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報告題名：

Comparative Injury and Fatality Risk Analysis of Building Trades

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中文摘要

1. 目的:

建造業在美國歷來遭受了不良記錄的職業傷害像是疾病
和死亡!在 2003 年勞工統計局的指出
，建築業是在所有行業擁有最高的死亡人數有 1126 人
。不幸的是，這個數字在過去的 10 年一直保持相對穩定.人們普遍意識到，建設工作本質上是危險的，目前建設項目現場有高風險受傷和死亡，尤其是當業主和承包商的安全方案是不是有效的實施

2.過程及方法

本文是在分析與比較 16 種建築行業研究報告中職業傷
害和死亡的風險.該方法是基於從(根本上的界定)風險機
率作為其頻率和嚴重程度，並利用風險概念評估和排名
各行業的術語與非致命性損傷率.此研究來源是用勞工
統計局的數據!風險分析方法包括頻率和嚴重程度的考慮
與非致命性的傷害

3. 結果

該結果表明：這項研究可以
指出為什麼往往這些行業會出現如此多的傷害訴訟,此外有這些風險
排行的訊息.施工項目經理可以是先計劃還有排定安全方案，現場的
施工方式將重點放在高風險部分和減災戰略和優先次序干預方法，
包括培訓需求，個人防護，以使有效的資源分配決定。
最後再跑中文統計 2.0 軟體,證明她 DATA 的信心水準

關鍵字：

中文統計 2.0
風險評估
風險量化和風險分析
risk plane concept to evaluate
rank the trades in terms of nonfatal injury rates
risk quantification and risk analysis

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Comparative Injury and Fatality Risk Analysis of Building Trades

Directory

Abstract

Occupational injury and fatality risk analysis was performed on 16 building trades in the study reported herein. The approach was based on defining risk fundamentally as the product of probability frequency┐ and severity, and using the risk plane concept to evaluate and rank the trades in terms of nonfatal injury rates. Bureau of Labor Statistics data was used in the study. The risk analysis methodology included both frequency and severity considerations associated with nonfatal injuries.

Introduction

The construction industry in the United States has historically suffered a poor record of occupational injuries, illnesses, and fatalities. The Bureau of Labor

Statistics for 2003 indicate that the highest number of fatalities among all industries occurred in construction, with 1,126 that year. Unfortunately, this number has stayed relatively constant over the past decade. It is commonly recognized that construction work is inherently dangerous, and construction project sites present a high risk of injury and fatality, especially when the owner and contractorsafety programs are not implemented effectively

Data published by the Bureau of Labor Statistics were used in these studies to evaluate the risks primarily in terms of the probability of injury and fatality.

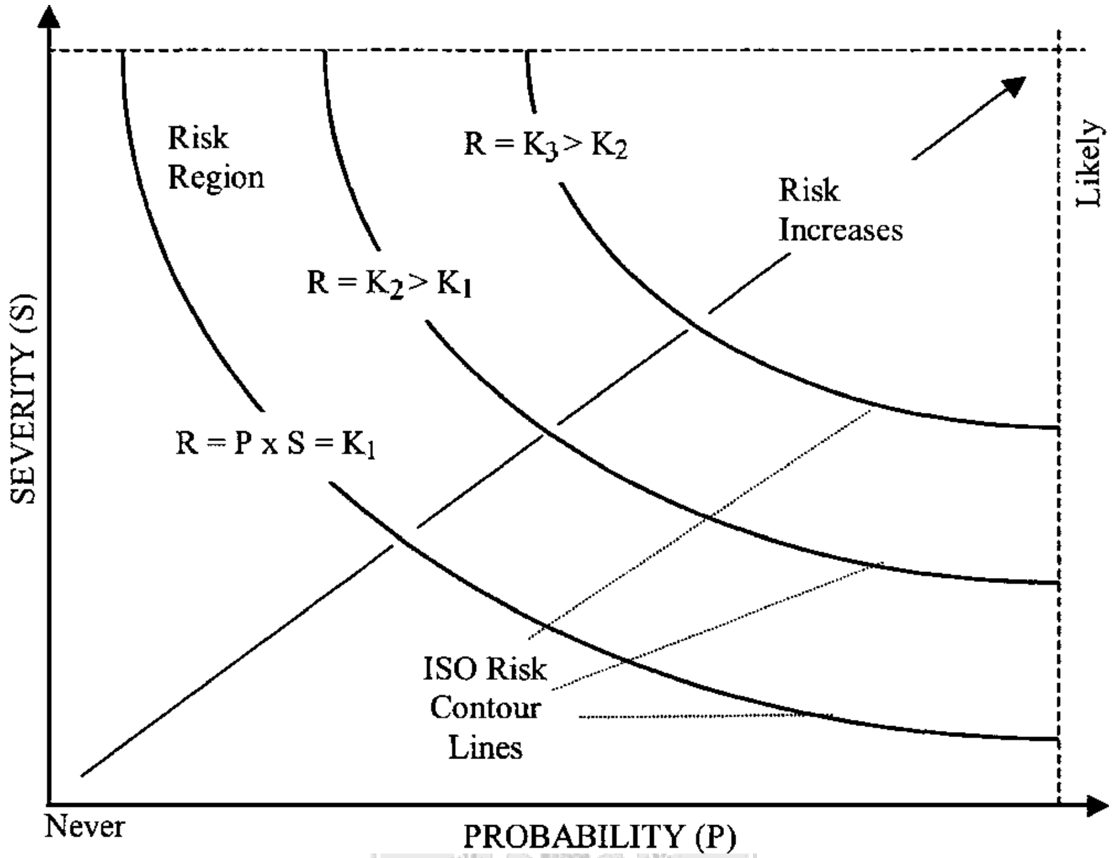
It is important to recognize that a large volume of data is required for risk quantification and risk analysis using injury, illness, and fatality statistics for each trade.

However, very few construction firms have the quantity and quality of data needed to perform meaningful risk analysis. Although insurance companies maintain extensive records, this data is confidential and not in the public domain. Consequently, all published risk analysis work on injuries and fatalities has drawn on the BLS data, which is easily accessible

What is evaluating risks?

Two methods have commonly been used in evaluating risks (Clemens and Simmons 1998): The risk plane, and its extension, risk assessment matrix.

Risk plane



Risk Analysis Methodology and *Steps for Analysis*

Data Source

The BLS provides several different statistics that can be used to identify and rank dangerous occupations, including annual incidence and fatality rates. Incidence rate is the number of injuries and illnesses per 100 full-time workers and represents their frequency in an industry or an industry sector.

It is based on 100 full-time equivalent workers working 40 h per week for 50 weeks in a given year. Fatality rate also termed rate of fatal occupational injuries is the number of deaths per 100,000 workers and represents the annual frequency of fatalities.

Formulations for Risk Analysis

$$NFR = (NF / E)$$

$$FR = (F / E) \times 100{,}000$$

$$CLT = MDAFW \cdot HW \cdot 8$$

Steps for Analysis

A two-step approach was taken to perform the risk analysis (Baradan 2004). As a first step, nonfatal injuries and fatalities were analyzed separately. The second step was based on the first, where the results for nonfatal injuries and fatalities were integrated into a combined risk analysis.

Table 1. Risk Score Criteria for Nonfatal Injuries and Fatalities

Nonfatal injuries		Fatalities	
Risk region	Risk score	Index of relative risk	Risk score
1	7	>1.50	7
2	6	1.25–1.49	6
3	5	1.00–1.24	5
4	4	0.75–0.99	4
5	3	0.50–0.74	3
6	2	0.25–0.49	2
7	1	0.01–0.24	1

Fatalities were analyzed using the index of relative risk, which is calculated by

$$\mathrm{IRR} = \mathrm{FR} \Big/ \left[\left(\sum \mathrm{F} \Big/ \sum \mathrm{E} \right) \cdot 100{,}000 \right]$$

$$RS_C = RS_{NF} + i \cdot RS_F$$

The index of harm term, *i*, in Eq. 5 implies that the effects of nonfatal injures and fatalities on the combined additive risk score term can be uneven. It was decided to use the same *i* value to compute RS*C* in this study, although it was recognized that there may be a range of values for this coefficient. Index of harm may Vary from trade to trade, and in cases where there are high-cost disabling injuries, it can be lower than 2.

Table 2. Mean Values of Nonfatal Injury and Fatality Related Data

Building trade	Abbreviation	1998–2001 mean values: Nonfatal injury rate	Median days away from work	Hourly wage ($)	Cost of lost time ($)	Fatality rate
Brickmasons, blockmasons, and stonemasons	Br	0.031	8.25	19.15	1,264	14.18
Carpenters	Cp	0.043	7.25	16.50	957	12.23
Carpet, floor, and tile installers and finishers	Cr	0.042	10.50	15.61	1,311	0
Cement masons, concrete and terrazzo finishers	Cn	0.015	9.25	14.63	1,083	0
Construction equipment operators	Op	0.003	23.50	14.22	2,673	7.55
Drywall installers	Dr	0.038	9.00	16.82	1,211	8.38
Electricians	El	0.025	8.25	19.84	1,310	17.28
Glaziers	Gl	0.046	5.00	15.09	604	0
Insulation workers	In	0.043	8.25	14.44	953	10.70
Ironworkers	Ir	0.056	8.50	18.41	1,252	52.70
Painters and paperhangers	Pa	0.026	8.00	14.19	908	14.93
Plasterers and stucco masons	Pl	0.026	9.75	16.23	1,266	0
Plumbers, pipelayers, pipefitters, steamfitters	Pm	0.030	7.50	18.93	1,136	9.26
Roofers	Rf	0.052	10.25	14.69	1,205	55.30
Sheet metal workers	Sh	0.033	6.25	16.47	824	8.19
Tilesetters and marble setters	Ti	0.028	7.50	17.63	1,058	0

Table 3. Trade Risk Ranking Results

Building trade	Nonfatal injuries				Fatalities			Combined results	
	R	Rank	Risk region	Risk score	Index of relative risk	Rank	Risk score	Risk score	Rank
Iron workers (Ir)	65.9	1	1	7	3.78	2	7	21	1
Roofers (Rf)	63.0	2	1	7	3.97	1	7	21	1
Carpet, floor, tile installers (Cr)	55.8	3	2	6	0	12	0	6	12
Drywall installers (Dr)	45.5	4	3	5	0.6	9	3	11	8
Insulation workers (In)	41.2	5	3	5	0.88	6	4	13	5
Carpenters (Cp)	41.0	6	3	5	0.77	7	4	13	5
Brickmasons (Br)	39.2	7	4	4	1.02	5	5	14	3
Plumbers (Pm)	33.8	8	4	4	0.66	8	3	10	9
Electricians (El)	33.2	9	4	4	1.24	3	5	14	3
Plasterers and stucco masons (Pl)	32.0	10	5	3	0	12	0	3	13
Tilesetters and marble setters (Ti)	28.2	11	5	3	0	12	0	3	13
Glaziers (Gl)	27.3	12	5	3	0	12	0	3	13
Painters and paperhangers (Pa)	23.9	13	5	3	1.07	4	5	13	5
Sheet metal workers (Sh)	17.2	14	5	3	0.59	10	3	9	10
Cement masons, concrete finishers (Cn)	15.5	15	6	2	0	12	0	2	16
Construction equipment operators (Op)	7.2	16	4	1	0.54	11	3	7	11

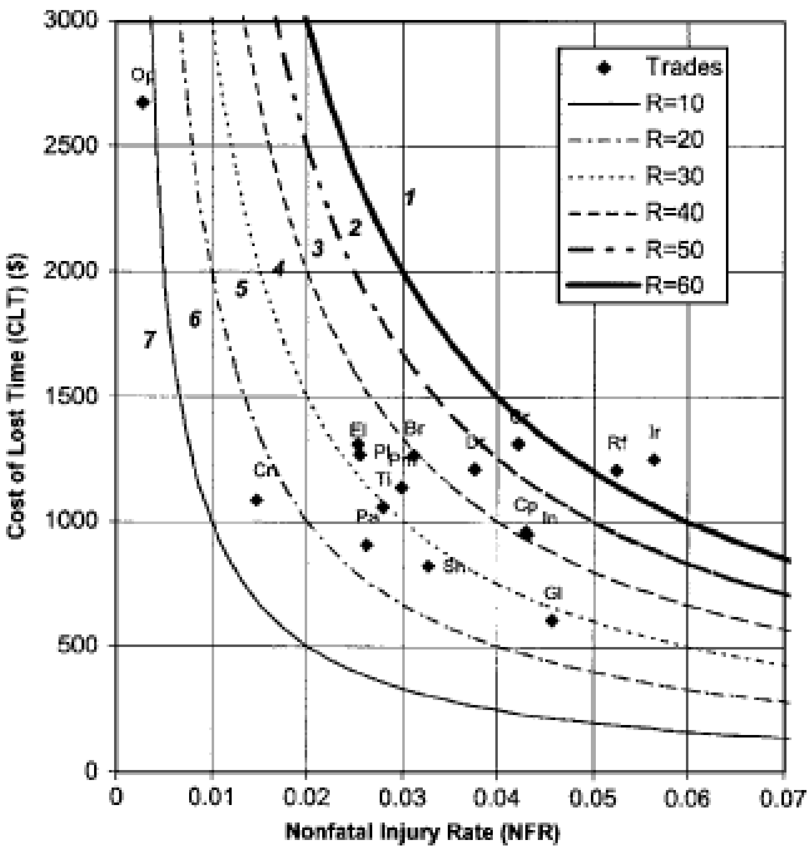


Fig. 2. Risk plane for years 1998–2001

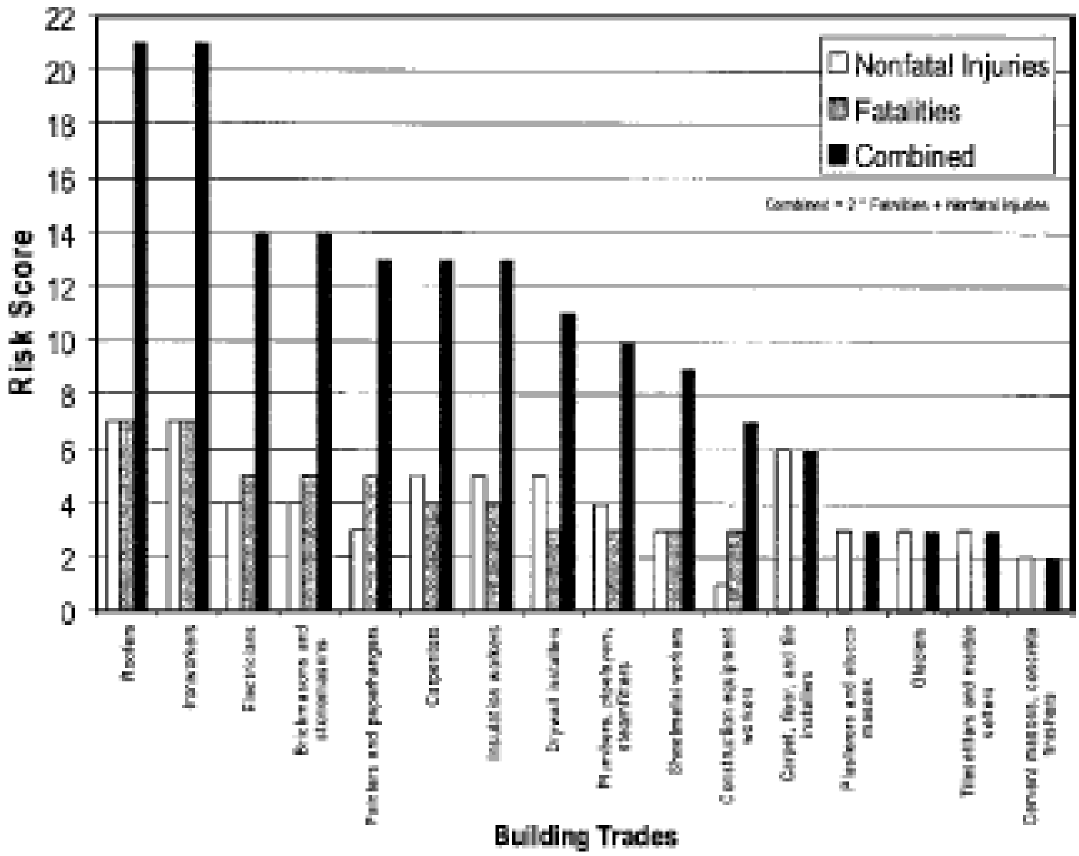


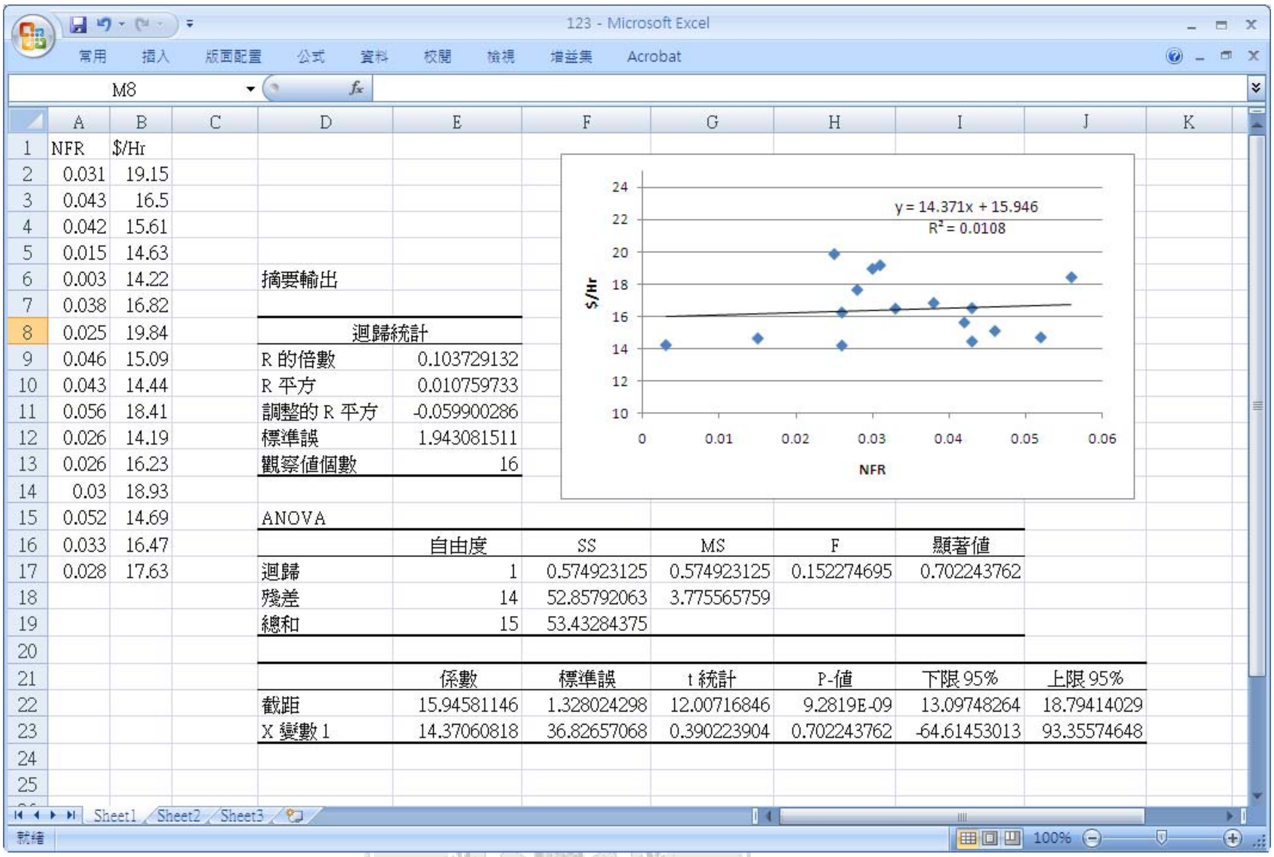
Fig. 3. Risk scores of building trades

使用中文統計 2.0 分析 加入新議題

上述報告是論文內容,以下所要講的是增加

新的議題,用中文統計 2.0 軟體來驗證和分析,

使本論文更加完善



NFR	$/Hr
0.031	19.15
0.043	16.5
0.042	15.61
0.015	14.63
0.003	14.22
0.038	16.82
0.025	19.84
0.046	15.09
0.043	14.44
0.056	18.41
0.026	14.19
0.026	16.23
0.03	18.93
0.052	14.69
0.033	16.47
0.028	17.63

摘要輸出

迴歸統計	
R 的倍數	0.103729132
R 平方	0.010759733
調整的 R 平方	-0.059900286
標準誤	1.943081511
觀察值個數	16

ANOVA

	自由度	SS	MS	F	顯著值
迴歸	1	0.574923125	0.574923125	0.152274695	0.702243762
殘差	14	52.85792063	3.775565759		
總和	15	53.43284375			

	係數	標準誤	t 統計	P-值	下限 95%	上限 95%
截距	15.94581146	1.328024298	12.00716846	9.2819E-09	13.09748264	18.79414029
X 變數 1	14.37060818	36.82657068	0.390223904	0.702243762	-64.61453013	93.35574648

利用t分配檢定 $H_0: \beta_1=0$ 的假設 $|t| = 0.3902 < t_{0.025,\ 14} = 2.145$,所以接受 H_0

在這裡我們假設每小時工資與非致命受傷率的關係

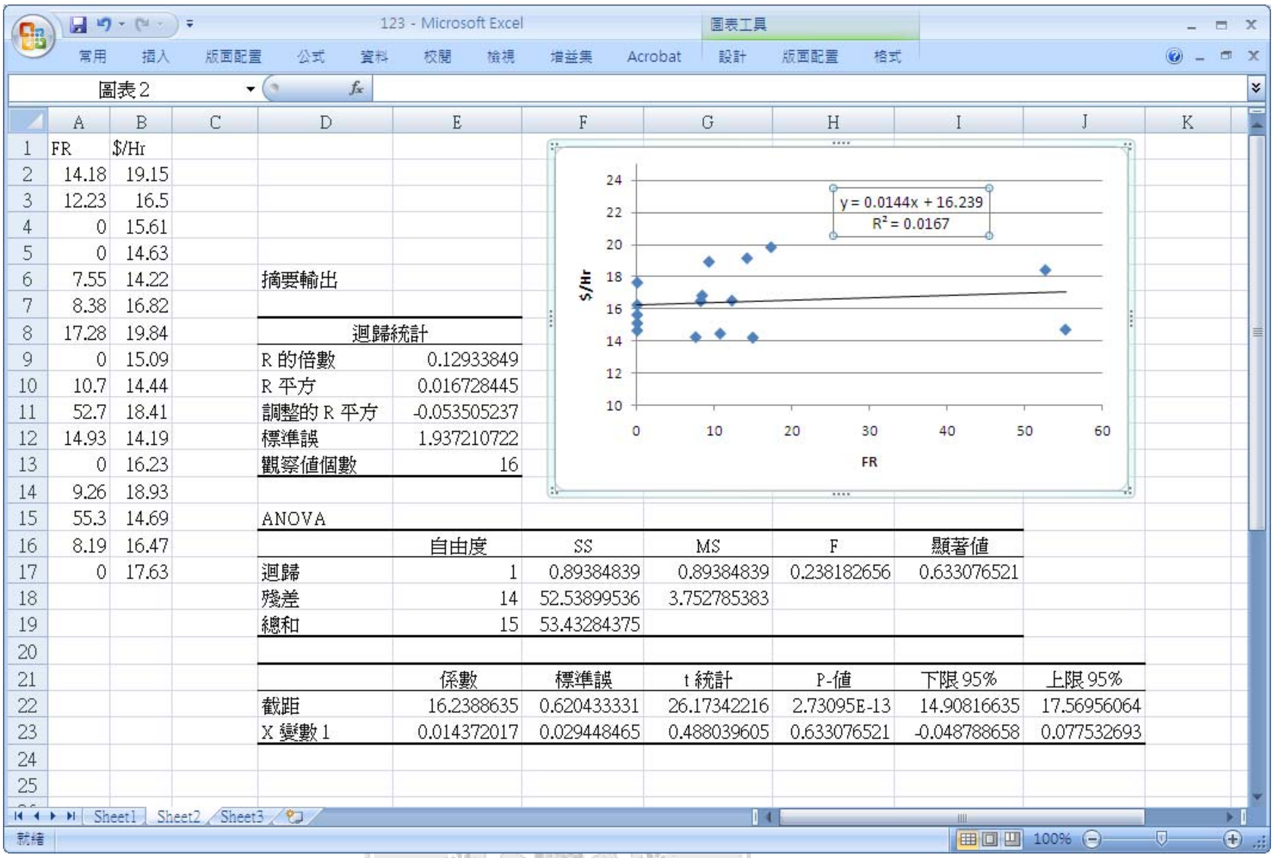
$$
\text{檢定}:\begin{cases} H_0: \beta_1 = 0 \\ H_1: \beta_1 \neq 0 \end{cases}
$$

利用變異數 F 分配檢定 $H_0: \beta_0 = 0$ 的假設:

因爲 $F = 0.1523 < F_{0.05,\ 1,\ 14} = 4.60$

,所以接受 H_0 ,即自變數和因變數沒有顯著關係

代表工資越高.和受傷率沒有顯著的正相關



FR	$/Hr
14.18	19.15
12.23	16.5
0	15.61
0	14.63
7.55	14.22
8.38	16.82
17.28	19.84
0	15.09
10.7	14.44
52.7	18.41
14.93	14.19
0	16.23
9.26	18.93
55.3	14.69
8.19	16.47
0	17.63

摘要輸出

迴歸統計	
R 的倍數	0.12933849
R 平方	0.016728445
調整的 R 平方	-0.053505237
標準誤	1.937210722
觀察值個數	16

ANOVA

	自由度	SS	MS	F	顯著值
迴歸	1	0.89384839	0.89384839	0.238182656	0.633076521
殘差	14	52.53899536	3.752785383		
總和	15	53.43284375			

	係數	標準誤	t 統計	P-值	下限 95%	上限 95%
截距	16.2388635	0.620433331	26.17342216	2.73095E-13	14.90816635	17.56956064
X 變數 1	0.014372017	0.029448465	0.488039605	0.633076521	-0.048788658	0.077532693

利用t分配檢定 $H_0: \beta_1=0$ 的假設 $|t| = 0.4880 < t_{0.025,\ 14} = 2.145$,所以接受 H_0

在這裡我們假設每小時工資與死亡率的關係

檢定: $\begin{cases} H_0: \beta_1 = 0 \\ H_1: \beta_1 \neq 0 \end{cases}$

利用變異數 F 分配檢定 $H_0: \beta_0=0$ 的假設:

因為 $F = 0.2382 < F_{0.05,\ 1,\ 14} = 4.60$

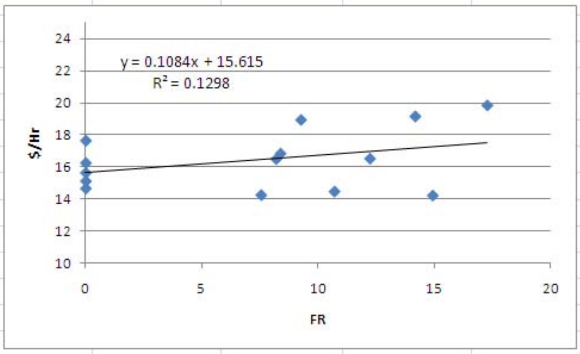
,所以接受 H_0 ,即自變數和因變數沒有顯著關係

代表工資越高.和死亡率沒有顯著的正相關

FR	$/Hr
14.18	19.15
12.23	16.5
0	15.61
0	14.63
7.55	14.22
8.38	16.82
17.28	19.84
0	15.09
10.7	14.44
14.93	14.19
0	16.23
9.26	18.93
8.19	16.47
0	17.63

摘要輸出

迴歸統計	
R 的倍數	0.360316398
R 平方	0.129827906
調整的 R 平方	0.057313565
標準誤	1.835876985
觀察值個數	14



ANOVA

	自由度	SS	MS	F	顯著值
迴歸	1	6.034361213	6.034361213	1.790375591	0.205684127
殘差	12	40.44533164	3.370444304		
總和	13	46.47969286			

	係數	標準誤	t 統計	P-值	下限 95%	上限 95%
截距	15.61534717	0.770768865	20.25944209	1.19987E-10	13.93598609	17.29470826
X 變數 1	0.108423949	0.081031364	1.338049174	0.205684127	-0.068128225	0.284976123

利用t分配檢定 $H_0: \beta_1 = 0$ 的假設 $|t| = 1.3380 < t_{0.025,\ 12} = 2.179$,所以接受 H_0

在這裡我們假設每小時工資與死亡率的關係(因上張圖有兩筆,離散值出現,所以我們刪除離散值.再做一次分析)

$$\text{檢定}:\begin{cases} H_0: \beta_1 = 0 \\ H_1: \beta_1 \neq 0 \end{cases}$$

利用變異數 F 分配檢定 $H_0: \beta_0 = 0$ 的假設:

因爲 $F = 1.7903 < F_{0.05,\ 1,\ 12} = 4.75$

,所以接受 H_0 ,即自變數和因變數沒有顯著關係,代表工資越高.和死亡率沒有顯著的正相關,就算刪除離散值也是如此

NFR	CLT
0.031	1264
0.043	957
0.042	1311
0.015	1083
0.003	2673
0.038	1211
0.025	1310
0.046	604
0.043	953
0.056	1252
0.026	908
0.026	1266
0.03	1136
0.052	1205
0.033	824
0.028	1058

摘要輸出

迴歸統計	
R 的倍數	0.561287234
R 平方	0.31504336
調整的 R 平方	0.266117885
標準誤	379.468416
觀察值個數	16

ANOVA

	自由度	SS	MS	F	顯著值
迴歸	1	927228.0352	927228.0352	6.439249981	0.023681281
殘差	14	2015947.902	143996.2787		
總和	15	2943175.938			

	係數	標準誤	t 統計	P-值	下限 95%	上限 95%
截距	1800.954067	259.3526179	6.944036583	6.82798E-06	1244.698026	2357.210108
X 變數 1	-18250.02806	7191.937323	-2.537567729	0.023681281	-33675.19945	-2824.85668

利用t分配檢定 $H_0:\beta_1=0$ 的假設 $|t| = 2.537 > t_{0.025,\ 14} = 2.145$,所以拒絕 H_0

最後我們在這張圖示用了因爲受傷關係而失去時間成本的關係做了

比較 檢定: $\begin{cases} H_0:\beta_1=0 \\ H_1:\beta_1\neq 0 \end{cases}$

利用變異數 F 分配檢定 $H_0:\beta_0=0$ 的假設:

因爲 $F = 6.392 < F_{0.05,\ 1,\ 14} = 4.60$

,即自變數和因變數有顯著關係,所以此圖形代表的是拒絕 H_0

有顯著的負相關

中文總結

因爲在社會上有各式各樣的行業,存在各種的死亡機率和受傷機率,但

以土木建築等較低階的產業來看,他們擁有的是低工資但往往擁有的是高受傷率和高死亡率,且工資差異並沒多大。但反過來看電子.機械等高科技產業,雖然工作時數可能會偏高.但他們並不存在如此高的死亡及受傷風險。可能有部分的原因是安全措施並不完善且確實,這是我們未來可以加強及改善的目標。

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