Relationship between demographic characteristics and psychosocial working conditions of construction workers in housing projects

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ABSTRACT

Data regarding three psychosocial factors of 438 construction workers in eight Bangkok subdivision housing projects, which had a selling price between 2.50 and 5.00 million Baht, were collected in October 2018. The subjects were divided into two groups. The first group consisted of 71 workers who worked under high strain isolated (HSI) psychosocial working condition (workers felt that their work entailed high demand, they possessed a low controllability over their job and low work–related social support). The second group consisted of 367 workers who worked under other conditions. The result from the chi-square test between workers' demographic characteristics and their psychosocial working conditions revealed that the probability of working under HSI condition for workers with different Gender, Age, Education Level, Work Experience, Work Position, and Average Monthly Income are different. It insisted the heterogeneity of working under HSI condition among construction workers. A logistic regression model for forecasting the probability of working under HSI condition, using the workers' demographic characteristics, has then been developed in this study. The model consists of five demographic characteristic variables, namely Work Position, Education Level, Average Monthly Income, Work Experience, and Age. The adjusted odds ratio value, which was obtained from the analysis of the model constants, indicates that Work Position, Average Monthly Income, Age, Education Level, and Work Experience have influence on workers' probability of working under HSI condition in descending order. Finally, an example of applying the model to identify specific demographic characteristics of workers who need special attention is presented at the end of this paper.

KEYWORDS: Construction workers, High strain isolated psychosocial working condition, Logistic regression model, Subdivision housing projects.

INTRODUCTION

Adverse psychosocial working conditions can impose a negative impact on workers' job–related well–being, general psychological well–being, and their physical health status (Cheng, *et al.*, 2000; Häusser *et al.*, 2010; Van der Doef & Maes, 1998), thereby decreasing their productivity at work.

A number of workers work in subdivision housing projects under the following adverse psychosocial conditions. According to a survey Suriyanon, Suriyanon, and Nont (2020), 16.21% of workers felt that their work entailed high demand; they possessed a low controllability over their job and low work–related social support. These environments stressed and isolated workers, termed as high strain isolated (HSI) psychosocial condition. If a manager can create a working environment such that the proportion of workers working under the HSI condition reduces significantly, an increase in their productivity can be achieved, enhancing competitiveness in the long term. Therefore, it is necessary for managers of subdivision housing projects to consider the psychosocial working conditions of the workers.

To balance the effective management of resources and the psychosocial working conditions of the workers, the manager should be aware of the relationship between the demographic characteristics and psychosocial working conditions of construction workers. With this information, a manager can identify worker groups that require special attention. Consequently, effective preventive or corrective actions can be performed.

The relationship between the demographic characteristics and psychosocial working conditions of workers has been examined in various countries. Some of these studies did not specify the industry in which the sample workers were working in, such as Dewa, Thompson, and Jacobs (2011) and Bonsaksen *et al* (2019). Other studies focused on workers of a specific industry/workplace such as lecturers of a Malaysian university Huda *et al.* (2004), Japanese civil servants Kawaharada *et al.* (2007), staff at Taiwan's disability institutions (Lin *et al.*, 2009), office workers of a multinational company in Malaysia (Maizura et al., 2010), workers of Thai hand–gloves manufacturing (Sein, Howteerakul, Suwannapong, & Jirachewee, 2010), nurses of a Thai cancer hospital (Siangpror, Rawiworrakul, & Kaewboonchoo, 2014), and employees of a Brazil banking network (Petarli e*t al.*, 2015).

Most related studies in the construction industry focused on investigating the influence of the three psychosocial factors, namely psychological demand, control latitude, and social support, on different variables such as mental health Boschman *et al* (2013), burnout, and health complaints (Janssen, Bakker, & De Jong, 2001), occupational stress (Asif, Javed, & Janjua, 2018; Bowen *et al.*, 2014; Joshi *et al.*, 2020; Jung, Lim, & Chi, 2020; Leung *et al.*, 2015), and safety behavior (Jung *et al.*, 2020). None focused on the relationship between the demographic characteristics and psychosocial working conditions.

Thus, information regarding the relationship between the demographic characteristics and psychosocial working conditions of construction workers is still unavailable. Therefore, this research studied and analyzed the relationship between the demographic characteristics and psychosocial working conditions of construction workers in housing projects in Thailand, as follows.

1) This study identified the proportion of construction workers working under HSI condition according to the classification of their demographic characteristics and its differences using the chi-square test.

2) This study developed a logistic regression model to predict the probability of working under HSI condition based on each worker's demographic characteristics. The data from the developed model were also used to calculate the adjusted odd ratio (AOR) of working under HSI condition.

3) This study illustrated an example of applying the developed logistic regression model to identify the specified demographic characteristics of workers who needed special attention.

This research was initiated to explain working under HSI condition for construction workers in housing projects. The proportion of workers working under HSI condition and chi-square test results, which were obtained from this study, reflect the presence and inconsistency of the problem on working under HSI condition for construction workers. The logistic regression model, AOD value, and the example of the model application, which are presented in this study, will make it easier to identify workers in housing construction projects who require attention to their psychosocial working conditions. Having this valuable information, a project can allocate resources to solve the problem of working under HSI condition more efficiently. As a result, a project can gain benefit from increased worker productivity.

PSYCHOSOCIAL WORKING CONDITIONS

Karasek Jr. (1979) proposed the Job-Demand-Control model to classify the four types of psychosocial working conditions based on two psychosocial factors which were psychological demand and control latitude. These four types of psychosocial working conditions were as follows:

1) Psychosocial working condition which caused workers to have high strain from work (High strain psychosocial working condition): Workers, who worked under this working condition, felt that their job demands were high, and they had a low level of control over their jobs. They had to work with the demands of the job with no negotiation. Workers in this group were at risk of getting sick or having serious health problems. Their absenteeism rate and the resignation rate were also higher than other groups of workers.

2) Psychosocial working condition that caused workers to be more active and work proactively (Active psychosocial working condition): Workers, who worked under this working condition, felt that their job demands were high, and they had a high control over their jobs. This condition caused moderate strain on workers. Workers in this group felt diligent, participative, motivated and energetic to learn, to be famous, and to deserve a successful life.

3) Psychosocial working condition that caused workers to have low strain from work (Low strain psychosocial working condition): Workers, who worked under this working condition, felt that their job demands were low and they had a high level of control over their jobs. In the short run, workers would be happy to work, but in the long run, they might feel pressured due to the lack of opportunities to utilize their full potential.

4) Psychosocial working condition that caused the workers to become inactive and work passively (Passive psychosocial working condition): Workers, who worked under this working condition, felt that their job demands were low and they had a low level of control over their jobs. This condition caused moderate strain on workers. Workers in this group felt inert, surrendering without making any changes, and having low development and creativity.

Later, in 1988, Johnson and Hall came up with the idea that having a high level of social support could alleviate job strain. The Demand-Control-Support Model, in which the social support factor was added to the Job-Demand-Control Model, further classified each of the four groups of psychosocial working conditions, according to the Job-Demand-Control model, into two subgroups based on the level of social support, namely corrective and isolated (Johnson & Hall, 1988).

According to the Job-Demand-Control model, workers working under high strain psychosocial working condition were at risk of having mental health and physical health problems. However, the workers' work strain could be alleviated if they received social support, according to the Demand-Control-Support model. Therefore, to identify specific groups of workers who needed special attention, this research specifically classified workers working under high strain psychosocial working condition into two subgroups based on the level of social support factors, namely HSI condition and high strain collective (HSC) psychosocial working condition.

RESEARCH METHODOLOGY

This research was carried out in seven steps as follows.

1) The questionnaire, to be used for the survey on the level of perception of workers working on housing projects on the three psychosocial factors, namely psychological demand, control latitude, and social support, was selected. This research used the psychosocial working condition (PWC) questionnaire developed by Maria Winderszal–Bazyl, which was translated into Thai language by Yingratanasuk, Serekajornkitcharoen, and Pusapakdeepob (2001) to survey the level of perception of workers working on housing projects on the three psychosocial factors. This questionnaire was one of the most popular questionnaires widely used in various psychosocial working condition studies in Poland (Bugajska *et al.*, 2011; Cheng *et al.*, 2000; Leszczyńska & Jeżewska, 2010; Praseeratesung, 2010; Praseeratesung, 2014; Rotter *et al.*, 2014; Sitthikan, Sutthakorn, & Kaewthummanukul, 2010; SpołEczno-Demograficznych *et al.*, 2015; Widerszal-Bazyl & Cieślak, 2000; Yingratanasuk *et al.*, 2001). In the PWC questionnaire, respondents were required to express their opinion on each of the five-score questions. There were 25, 20 and 16 questions related to psychological demand, control latitude, and social support, respectively. Positive questions were scored from one to five while negative questions were scored from five to one. The mean scores of a worker's perception on each psychosocial factor was calculated by averaging question scores related to each psychosocial factor. The average scores of the worker's perception on each psychosocial factor were therefore ranged from 1 to 5.

2) The housing projects were sampled and the data was collected from the sample group. This research conducted stratified sampling. Firstly, the subdivision housing projects at selling prices between 2.5 and 5.0 million Baht (82,000 and 164,000 USD) per house, which was the most popular selling price in Bangkok, were randomly selected. Then, all construction workers in those selected projects were asked to answer the questionnaire. The minimum sample size for the chi-square test of this study was calculated based on a confidence level of 95%, a margin of error at 5%, and the assumption of a proportion of workers working under HSI condition at 0.50. As a result, 385 samples were required.

3) The workers were classified according to their psychosocial working conditions into five groups, namely: 1A - High strain isolated psychosocial working condition, 1B - High strain collective psychosocial working condition, 2 - Active psychosocial working condition, 3 - Low

strain psychosocial working condition, and 4 - Passive psychosocial working condition. The mean score of 3.00 was used to separate the low and high levels of each psychosocial factor.

4) The probability (proportion) value for each type of demographic characteristic of a worker working under HSI condition was calculated. Thereafter, the chi-square test was used to obtain the relationship between each type of demographic characteristic and the different psychosocial working conditions.

5) A logistic regression model was developed to predict the probability value of working under the particular HSI condition with respect to the workers' demographic characteristics, as presented in equation (1)

$$P_i = \frac{e^{\beta_0+\beta_{1(x_1(i))}+\beta_{2(x_2(i))}+\dots+\beta_{n(x_n(i))}}}{1+e^{\beta_0+\beta_{1(x_1(i))}+\beta_{2(x_2(i))}+\dots+\beta_{n(x_n(i))}}} \quad (1)$$

where,

P_i is the probability value that the i^{th} sample worker may work under HSI condition.

n is the ordering number of each type of demographic characteristic.

$x_n(i)$ is the x^{th} category of the n^{th} demographic characteristics which a worker (person i) is in.

$\beta_{n(x_n(i))}$ is the co–efficient value of the x^{th} category of the n^{th} demographic characteristics which a worker (person i) is in.

6) AOR was calculated using equation (2) based on the data received from the developed logistic regression model.

$$AOR_{nx} = e^{\beta_{n(x)}} \quad (2)$$

where,

AOR_{nx} is an odds ratio of a worker working under HSI condition in the x^{th} category of the n^{th} demographic characteristics when the remaining demographic characteristics variables are controlled.

β_{nx} is the co–efficient value of the x^{th} category of the n^{th} demographic characteristics which is obtained from the regression formula.

For example, β_{GF} represents the coefficient value of the female category of the gender demographic characteristics.

7) An example was illustrated for applying the developed logistic regression model to identify the specified demographic characteristics of workers who required special attention.

DATA COLLECTION AND SAMPLE CLASSIFICATION

In October 2018, various housing projects with selling prices between 2.5 and 5.0 million Baht, using similar construction techniques, were randomly selected and contacted to request permission to collect information from their workers. Permission was granted by eight housing projects. All 575 workers in these projects were asked to complete a questionnaire. 450 questionnaires were returned from the sample group. The data of 12 respondents was excluded due to a lack of relevant information. A total of 438 screened questionnaires were left for the analysis. It was more than the required minimum sample size, which was 385. The results from classifying the sample group into five sub-groups based on the three psychosocial factors, namely psychological demand, control latitude, and social support, are shown in Table 1.

Table 1: Number and percentage of samples classified based on different psychosocial working conditions

Types Of Psychosocial Working Conditions	**Number**	**Percentage**
1A – High strain isolated	71	16.21
1B – High strain collective	93	21.24
2 – Active behavior	94	21.46
3 – Low stain	93	21.23
4 – Passive behavior	87	19.86
Total	438	100.00

PROBABILITY VALUE OF WORKING UNDER HSI CONDITION

According to Table 1, 71 of the 438 persons were working under HSI condition. Therefore, the probability value of the same was calculated to be 16.21 % (71 persons / 438 persons). Table 2 shows the results of the probability (or proportion) value of working under HSI condition on classifying the data based on the type of demographic characteristic. The results of applying the chi-square test to obtain the relationship between each type of demographic characteristic and the different psychosocial working conditions are summarized in Table 2.

The types of demographic characteristics that passed the test included Gender, Age, Education Level, Work Experience, Work Position, and Average Monthly Income. The results indicated that there was at least one category in each of these demographic characteristic types that had a different probability (proportion) of workers working under HSI condition from those of the other categories. This finding was relatively consistent with the finding of Bonsaksen et al. (2019), which analyzed the proportion of workers working under high strain (HS) psychosocial working condition in various industries. Bonsaksen *et al.* (2019) revealed that the proportion of workers working under HS condition with different Gender, Age and Education Level, are different.

Table 2: Probability (or Proportion) value of working under HSI condition and results of the chi-square test

Demographic Characteristics	Number (Persons)			Proportion		Statistics	
	1a	Others	Total	1a	Others	Chi-Square	Asy. Sig
Gender (G)						12.328	<0.001*
1 – Female	4	89	93	4.30	95.70		
2 – Male	67	278	345	19.42	80.58		
Age (A)						6.091	0.048*
1 – ≤ 30 years	26	121	147	17.69	82.31		
2 – >30 and ≤ 40 years	27	190	217	12.44	87.56		
3 – > 40 years	18	56	74	24.32	75.68		
Education Level (E)						15.078	0.001*
1 – Primary school	15	107	122	12.30	87.70		
2 – Junior high school	13	127	140	9.29	90.71		
3 – Senior high school	43	133	176	24.43	75.57		
Nationality (N)						0.153	0.696
1 – Thai	62	314	376	16.49	83.51		
2 – Others	9	53	62	14.52	85.48		
Work Experience (X)						4.265	0.039*
1 – ≤ 10 years	35	229	264	13.26	86.74		
2 – > 10 years	36	138	174	20.69	79.31		
Employment (H)						2.176	0.140
1 – Daily	47	274	321	14.64	85.36		
2 – Weekly	24	93	117	20.51	79.49		
Work Position (P)						35.339	<0.001*
1 – Non–skilled labourer	4	114	118	3.39	96.61		
2 – Carpenter	25	55	80	31.25	68.75		
3 – Bricklayer	30	97	127	23.62	76.38		
4 – Smith	12	101	113	10.2	89.38		
Average Monthly Income (I)						17.670	<0.001*
1 – ≤12,000Baht	32	180	212	15.09	84.91		
2 – 12,001–15,000 Baht	15	135	150	10.00	90.00		
3 – > 15,000 Baht	15	52	76	31.58	68.42		

* p-value < 0.05

The data from the chi-square test showed that the problems on working under HSI condition for construction workers were not consistent. There were certain groups of workers of different Gender, Age, Education Level, Work Experience, Work Position, and Average Monthly Income that had a greater chance (proportion) to work under HSI condition than other groups of workers.

For example, a group of workers working as carpenters had a proportion for working under HSI condition as high as 31.25%. It was ten times higher than that of a group of workers working as non-skilled labourers whose proportion for working under HSI condition was just 3.39%. From the above facts, allocating resources to address problems on working under HSI condition uniformly, regardless of the difference in the level of problem among workers, was an inefficient and inappropriate process. A study on the relationship between the workers' demographic characteristics and HSI condition, to build an in-depth knowledge on identifying groups of workers who were likely to work under HSI condition, was essential.

LOGISTIC REGRESSION MODEL

The probability data presented in Table 2 was analyzed on the assumption that effects from other types of worker's characteristics could be neglected. In a real-life situation, where various demographic characteristics had effects on the probability value of working under HSI condition, using information form Table 2 to identify workers who needed special attention was not appropriate.

Logistic regression analysis is a statistical tool used to predict the probability of an event occurring based on one or more predictor variables. Having a logistic regression model to predict the probability value of working under HSI condition based on the workers' demographic characteristics will benefit the project. With this model, the influence of each demographic characteristic on a worker's probability value for working under HSI condition can be analyzed. The model can also be applied to identify specific characteristics of a worker who requires special attention.

From the above facts, this research analyzed the sample data to develop a logistic regression model which predicts the probability value of working under HSI condition based on the workers' demographic characteristics. The demographic variables for the model were selected into the model using the backward stepwise likelihood ratio method. From eight types of demographic characteristics, only five types were selected for the model: Work Position, Educational Level, Average Monthly Income, Work Experience, and Age. The model constants are listed in Table 3.

It was worth noting that the variables selected into the model were relatively consistent with the results from the chi-square test shown in Table 2. Five of the six variables that the chi-square test reported a different probability (proportion) of workers working under HSI condition were selected into the model. Gender was the only variable that was not selected into the model. This was because the Gender variable and Position variable have a high statistical correlation. 66.9 percent of the non–skilled labourers were female while only 1.3%, 3.9% and 7.1% of carpenters, plasterers, and blacksmiths were female. As a result, once the Position variable was selected into the Model, there was no longer a need to bring the Gender variable into the model.

Table 3: Logistic regression model data, developed from the sample data analysis.

Demographic Characteristics	β_N	Df	Sig.
Constant (β_0)	-3.495	1	0.000*
Work Position (P)		3	0.000*
1 – Non–skilled labourer[r]	0.000		1.000
2 – Carpenter	2.443	1	0.000*
3 – Bricklayer	1.737	1	0.004*
4 – Smith	0.874	1	0.176
Education Level (E)		2	0.082
1 – Primary school[r]	0.000		1.000
2 – Junior high school	0.502	1	0.316
3 – Senior high school	0.995	1	0.029*
Average Monthly Income (I)		2	0.006*
1 – ≤ 12,000 Baht[r]	0.000		1.000
2 – 12,001–15,000 Baht	-0.796	1	0.037*
3 – > 15,000 Baht	0.495	1	0.213
Work Experience (X)			
1 – ≤ 10 years[r]	0.000		1.000
2 – > 10 years	0.484	1	0.232
Age (A)		2	0.017*
1 – ≤ 30 years[r]	0.000		1.000
2 – >30 and ≤ 40 years	-0.783	1	0.045*
3 – > 40 years	0.231	1	0.664

[r]Referenced category
* p-value < 0.05

The number of samples used in developing the logistic regression model in this study was 438. This number was greater than the minimum sample size in developing the logistic regression model for 5 independent variables in the model, and the proportion of an event occurring was 16% which requires a minimum sample size of 313.

The Nagelkerke R square value of the model was found to be 0.241, indicating that the model could explain 24.10% of the variance in psychosocial work types. This value reflected that the expected probability value for working under HSI condition for each worker based on the model was 24.10% more accurate than using the average value which was 16.21%.

When the data from Table 3 was substituted into equation (3), the model evaluated the likelihood of workers to work under HSI condition, as shown in equation (5) as follows:

$$P_i = \frac{e^{\beta_0+\beta_P(x_P(i))+\beta_E(x_E(i))+\beta_I(x_I(i))+\beta_X(x_X(i))+\beta_A(x_A(i))}}{1+e^{\beta_0+\beta_P(x_P(i))+\beta_E(x_E(i))+\beta_I(x_I(i))+\beta_X(x_X(i))+\beta_A(x_A(i))}} \quad (3)$$

where,

P_i	is the probability value that the i^{th} sample worker may work under HSI condition.
β_o	is equal to -3.495.
$\beta_{P(x_P(i))}$	is equal to 0.000 when the i^{th} sample worker is working as a non–skilled labourer (P = 1).
	is equal to 2.443 when the i^{th} sample worker is working as a carpenter (P = 2).
	is equal to 1.737 when the i^{th} sample worker is working as a bricklayer (P = 3).
	is equal to 0.874 when the i^{th} sample worker is working as a smith (P = 4).
$\beta_{E(x_E(i))}$	is equal to 0.000 when the i^{th} sample worker is an elementary school graduate (E = 1).
	is equal to 0.502 when the i^{th} sample worker is a junior high school graduate (E = 2).
	is equal to 0.995 when the i^{th} sample worker is a senior high school graduate (E = 3).
$\beta_{I(x_I(i))}$	is equal to 0.000 when the i^{th} sample worker has an average monthly income of equal or less than 12,000 Baht (I = 1).
	is equal to -0.796 when the i^{th} sample worker has an average monthly income between 12,001 and 15,000 Baht (I = 2).
	is equal to 0.495 when the i^{th} sample worker has an average monthly income of more than 15,000 Baht (I = 3).
$\beta_{X(x_X(i))}$	is equal to 0.000 when the i^{th} sample worker has less than or equal to 10 years of work experience (X = 1).
	is equal to 0.484 when the i^{th} sample worker has more than 10 years of work experience (X = 2).
$\beta_{A(x_A(i))}$	is equal to 0.000 when the i^{th} sample worker is 30 years old or less (A = 1).
	is equal to -0.783 when the i^{th} sample worker is over 30 but not over 40 years old (A = 2).
	is equal to 0.231 when the i^{th} sample worker is over 40 years old (A = 3).

An example of applying equation (5) to calculate the likelihood for workers working under HSI condition is as follows. A carpenter (P=2; $\beta_{P(x_P(i))}$ =2.443) who is a senior high school graduated (E=3; $\beta_{P(x_E(i))}$=0.995) which has an average monthly income of more than 15,000 Baht (I=3; $\beta_{P(x_I(i))}$=0.495), has more than 10 years of work experience (X=2; $\beta_{P(x_X X(i))}$=0.484), and is 30 years old or younger (A=3; $\beta_{P(x_A(i))}$=0.231), has the likelihood of working under HSI condition of 0.7601.

It was worth noting to compare types of independent variables selected into the model in this study with the results from previous research. Since, in the literature review process of this research, no previous research on developing a logistic regression model to predict the probability of working under HSI condition was found. Only research that applied logistic regression models to identify variables that were critical to working under the HS condition was found. Although, that research did not focus on the construction worker population. Independent variables used in each study, and their detail concepts of model development, were also different. Therefore, comparing the similarities and differences of the developed model with these models, cannot be done directly. However, discussion on identical independent variables that were studied in this research and previous research is still worth presenting.

The findings of previous research are compared together with those of this study, as follows. The study of Bonsaksen *et al.* (2019) studied the associations between socio-demographic factors and being under HS condition of workers in twenty companies of Norway. The study of Huda *et al.* (2004) studied risk factors of job strain in the lecturers at a Malaysian university. The study of Maizura *et al.* (2010) investigated the prevalence and factors associated with high job strain among office workers of a multinational company in Malaysia. The study of Petarli *et al.* (2015) investigated significant independent variables for separating workers of a Brazil banking network who were working in HS condition and those who were working in low strain working condition. Discussion on the identical independent variables that were studied in this research and previous research are as follows:

1) The Gender variable was indicated as one of the important variables that have influence on being in HS condition for a worker in (Bonsaksen *et al.*, 2019). In Maizura *et al.* (2010), it was selected into their model. However, the absence of Gender variables in the model developed in this study cannot be considered a contradiction to the previous two studies. As for construction worker population, the Gender variable and Work Position variable, which was selected into the model, have a high statistical correlation as discussed earlier.

2) For the Work Position variable, being selected to the model developed in this research, is consistent with the result of Petarli *et al.* (2015). In Petarli *et al.* (2015), the Work Position variable was indicated as one of the important variables for separating workers working under HS condition and workers working under low strain condition.

3) For the Education Level variable, being selected to the model developed in this research, is consistent with the result of Bonsaksen *et al.* (2019). In Bonsaksen *et al.* (2019), the Education Level variable was indicated as one of the important variables that have influence on being in HS condition for a worker. However, this finding contradicted the result of Maizura *et al.* (2010) in which the Education Level variable was not selected into their model.

4) For the Age variable, being selected to the model developed in this research, is contradictory with the result of Bonsaksen *et al.* (2019), Huda *et al.* (2004) and Maizura *et al.* (2010). In Bonsaksen *et al.* (2019), the Age variable was not indicated as one of the important variables that have influence on being in HS condition for a worker. In Huda *et al.* (2004); Maizura *et al.* (2010), the Age variable was not selected into their model.

AOR FOR HSI CONDITION

The odds value is the ratio between the probability that a particular outcome occurs to the probability that it will not occur. The odds ratio is the ratio of the odds of a particular outcome in one category to the odds of it occurring in a reference category. The odds ratio reflects the influence of differences in the characteristics of the considering independent variable on the tendency that a particular outcome occurs. There are two types of odds ratios: crude odd ratio (COR) and adjusted odd ratio (AOR).

The COR provides a ratio for the odds of a particular outcome in a specified category to the odds of it occurring in the reference category, when assuming that there is no effect of the other independent variables on a particular outcome occurring. An example of calculating the COR for working under HSI condition for a less than or equal to 10 years of work experience worker category (X = 1), of work experience variable (X) was as follows:

From Table 2, the probability for working under HSI condition, for a less than or equal to 10 years of work experience worker category (X = 1), was 0.2069. The odds value for working under HSI condition, for a less than or equal to 10 years of work experience worker category (X = 1), was 0.2609 (0.2069/(1-0.2069)).

From Table 2, the probability for a worker working under HSI condition, for a more than 10 years of work experience worker category (X = 2), which was the reference category, was 0.1326. The odds value for working under HSI condition, for a more than 10 years of work experience worker category (X = 2), was 0.1529 (0.1326/(1-0.1326)).

The COR for working under HSI condition, for a less than or equal to 10 years of work experience worker category, was 1.706 (odds given X = 1 / odds given X = 2; 0.2609/0.1529).

The AOR provides a ratio of the odds of a particular outcome occurring in a specified category to the odds of it occurring in a reference category, given that other independent variables are controlled. Given coefficient values of a logistic regression model, the AOR value can be calculated from Equation (2) presented in the research methodology section. In this study, because various independent variables had influence on a particular outcome (workers working under HSI condition), the AOR value was selected to be presented.

The AORs calculated from the coefficient of the logistic regression model using Equation (2) are presented in Table 4.

Table 4: β_{nx} and AORs of working under HSI condition

Demographic Characteristics	β_{NX}	AOR
Work Position (P)		
1 – Non–skilled labourer[r]	0.000	1.000
2 – Carpenter	2.443	11.508
3 – Bricklayer	1.737	5.683
4 – Smith	0.874	2.398
Education Level (E)		
1 – Primary school[r]	0.000	1.000
2 – Junior high school	0.502	1.652
3 – Senior high school	0.995	2.704
Average Monthly Income (I)		
1 – ≤12,000 Baht[r]	0.000	1.000
2 – 12,001–15,000 Baht	-0.796	0.451
3 – > 15,000 Baht	0.495	1.640
Work Experience (X)		
1 – ≤ 10 years[r]	0.000	1.000
2 – > 10 years	0.484	1.622
Age (A)		
1 – ≤ 30 years[r]	0.000	1.000
2 – >30 and ≤ 40 years	-0.783	0.457
3 – > 40 years	0.231	1.260

Considering the AOR data in Table 4, it is noteworthy that:

Work Position (P): Carpenter category (P = 2), bricklayer category (P = 3) and smith category (P = 4) have odds values for working under HSI condition of 11.508 (11.508 /1.000), 5.683 (5.683/1.000), and 2.398 (2.398/1.000) times higher than that of the non–skilled labourers category (P = 1), respectively. Non-skilled labourers are usually assigned to unimportant supportive tasks in which they do not require skill and there is no specific target set for productivity evaluation. They, therefore, feel more relieved and tend to have a much lower odds value for working under HSI condition than workers in other positions. On the contrary, carpenters are often scheduled to work overtime to accelerate the completion of structural work. Moreover, a carpenter usually cannot finish his assigned work by himself. They have to work together as a team to perform their work. These reasons may cause carpenters to feel stressed. As a result, their odds value for working under HSI condition are much higher than workers in other positions.

Education Level (E): Senior high school graduated category (E = 3) and junior high school graduated category (E = 2) have odds values for working under HSI condition 2.704 (2.704/1.000) and 1.652 (1.652/1.000) times higher than that of the primary school graduated category (E = 1), respectively. Workers with higher education levels are often assigned more important tasks and also are assigned to be responsible for a greater number of subordinates. Therefore, construction workers with higher education levels tend to have odds values for working under HSI condition greater than those with lower education levels.

Average Monthly Income (I): Having an average monthly income of more than 15,000 Baht, category (I = 3), and having an average monthly income equal to or less than 12,000 Baht, category (I = 1), have an odds value for working under HSI condition 3.636 (1.640/0.451) and 2.217 (1.000/0.451) times higher than that of having an average monthly income between the 12,001 Baht and 15,000 Baht categories, respectively. The fact that workers that have an average monthly income of more than 15,000 Baht has an odds value higher than workers having an average monthly income between 12,001 Baht and 15,000 Baht can be explained as follows. Most of the workers having an average monthly income of more than 15,000 Baht usually are workers who receive high wage rates or are often assigned to work overtime. They are normally assigned either to be responsible for high skill work or to take care of their subordinates. Therefore, they feel that their job demands are high, and they have a low level of control over their jobs. The fact that workers having an average monthly income equal to, or less than 12,000 Baht have an odds value higher than workers having an average monthly income between 12,001 Baht and 15,000 Baht can be explained as follows. Most of the workers having an average monthly income equal to or less than 12,000 Baht usually are workers who receive minimum wage rates and are rarely assigned to work overtime. This group of workers normally have performance below the standard. Therefore, they often feel that the work demands exceed their abilities.

Work Experience (X): The more than 10 years of work experience category (X = 2) have an odds value for working under HSI condition 1.622 (1.622/1.000) times higher than that of the less than or equal to 10 years of work experience category (X = 1). More experienced workers are normally assigned to more important tasks and also are assigned to be responsible for a greater number of subordinates. This situation tends to make them feel that their job demands are high, and they have a low level of control over their jobs.

Age (A): The over 40 years old category (A = 3) and 30 years old or less category (A = 1) have an odds value for working under HSI condition 2.757 (1.260/0.457) and 2.189 (1.000/0.457) times higher than that of over 30 but not over 40 years old category (A = 2), respectively. The odds value of workers in the second category is lower than that of the others. This may be because workers aged over 30 but not over 40 years old usually have moderate skills. Furthermore, they are normally not assigned to take care of subordinates. Therefore, workers in this category face less work problems compared to workers in other categories. They did not have problems related to working skills, whereas workers at age 30 years old or less did. They also did not have problems related to subordinates, whereas workers aged over 40 years old did.

From the above information, it can be seen that differences in each demographic characteristic have influence on the tendency of working under HSI condition for construction workers. Differences in Work Position, Education Level, Average Monthly Income, Work Experience, and Age may increase the odds value of working under the HSI condition up to 11.508 times, 2.704 times, 3.636 times, 1.622 times, and 2.757 times, respectively.

WORKERS THAT NEED SPECIAL ATTENTION

This section presents an example of how the developed logistic regression model can be applied to identify worker groups that require special attention. The model shown in equation (2) was used to calculate the probability that workers with different demographic characteristics may be working under HSI condition.

In this example, the probability of greater than 50% was used as a criterion to classify worker groups that required special attention from other workers. It was found that out of 216 possible cases (five demographic variables; 4 × 3 × 3 × 2 × 3), there were only 15 cases in which the probability for working under HSI condition was greater than 50%. These cases were shown in Table 5.

Table 5: The 15 cases where the probability value for working under HSI condition was greater than 50%.

Case	P	E	I	X	A	Sum(β_N)	Prob.
1	2	3	3	2	3	1.153	0.7601
2	2	3	3	2	1	0.922	0.7154
3	2	3	3	1	3	0.669	0.6613
4	2	2	3	2	3	0.660	0.6593
5	2	3	1	2	3	0.658	0.6588
6	3	3	3	2	3	0.447	0.6099
7	2	3	3	1	1	0.438	0.6078
8	2	2	3	2	1	0.429	0.6056
9	2	3	1	2	1	0.427	0.6052
10	3	3	3	2	1	0.216	0.5538
11	2	2	3	1	3	0.176	0.5439
12	2	3	1	1	3	0.174	0.5434
13	2	2	1	2	3	0.165	0.5412
14	2	1	3	2	3	0.158	0.5394
15	2	3	3	2	2	0.139	0.5347

To identify these high-risk groups of workers, it was necessary to consider all five types of demographic characteristics. This might cause a confusing problem in actual implementation. Therefore, the characters of the 15 workers were analyzed in order to reveal their similarities and differences. Then, the worker groups that required special attention were concluded.

Considering the Work Position variable (P), 13 out of 15 cases were in the carpenter category (P = 2), and two cases were of the bricklayer category (P = 3). None of them belonged to the non–skilled labourer category or the smith category.

Considering the highest Education Level variable (E), 10 out of 15 cases were in the senior high school graduated category (E = 3), four cases were in the junior high school graduated category (E = 2), and only one case was of the elementary school graduated category.

Considering both the Work Position variable and the highest Educational Level variable together, it was found that eight cases fitted the carpenter category along with the senior high school graduated category (P = 2 and E = 3). Four cases were found in the carpenter category with the junior high school graduate category (P = 2 and E = 2). One case was found in the carpenter category with the elementary school graduated category (P = 2 and E = 1). The other two cases were found in the bricklayer category together with the senior high school graduated category (P = 3 and E = 3).

There were 18 cases (1 × 1 × 3 × 2 × 3) where the Work Position was the carpenter category and the highest Educational Level was the senior high school graduated category (P = 2 and E = 3). In addition to the eight cases shown in Table 4 (cases no. 1, 2, 3, 5, 6, 7, 9, 12, and 15), where the probability value was greater than 50%, there were five cases, two cases, two cases, and one case with a probability value between 40% and 50%, between 30% and 40%, between 20% and 30%, and between 10% and 20%, respectively.

There were six cases (1 × 1 × 1 × 2 × 3) where the worker was a carpenter, junior high school graduated was the highest educational qualification, and the average monthly income was higher than 15,000 Baht (P = 2, E = 2, and I = 3). It was found that, in addition to the three cases shown in Table 4 (case no. 4, 8, and 11), where the probability was greater than 50%, there were two cases and one case with a probability value between 40% and 50%, and between 30% and 40%, respectively.

In all the three cases (1 × 1 × 1 × 1 × 3) where the work position was that of a bricklayer, the highest educational level was that of the senior high school graduated category, work experience was more than 10 years, and the average monthly income was higher than 15,000 Baht (P = 3, E = 3, I = 3, and X = 2). It was found that, in addition to the two cases shown in Table 4 (cases no. 6 and 10), where the probability value was greater than 50%, the probability value of the other case was 36.19%.

From the information mentioned above and the data in Table 4, it can be concluded that workers working as carpenters deserve special attention. More specific groups of workers can be identified according to their education level as follows:

1) A carpenter who is a senior high school graduate (P = 2 and E = 3) at any age, work experience, and average monthly income (18 cases).

2) A carpenter who a junior high school graduate which are further classified into two subgroups:

2.1) A carpenter who is a junior high school graduate which earns an average monthly income of more than 15,000 Baht (P = 2, E = 2, and I = 3) at any age and working experience (six cases).

2.2) A carpenter who is a junior high school graduate which earns an average monthly income of equal to or less than 12,000 Baht, and has more than 10 years of work experience with an age of over 40 years (P = 2, E = 2, I = 1, X = 2, and A = 3; one case).

3) A carpenter who is a primary school graduate which earns an average monthly income of more than 15,000 Baht, and has more than 10 years of work experience with an age of over 40 years old (P = 2, E = 1, I = 3, X = 2, and A = 3; one case).

In addition to workers working as a carpenter, a bricklayer who is a junior high school graduate, earns more than 15,000 Baht a month, and has more than 10 years of working experience (P = 3, E = 3, I = 3, and X = 2) at all ages (three cases), is another group of workers that deserves special attention.

CONCLUSION

This research delved into the relationship between the demographic characteristics of construction workers in housing projects and their psychosocial working conditions. The results of the chi-square test revealed that Gender, Age, Education Level, Work Experience, Work Position, and Average Monthly Income significantly affected the probability for working under HSI condition.

A logistic regression model for forecasting the probability of working under HSI condition using workers' demographic characteristics was also developed in this study. The model revealed five important demographic characteristics for identifying workers who were working under HSI condition, which were Age, Education Level, Work Experience, Work Position, and Average Monthly Income.

The results of the study's AOR analysis indicated that differences in Work Position, Education Level, Average Monthly Income, Work Experience, and Age may cause workers' odds value for working under HSI condition to increase up to 11.508 times, 2.704 times, 3.636 times, 1.622 times, and 2.757 times, respectively. It showed that Work Position, Average Monthly Income, Age, Education Level, and Work Experience had influenced the tendency of working under HSI condition for construction workers in descending order.

Applying the aforementioned developed logistics regression model to evaluate the probability that a worker might work under HSI condition, it was revealed that 15 cases in which the probability for working under HSI condition was greater than 50%. Thirteen out of 15 cases were in the carpenter category and two cases were of the bricklayer category. None of them belonged to the non–skilled labourer category or the smith category.

Construction projects can use the knowledge gained from this research, particularly the model, to effectively distinguish workers who are highly likely to work under HSI condition from those who are not. The ability to do so will enable the project to properly allocate resources to solve the worker's HSI condition problem.

This research explained the issues related to working under HSI condition for construction workers. The proportion of workers working under HSI condition, and chi-square test results which were obtained from this study, showed the existence of inconsistency in the problem of working under HSI condition for construction workers. The logistic regression model and AOD for working under HSI condition, obtained from this research, identified the demographic characteristics that were significantly related to working under HSI condition for construction workers. Information from this research sparked further questions like; Why did workers, who were in a specific category of each demographic characteristic type, have a significantly higher probability for working under HSI condition than those who were in other categories? The fact that the model, developed to predict the probability value of working under HSI condition based on workers' demographic characteristics, did not have a very high Nagelkerke R square value, also revealed that only demographic characteristics of workers may not be sufficient to effectively predict the probability of working under HSI condition. Furthermore, knowledge gaps on other types of variables which were significantly influential on working under HSI condition for construction workers, still need to be filled. The findings from this research are expected to potentially lead to an improvement of productivity practices or theories in construction project management.

STRENGTHS AND LIMITATIONS OF THE STUDY

This research provides various useful information: The relationship between the demographic characteristics of construction workers working in subdivision housing projects, regression models to predict the probability for workers working under HSI condition, AOR, and characteristics of worker groups that need special attention. Project managers of subdivision housing projects may apply this information to managing the workforce and improving productivity at work.

The data for this study were only collected from the population of workers working for the subdivision housing projects, which had a selling price between 2.50 million Baht and 5.00 million Baht. Applying data or information from this study in managing the workforce working on subdivision housing projects that have different selling prices, especially those with higher selling prices, should be done cautiously. This is because workers working in subdivision housing projects that have significantly different selling price trends have different levels of job demands, gain different levels of autonomy in their jobs, and receive different levels of support from supervisors and co–workers.

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