your PPE? Expressive (SE 1 and 2) and aesthetic (SA1 and 2) need attributes (see Table 3)	1 = Strongly dissatisfied; 2 = Somewhat dissatisfied; 3 = Neither dissatisfied nor satisfied; 4 = Somewhat satisfied; 5 = Strongly satisfied
Overall satisfaction with PPE (*S_OA*)	Overall, how satisfied are you with your PPE?	1 = Strongly dissatisfied; 2 = Somewhat dissatisfied; 3 = Neither dissatisfied nor satisfied; 4 = Somewhat satisfied; 5 = Strongly satisfied

4. Results

4.1. The Survey Respondents

A total of 635 sets of usable responses were obtained from the online survey. Table 2 shows the respondents' profiles. The largest group was professional women (92.6%), followed by tradeswomen (5.8%) and labour (1.6%), and they were based in different states and territories in Australia. Professional women were those who worked in a professional capacity in construction, including in consultancy, contracting and client organisations (e.g., project manager, architect, contract manager, estimator). Most respondents (93.7%) were employed by public or private sector organizations. About 65% of the respondents had more than 5 years of experience in the industry. The largest age group (71.5%) was between 26 and 45 years old and about 75% of the respondents held an undergraduate or postgraduate degree. Next, regarding their pre-tax annual income, about 47% of the respondents earned above AUD 100,000, and of these, close to 31% earned above AUD 120,000 (USD 1 = approx. AUD 1.3 as of the time of the survey). Indeed, this income group with above AUD 120,000 was the largest cohort among the respondents. This was followed by the cohort (20.8%) who had an annual income between AUD 81,000 and AUD 100,000. Above all, most respondents (70%) were frequent users of PPE who worked on-site on a weekly basis, while the remaining used PPE fortnightly, monthly or on an ad hoc basis. Their responses are thus valuable in shedding light on the matter of interest in the present study.

Table 2. The respondents' profile.

Profile	Freq.	%
Age		
18–25	90	14.2
26–35	275	43.3
36–45	179	28.2
46–55	78	12.3
56 and above	13	2.0
Country of birth		
Australia	473	74.5
Others	162	25.5
Highest level of education		
Primary and secondary education	23	3.6
Certificate	57	9.0
Diploma/advanced diploma	65	10.2
Undergraduate degree	312	49.1
Postgraduate degree	178	28.0
Years of working experience		
Less than 1	36	5.7
1–5	183	28.8
6–10	166	26.1
11–15	124	19.5
16–20	69	10.9
21–25	29	4.6
25 and above	28	4.4
Workforce group		
Professional women	588	92.6
Tradeswomen	37	5.8
Labour	10	1.6
Current employment status		
Self-employed	30	4.7
Employed in private or public sector	595	93.7
Family business	8	1.3
Others	2	0.3
Current working location (states and territories)		
New South Wales	156	24.6
Queensland	93	14.6
Victoria	104	16.4
Australian Capital Territory	33	5.2
Northern Territory	13	2.0
South Australia	40	6.3
Western Australia	146	23.0
Tasmania	12	1.9
Multiple states and territories	38	6.0
Average working hours per week		
Below 20	5	0.8
21–40	236	37.2
41–60	352	55.4
Over 60 h	42	6.6
Annual job income (before tax)		
Up to 40k	21	3.3
41–60k	47	7.4
61–80k	113	17.8
81–100k	132	20.8
101–120k	103	16.2
121k and above	196	30.9
Prefer not to answer	23	3.6
Frequency of PPE usage		
Weekly basis	445	70.0
Other (fortnightly, monthly or ad hoc basis)	190	30.0

4.2. The Respondents' Satisfaction with PPE Attributes

The respondents' satisfaction with their PPE was measured using 13 attributes characterizing the functional (SF1 to 9), expressive (SE1 and 2) and aesthetic (SA1 and 2) needs of PPE (see Table 3). Despite high variability in the responses, as demonstrated by the standard deviation values, the findings suggest that they were generally satisfied with the functional attributes of their PPE, given that the mean scores for six (out of nine) functional need attributes were statistically significantly higher than 3 (i.e., the neutral level). Of these, the three top attributes were: (i) protection against health and safety risks (SF4, mean = 3.94); (ii) safety features (SF3, mean = 3.71); and (iii) durability (SF6, mean = 3.69). On the other hand, it was notable that many respondents were somewhat dissatisfied with the "fit", "comfort" and "flattering to female body" attributes, as demonstrated by the considerably low mean scores, ranging between 2.11 and 2.74, which were statistically significantly lower than 3 at a $p < 0.05$ significance level. Next, the three attributes for expressive and aesthetic needs (i.e., appropriateness for work roles, fit in with the rest of the crew on site, and visual design) recorded mean scores (ranging between 3.24 and 3.61) that were statistically significantly higher than 3 at the $p < 0.05$ significance level, signifying that the respondents' satisfaction level with these attributes was on the satisfaction side of the scale. Nonetheless, the recorded overall satisfaction mean score was marginally below 3 (mean = 2.99), although it was not statistically significant at the 95% confidence level (p-value = 0.70).

Table 3. The respondents' satisfaction with the functional, expressive and aesthetic (FEA) need attributes of PPE.

Code	PPE Attributes	Mean #	Std. Dev.	Rank	One-Sample *t*-Test (Test Value = 3)	
					t	*Sig.*
SF1	Fit	2.59	1.17	12	−8.90	0.00
SF2	Comfort	2.74	1.13	11	−5.80	0.00
SF3	Safety features (e.g., use of bright colours and reflective tape, functional pocket placement for stowing of items)	3.71	1.06	2	16.92	0.00
SF4	Protection against health and safety risks	3.94	0.84	1	28.19	0.00
SF5	Thermal comfort	3.13	1.09	9	3.05	0.00
SF6	Durability	3.69	0.96	3	18.24	0.00
SF7	Ease of movement/mobility	2.98	1.15	10	−0.48	0.63
SF8	Ease of donning and doffing	3.23	0.92	7	6.34	0.00
SF9	Weight	3.17	1.00	8	4.36	0.00
SE1	Appropriateness for work roles	3.45	0.98	5	11.50	0.00
SE2	Fit in with the rest of the crew on a job site	3.61	1.01	4	15.25	0.00
SA1	Visual design (style, colour, coordination of garments)	3.24	1.07	6	5.57	0.00
SA2	Flattering to female body	2.11	0.99	13	−22.65	0.00
	Overall satisfaction	2.99	0.92		−0.39	0.70

Scale: 1 = strongly dissatisfied; 2 = somewhat dissatisfied; 3 = neither dissatisfied nor satisfied; 4 = somewhat satisfied; 5 = strongly satisfied.

4.3. Factors Affecting the Respondents' Overall Satisfaction with PPE

The best-fit regression model for the respondents' overall satisfaction with PPE was pleasingly simple, containing only 5 (out of 11) predictor variables, and of satisfactory explanatory power (see Table 4). In terms of the model utility statistics, the adjusted R^2 showed that 54.5 percent of the total sample variation in the overall satisfaction with PPE (i.e., the outcome variable) was explained by the five predictor variables. The model was statistically useful in predicting the outcome variable, as indicated by the global F-test statistic (i.e., 153.03, $df_1 = 5$, $df_2 = 629$, $p < 0.05$). It was notable that none of the demographic variables were found to have statistically significant effects on the respondents' overall satisfaction with PPE. Furthermore, the respondents' overall satisfaction with PPE was

not significantly affected by their frequency of PPE usage and the need to purchase their own PPE. Of the five predictor variables included, they all had the expected signs; i.e., the expected positive or negative impacts on the outcome variable. The positive coefficients of satisfaction with functional *(S_Func*) and expressive and aesthetic (*S_ExpAes*) need attributes suggested that these predictor variables had positive impacts on the outcome variable; i.e., the overall satisfaction with PPE increased as the satisfaction with these FEA need attributes increased. Indeed, the satisfaction with functional need attributes had the highest positive coefficient value among the three positive predictor variables. Similarly, the predictor variable training for PPE use (*Trng*) had a positive sign, which indicated that the more adequate the information, instruction and/or training provided for proper use of PPE was, the higher the overall PPE satisfaction level. Next, for the two coefficients with negative signs, the overall PPE satisfaction level decreased when there was a need to make alterations or adjustments to PPE before use (*Al*), and when ill-fitting PPE was perceived to hamper work productivity (*Prod*).

Table 4. The best-fit regression model.

	Unstandardized Coefficients		**Standardized Coefficients**	***t***	***Sig.***
	B	***SE***	***Beta***		
Constant	0.181	0.174		1.041	0.298
Satisfaction with functional need attributes (*S_Func*)	0.600	0.055	0.442	10.850	0.000
Satisfaction with expressive and aesthetic need attributes (*S_ExpAes*)	0.317	0.046	0.263	6.824	0.000
Alterations or adjustments to PPE (*Al*)	−0.190	0.056	−0.096	−3.422	0.001
Training for PPE use (*Trng*)	0.041	0.016	0.073	2.638	0.009
Work productivity and PPE (*Prod*)	−0.088	0.034	−0.080	−2.610	0.009

5. Discussion

The demographic characteristics of the respondents suggested that most respondents were experienced workers employed in a professional capacity with post-secondary education who made a decent income. Most respondents' self-reported annual income was higher than the average weekly ordinary time earnings for full-time female adults in the Australian construction industry, which is around AUD 1450 per week or AUD 75,400 annually [38]. The small sample size for tradeswomen in the present study could be explained by the fact that less than two percent of construction trade workers (approx. 300,000 in 2016) in Australia are female [39]. Above all, recruitment of these sample respondents via construction women's networks and professional bodies, although not representative of all construction women workforces in Australia, was more appropriate than soliciting respondents via general recruitment with unknown populations. Thus, the 635 sets of survey responses were considered significant for providing useful insights, especially since most respondents were frequent users of PPE who worked on-site on a weekly basis.

Using Lamb and Kallal's [35] renowned FEA consumer needs model as the backbone, this study provides an evaluation of the respondents' satisfaction with PPE based on a set of 13 attributes. While the recorded mean scores for some attributes were statistically significantly higher than 3 (i.e., on the satisfaction side), it is worth noting that none of the mean scores were equal to or above 4 (i.e., the somewhat satisfied level; see Table 3). This evaluation provides useful insight into the evolving design problems affecting PPE for women in construction, whether the problems are predominantly oriented towards functional, expressive and/or aesthetic needs. The results show that most respondents were somewhat dissatisfied with the attributes related to "fit", "comfort" and "flattering to female body", echoing the previous anecdotal findings on difficulties faced by women in construction in accessing properly fitting and comfortable PPE (e.g., [14,15,18]).

The next significant aspect of the research findings was the statistical model, which investigated the factors affecting the respondents' (i.e., users') overall satisfaction with PPE (see Table 4). This is the first modelling attempt, to the authors' knowledge, that provides insight into the effects of PPE users' demographic factors and experiences with PPE use on overall satisfaction with PPE. While users' demographic variables have been found to be significant in affecting use or non-use of PPE among construction workers (e.g., [11,26,27]), it was rather unexpected that none of the demographic variables (i.e., age, years of working experience, employment status and educational level) were found to have statistically significant impacts on the respondents' overall PPE satisfaction in this study. For example, it could be expected that more experienced users would have better access to properly fitting PPE by sourcing from different suppliers and/or networks, thus having an impact on their overall PPE satisfaction level. Similarly, users' employment status could have implications for their access to and need to purchase their own PPE, thus affecting their PPE satisfaction. Nonetheless, the current findings showed insignificant effects from demographic variables, outwardly suggesting that the respondents, regardless of their demographic background, faced varying difficulties in meeting their PPE needs. Although some of the PPE items may not have fit them properly, another plausible explanation is that they seemingly accepted the potential difficulties they faced as a "norm" due to the male-dominated culture of the construction industry [13]. This "norm" explanation may also be applicable to the observation that the respondents' overall satisfaction with PPE was not significantly affected by the need to purchase their own PPE (i.e., which could be another "norm" in the industry cultural setting). Above all, the five predictor variables in the regression model clearly have implications for the different stakeholders involved in the design, manufacturing, purchase and supply of PPE for women in construction, as discussed next.

6. Research Implications

The overall picture that emerges from the research findings calls for action to address construction women workforces' PPE needs—in particular, in accessing adequate and properly fitting PPE—and thus enhance their experiences and satisfaction with PPE use. The significant effect of PPE training on users' PPE overall satisfaction highlights the need for construction employers and the respective training organizations to review their PPE protocols and training curriculums. Construction apprenticeship programs should emphasize the importance of wearing properly fitting PPE and provide training on how to ascertain that it does fit properly [13]. Indeed, PPE training (also known as safety training) is a critical factor affecting the use or non-use of PPE among construction workers in different countries (e.g., [9,10,16]). For PPE designers, the findings indicate the importance of evaluating PPE users' needs from a comprehensive perspective. The FEA consumer needs model, which has been widely applied to products targeted to various consumer groups and product types [36], could be a candidate framework to facilitate the resolution of PPE design problems for construction women workforces. This would contribute to enhancing users' satisfaction with various PPE need attributes, which were found to have significant impacts on their overall PPE satisfaction in the present study. While not referring to any specific need attributes, Wong et al. [16] recommended that PPE designers should consider both the needs of and difficulties faced by users in designing so as to enhance the perceived usefulness and ease of use of PPE among users. They found that these perceptions contribute positively to the use of PPE by construction workers. For PPE manufacturers, on the other hand, it would be helpful if they could make PPE designed specifically for women more accessible through their distribution networks, especially for construction employers who provide PPE for their workforces. Addressing these design and manufacturing issues could reduce the need for users to purchase their own PPE and the need for PPE alterations or adjustments. The latter was found to be one of the significant factors affecting users' overall PPE satisfaction.

Next, construction employers who purchase and supply PPE to their employees play an important role in addressing the industry "norm" that consists of a lack of awareness of women's PPE needs. They could consider reassessing their PPE purchasing protocols by investigating the PPE needs of female employees using regular in-house surveys [13]. Indeed, direct input from female employees is imperative to meet their exact PPE needs [17]. A positive experience with the use of PPE could contribute to the employer–employee relationship and work productivity, especially since the current findings revealed that users' overall PPE satisfaction is negatively affected when ill-fitting PPE is perceived to hamper their work productivity. Above all, while echoing the importance of positive PPE experiences highlighted in the study by Wagner et al. [22], the current findings and implications must be taken within the context of the study, with its focus on construction women workforces in the construction industry in Australia, which is a developed country.

Lastly, in terms of implications for the research community, as one of the very few studies on PPE for construction women, the findings suggest the need to examine women's PPE needs in a comprehensive manner. Additionally, the detected relationship between experiences of PPE use and overall PPE satisfaction should be considered in future research efforts. Indeed, the current research findings could serve as a foundation for future studies on the relationship between PPE needs and satisfaction, job performance and job satisfaction.

7. Conclusions

Using the Lamb and Kallal's [35] renowned functional, expressive and aesthetic (FEA) consumer needs model as the backbone, this study investigated construction women workforces' satisfaction with PPE. To the best of the authors' knowledge, this is the first study of its kind on women's satisfaction with PPE in the context of the construction industry. The results showed that the respondents' satisfaction levels for all the 13 FEA need attributes of their PPE were significantly below the "somewhat satisfied" level, with an average overall satisfaction score falling on the dissatisfaction side of the scale. The regression analysis showed that their overall satisfaction with PPE was significantly affected by their experiences of PPE use (i.e., the need for alterations or adjustments to PPE, the adequacy of training for PPE use, the perceived impact of ill-fitting PPE on work productivity) and satisfaction with the FEA need attributes of PPE but not their demographical factors. The research findings call for action among industry stakeholders to address women's PPE needs and thus enhance their experiences and satisfaction with PPE use. These stakeholders include construction training organizations, PPE designers and manufacturers and construction employers, who have roles to play in recognising and addressing the PPE needs of women workforces in the industry.

The rather large sample size could be considered a strength of this study; however, the findings and implications must be considered in the light of its limitations. Since the majority of the respondents were professional women in the Australian construction industry (i.e., a developed country), sample bias could not be excluded. There is a need for future studies to focus on other workforce cohorts in the industry internationally, including smaller and larger individuals (regardless of their gender), pregnant women and persons with disabilities, to provide comprehensive insight and facilitate the development of an inclusive action plan. Based on the current findings regarding the rather poor level of satisfaction with PPE's functional, expressive and aesthetic need attributes among women workforces in the Australian construction industry, future studies could consider adopting focus group research to reveal the underlying issues that lead to their dissatisfaction.

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