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UNPACKING THE HIERARCHICAL DIMENSIONS OF COMMUTE COST RESILIENCE: EVIDENCE FROM CONSTRUCTION WORKERS

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Abstract
This paper delves into the philosophical and economic conceptualizations of ends and means, scrutinizing their inherent nature and categorization. The assertion is made that ends inherently pertain to the subjective realm, while means are firmly situated in the objective domain. Within the subjective sphere, human wants and needs are considered, and further dissected through the lens of Maslow's hierarchy, delineating a hierarchical structure. However, in contrast, resources and means resist hierarchical division akin to Maslow's hierarchy of needs. Specifically, transportation, identified as a subset of means/resources, challenges the appropriateness of applying the theory of Transportation System Users' Hierarchy of Needs, as posited by Sun and Philips in 2020.

1 Introduction

According to the philosophical and economic definitions of ends and means, and the nature of end and means, we argue that ends belong to subjective category, and means belong to objective category, human wants/needs belong to subjective category, human wants/needs can be divided into Maslow's hierarchy of needs, resources/means can't be divided hierarchically modeled Maslow's hierarchy of needs. Transportation belongs to the category of means/resources, so the theory of Transportation System Users' Hierarchy of Needs is inappropriate (Sun &Philips, 2020).

It is not the completion of the task that just only points out that the theory of Transportation System Users' Hierarchy of Needs is inappropriate, more important is to find an alternative theory.

So, this paper proposes a new alternative hierarchy theory, i.e., hierarchy divisions of the ability to endure commute costs.

2 Literature Review

Abraham Maslow divided the needs of human beings hierarchically into five levels at the beginning of his career and six levels during his later years: (a) physiological, (b) safety, (c) social belonging, (d) esteem, (e) selfactualization, and (f) self-transcendence.[3] Winters, Cleland, Mierzejewski, and Tucker (2001) divide the transportation needs hierarchically after Maslow's hierarchy of needs as the transportation system users' hierarchy of needs.

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The block diagram of the transportation system users' hierarchy of needs is as follows:

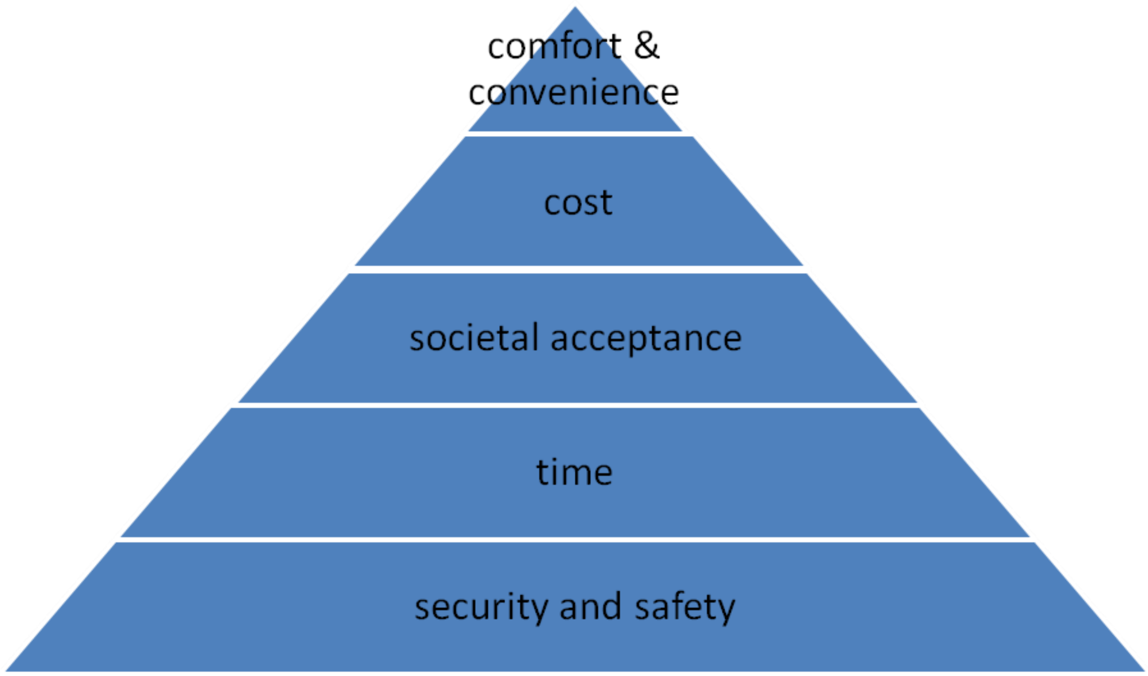

Figure 1 transportation hierarchy of needs Cited from Winters, et al, 2001, p37

The first layer is personal security and safety which is the most basic needs. The second layer is about time, which means time saving and trip efficiency. The third layer is societal acceptance. The fourth layer is cost, and the fifth layer is comfort and convenience. Winters, et al directly determine the content and order of the five hierarchies according to their preferences and intuitions. Winters, et al also argue their views by way of examples, such as "a commuter may be circling downtown looking for an affordable parking space but once the price level need is met then the next need is convenience in terms of parking in a nearby location" (Winters, et al., 2001, pp.39).

Perone, et al (2005) is the most prominent proponents of the theory of transportation system users' hierarchy of needs, the primary focus of their research project "was in providing empirical evidence of a Hierarchy of Transportation Needs" (Perone, et al, 2005, Abstract). To offer empirical evidence of a Hierarchy of Transportation Needs, they first replaced the Maslow's Hierarchy of Needs theory by Alderfer's Existence, Relatedness, and Growth (ERG) theory, then they designed a statistical questionnaire, in which those questions could be divided into three parts. The first part included some the "Existence versus Growth (ER), Existence versus Growth (EG), and Relatedness versus Growth (RG) types of questions" (Perone, et al, 2005, p23). The second part of the questions was relative to a certain scenario which were rank Existence, Relatedness, and Growth variables, the respondents were asked which situation they would choose. The third part was the specified 30 items questions. Their survey showed that "most participants chose Existence needs over Relatedness over Growth needs" (Perone, et al., 2005, Abstract).

Based on the analysis of the philosophical and economic definitions of ends and means, and the close relationship between ends and means, Sun and Philips (2020) argued that the theory of Transportation System Users' Hierarchy of Needs is inappropriate.

Neveu, et al (1979) use perceptual mapping techniques to analyze the influence of the three factors, as comfort, convenience, and reliability with regard to commute. Koppelman and Pas (1980) disclose a generally very positive attitude toward car mode, a less positive attitude toward walking mode, and a neutral attitude toward bus mode. Also, they find that there has a high degree of sensitivity toward major increase in gas prices, and little sensitivity toward lower bus fares. Mitchelson and Gauthier (1980) find that psychological and situational variables will affect the travel mode choice greatly.

Ulberg (1989) argues that values, beliefs, and psychological factors will affect the choice of mode. Cervero (1989) finds that metropolitan areas in the United States had already exhibited the phenomenon of the widening gulf between the Americans' living place and working place.

Levinson (1998) argues that residence in job-rich areas is associated with shorter commutes, as is having workplaces in housing-rich areas. Green (1999) argues that many rural residents have longer than average commute times. Axisa, Scott, and Newbold (2012) examine factors that influence commute distance within the commuter shed of Toronto, Canadausing data drawn from the 2006 Census of Canada Master File.

Sun(2020) analyzes the factors affecting the commute distance/time of construction workers, and finds that construction workers cherish work opportunities more than other professionals, and endure longer commute time; contractors like to hire construction workers in the local labor market, and construction workers frequently live closer to their contractors than to the projects; occupations such as construction do not allow workers to pick a jobsite and then select a home, so the workers' strategy is to pick a contractor and follow that contractor's work, or to pick a home and then pick a nearby contractor; specialty contractors rely more upon local union hiring halls whereas general contractors may try to attach workers to them and have them follow their work.

3 The Ability to Endure Commute Costs of Construction Workers

3.1 Commute cost structure of construction workers

In a broad sense, the commute cost of construction workers includes cost of money, aversion cost of commute time, the opportunity cost of commute time. This research area is too broad, so we narrow the research area a little, and adopt the framework of Winters, et al' s hierarchy elements of transportation system users' hierarchy needs.

Winters, et al' s hierarchy elements of transportation system users' hierarchy needs comes from the Dow Jones User Ratings, in which rating elements include comfort, safety, speed or time, reliability, connectivity, convenience, enjoyment/aesthetics (Winters, et al, 2001, p19).

In the Dow Jones User Ratings system, during the decision-making process, all elements must be considered at the same time, and the weighted average method is used, but these elements have different weights, and different people use different weights. For Winters, et al' s hierarchy elements of transportation system users' hierarchy, the weighted average method should also be used, and all elements are needed to be considered at the same time. That means all hierarchies, i.e. safety and security, time, societal acceptance, cost, comfort and convenience, should be rated at the same time, rather than when the first hierarchy safety and security need is met, then begin to consider the second hierarchy time need, and so on to the fifth hierarchy comfort and convenience.

View from cost, Winters, et al' s hierarchy elements of transportation system users' hierarchy needs represent five kinds of cost, safety and security mean safety cost, time represent time cost, societal acceptance represents societal cost, cost represents money cost, comfort and convenience represent the extra cost that people have to pay for comfort and convenience. In fact, the cost of comfort and convenience generally is included in money cost.

The cost of traffic safety generally consists of three parts. The first part is the expense of safety equipment, for example, you need to buy a helmet for bicycles and motorcycles; the second part is the cost of safety prevention, such as insurance for driving and flying; the third part is the loss after the traffic accident, such as the loss of the safety accident itself and the loss of away from jobs, etc.

Time cost belongs to subjective cost. Driving too much is not good for health: "The more time people spend driving, the greater their odds of having poor health and risk factors for poor health"[4]. According to TIME[5], a commute negatively affects the body in ten ways: raising blood sugar level, raising cholesterol level, raising risk of depression, increasing anxiety, decreasing happiness and life satisfaction, temporarily spiking blood pressure, raising blood pressure over time, decreasing cardiovascular fitness, impacting sleep patterns, causing back problems. Cheu and Kreinovich (2007) argue that commute disutility functions, i.e., describing the relationship between disutility and commute time, present an exponential function form, and are consistent with common sense.

With regard to the societal acceptance, some commuters are environmentalists or health-conscious commuters, they may be more willing to choose bike rather than car for their commute in order to be more in line with their personal beliefs and more acceptable to society (Winters, et al., 2001, p39). Due to choosing bike, the commuters decrease their comfort degree during their commute journey and increase the commute time.

So, this means that the commuters will increase their cost for theirs more acceptable to society. We can call this kind of cost as societal cost. So, commute cost of a construction worker = safety cost + time cost + societal cost + money cost + cost of comfort and convenience

3.2 The ability to endure commutecosts of construction workers

From the above part, we know that commute cost of a construction worker consists of safety cost, time cost, societal cost, money cost, cost of comfort and convenience. Some of these five costs are subjective costs, and some are monetary expenditures. These five costs are interdependent. When a mode of transportation and means of transportation are selected and determined, then the commute costs are determined. It is obvious that there is a positive correlation between the commute cost and the commute distance or commute times.

Construction workers need to endure longer commute times due to some characteristics of construction industry. The localness characteristic of the construction industry means that construction workers need to endure longer commute times. The highly volatile characteristic of construction industry means that construction workers will cherish work opportunities more than other professionals and one of the byproducts of cherishing job opportunities is enduring longer commute times.

The fact that the construction workers have to take endured travel times is supported by survey data.

Priceonomics Company[6] computed the average commute time by occupational category based on data from the 2014 American Community Survey. The calculation results show that professions in the construction and mining industry have the longest commutes. Specific results are shown in Table 1.

Table 1 Average Commute Time by Occupation Type

Rank	Occupation Group	Commute in Minutes
1	Construction and mining	33.4
2	Computer science and math	31.8
3	Business operations specialists	30.2
4	Architecture and engineering	30.2
5	Finance	29.4
6	Lawyer and legal support	28.9

[4] www.sbs.com.au/news/too-much-driving-is-bad-for-you-study
[5] http://time.com/9912/10-things-your-commute-does-to-your-body/
[6] www.priceonomics.com/

7	Physical and social science	28.8
8	Arts, design, entertainment, sports, and media	28.6
9	Protective service (police, firefighter, etc.)	28.4
10	Management	28.0
11	Installation, maintenance, and repair	27.7
12	Transportation	27.2
13	Healthcare practitioners	26.2
14	Administrative support	26.0
15	Industrial production	25.8
16	Cleaning and maintenance	25.7
17	Sales	25.4
18	Healthcare support	25.3
19	Social service	24.9
20	Farming, fishing, and forestry	24.6
21	Personal care and appearance	23.6
22	Education	23.1
23	Food preparation and serving	22.0
24	Military specific	21.0

Cited from https://priceonomics.com/which-professions-have-the-longest-commutes/

The commute cost is positive to the commute distance or commute times, we can compute the average commute cost per person per mile.

The average commute cost per person per mils includes the subjective cost, so the different people's commute costs per person per mile are different. We can assume that the variable commute cost per person per mile follows a normal distribution, as the normal distribution is the most common distribution. In this way, we can use the expected value or average value of random variable commute cost per person per mile as a representative of the data set of the random variable commute cost per person per mile, we use symbol $\dot{c}$ to represent this expected value or average value. So that the i-th person's commute cost will be $\dot{c}*d_i$, d_i means the commute distance of the i-th person. The size of the commute cost depends on the commute distance. The greater the commute distance, the greater the commute cost. The difference in commute cost represents the different ability of people to endure the commute cost. We can imagine that some construction worker can endure higher commute cost, some construction workers can only endure lower commute cost. So, according to the difference in the ability of construction workers to endure commuting costs, we do hierarchical division of the ability to endure transportation costs of construction workers.

4 The Empirical Hierarchy Division of the Ability to Endure Commute Costs of Construction Workers 4.1 The empirical model of hierarchy division of the ability to endure commute costs of construction workers

The goal of commute for construction workers is to reach the worksites to work, and then get wages. So, the commute cost is a part of wages, accounting for a certain percentage of wages, this percentage will not be a fixed value, but there must be an interval range. This interval range represents people's ability to endure commuting costs. Outside this range, people will not accept the corresponding work, then, commuting costs will not be realized.

In the section third, we have simplified the commute cost as a function of commuting distance, commuting cost is proportional to commuting distance. So that the problem of hierarchical dividing the endure ability of commuting cost into the division of the acceptance of commuting distance, we divide the endure ability of commuting cost into three hierarchies, i.e., the ability that can endure high commute cost, the ability that can endure medium commute cost, and the ability that can endure low commute cost.

The abilities to acceptance of commuting distance for construction workers are mainly relative to their wage levels, as commute costs are part of their wage incomes. Also, construction workers' wage levels are relative to their wages per hour, so we choose wages per hour and commute distance as clustering variables, data used in this paper are from individual worker payroll data for several public building projects completed in San Jose, California between 2008 and 2016.

4.2 Overall empirical hierarchy division of the construction workers' ability to endure commutecosts

We do clustering analysis on the overall data, which are from individual worker payroll data for several public building projects completed in San Jose, California between 2008 and 2016. The clustering results are shown in Table 2.

Table 2

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	25	51.08	16.46	35.05	91.64
	Distance of worker to project	25	553.97	161.08	372.32	1127.70
2	Wages per hour	297	46.53	25.01	14.21	216.96
	Distance of worker to project	297	152.22	43.85	102.14	348.57
3	Wages per hour	2218	42.78	19.29	10.66	402.13
	Distance of worker to project	2218	50.43	20.48	10.40	100.93

Based on the data in Table 2, we can draw the block diagram of the hierarchical division of the ability to endure the commute costs of the overall construction workers, as Figure 2.

Figure 2

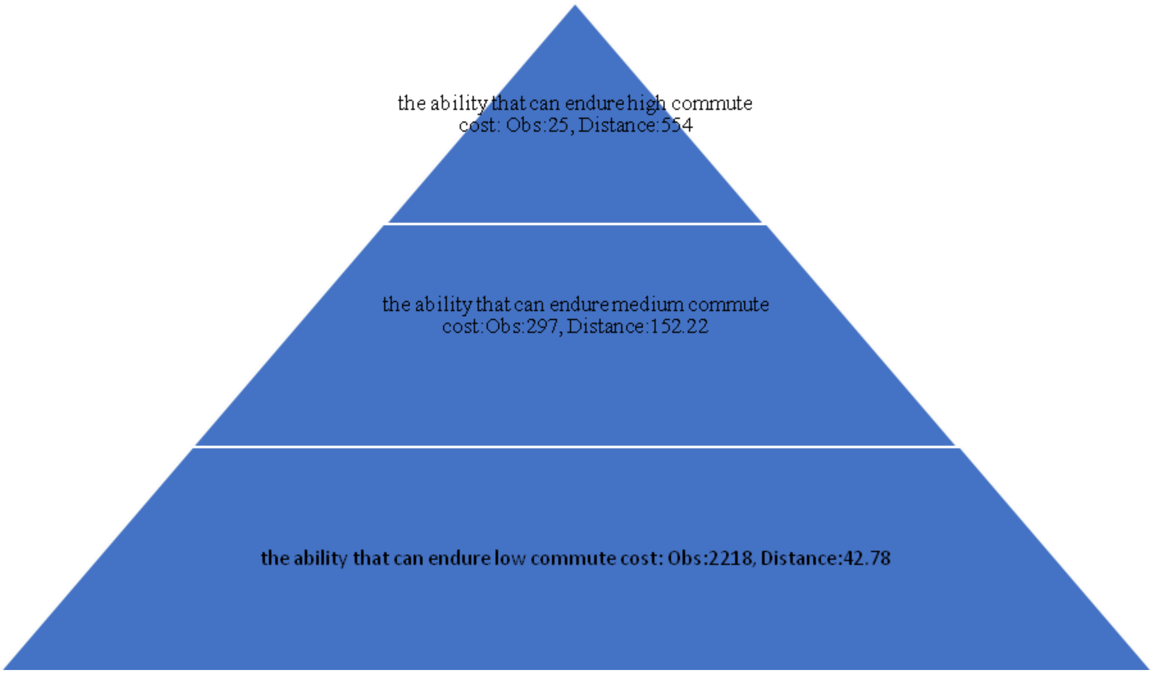

Figure 2, i.e., the block diagram of the hierarchy divisions of the ability to endure the commute costs of the overall construction workers is pyramidal. According to the calculation of the data in Table 2, we can know that the proportion of constructionworkers locatedin the hierarchyof the ability that can endure low commute cost is 87.32%; the proportion of construction workers located in the hierarchy of the ability that can endure medium commute cost is 11.69%; the proportion of construction workers located in the hierarchy of the ability that can endure high commute cost is 0.98%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and a large proportion of construction workers can only or only willingly endure low commute cost, the commute distances are around 42.78 mile.

4.3 Empirical hierarchy division of the different ethnicity construction workers' ability to endure the commute costs

We use STATA to compute the structural characteristics of the two variables wages per hour and distance of worker to project corresponding to the different ethnicity. The computation results are shown in Table 3.

Table 3

Ethnicity	Variables	Obs	Mean	Std. Dev.	Min	Max
Asian or Pacific Islander	Wages per hour	16	45.51	13.42	16.85	67.94
	Distance of worker to project	16	39.11	40.22	0.0004	143.12
American Indian	Wages per hour	10	33.06	8.64	22.6	43.82
	Distance of worker to project	10	52.12	18.44	2.81	67.06

African American	Wages per hour	8	31.08	10.50	15.66	42.42
	Distance of worker to project	8	63.66	34.41	17.69	124.50
Hispanic	Wages per hour	1170	39.03	10.27	15.86	106.97
	Distance of worker to project	1173	34.41	40.96	0.0004	667.97
Other	Wages per hour	459	48.22	20.56	15.65	124.38
	Distance of worker to project	459	37.70	47.88	0.0004	597.31
Mixed races	Wages per hour	2	42.16	12.37	33.41	50.90
	Distance of worker to project	2	25.07	24.27	7.90	42.23
White	Wages per hour	363	52.45	28.91	11.54	216.96
	Distance of worker to project	363	63.17	84.17	0.0004	1127.70

Viewing from the Table 3, we can know that the ability of construction workers of different ethnicity to endure commuting costs is ranked as follows: African American> White>American Indian>Asian or Pacific Islander> Other>Hispanic>Mixed races. The three largest ethnicity groups working in the construction industry are White, Other races, and Hispanic race. Their ability to endure commuting costs is ranked as follows: White> Other> Hispanic. Now we do cluster analysis on the data of White group, Other Races group, and Hispanic race group. The clustering results are shown in Table 4, Table 5, and Table 6 respectively.

Table 4 with regard to Hispanic

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max

1	Wages per hour	3	46.54	11.95	35.05	58.91
	Distance of worker to project	3	544.81	153.88	372.32	667.97
2	Wages per hour	584	39.16	10.12	15.86	106.97
	Distance of worker to project	584	58.74	23.65	33.80	260.86
3	Wages per hour	583	38.87	10.41	16.2	85.79
	Distance of worker to project	583	7.50	8.50	0.0004	31.58

According to the calculation of the data in Table 4, we can know that the proportion of Hispanic construction workers located in the hierarchy of the ability that can endure low commute cost is 49.83%; the proportion of Hispanic construction workers located in the hierarchy of the ability that can endure medium commute cost is 49.91%; the proportion of Hispanic construction workers located in the hierarchy of the ability that can endure high commute cost is 0.26%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive and about 49.83% of Hispanic construction workers are hired from local labor market of the project located, and 49.91% Hispanic construction workers are hired from nearby labor market of the project located, and very small proportion of Hispanic construction workers can endure high commute cost.

Table 5 with regard to other races

Clustering group	Clustering Variables		Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour		18	54.21	17.92	21.20	89.39
	Distance of worker to project		18	191.82	107.36	131.26	597.31
2	Wages per hour		181	55.17	23.60	19.46	124.38
			181	64.30	17.00	21.96	123.84

	Distance of worker to project					
3	Wages per hour	260	42.98	16.60	15.65	109.92
	Distance of worker to project	260	8.51	9.82	0.0004	39.10

According to the calculation of the data in Table 5, we can know that the proportion of other races construction workers located in the hierarchy of the ability that can endure low commute cost is 56.64%; the proportion of other races construction workers located in the hierarchy of the ability that can endure medium commute cost is 39.43%; the proportion of other races construction workers located in the hierarchy of the ability that can endure high commute cost is 3.92%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the other races' construction workers should be standard pyramidal.

Table 6 with regard to White race

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	4	66.10	29.49	40.28	91.64
	Distance of worker to project	4	687.92	295.24	504.13	1127.70
2	Wages per hour	68	64.34	45.08	19.46	216.96
	Distance of worker to project	68	131.64	30.81	63.22	201.31
3	Wages per hour	291	49.49	22.81	11.54	208.36
	Distance of worker to project	291	38.58	25.16	0.0004	82.27

According to the calculation of the data in Table 6, we can know that the proportion of White construction workers located in the hierarchy of the ability that can endure low commute cost is 80.17%; the proportion of White construction workers located in the hierarchy of the ability that can endure medium commute cost is 18.73%; the proportion of White construction workers located in the hierarchy of the ability that can endure high commute cost is 1.10%.

Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the White construction workers should be standard pyramidal.

4.4 Empirical hierarchy division of the different occupation construction workers' ability to endure the commute costs

Table 7

Occupation/ Trade	Variables	Obs	Mean	Std. Dev.	Min	Max
Apprentice	Wages per hour	435	29.48	9.63	8.36	83.5
	Distance of worker to project	468	41.57	42.06	0.0004	501.04
Journeyman	Wages per hour	2895	44.59	17.68	4.94	299.36
	Distance of worker to project	2899	46.73	63.14	0.0004	1127.70
Foreman	Wages per hour	114	47.34	9.79	29.65	76.98
	Distance of worker to project	114	47.19	55.02	0.0004	273.91
Carpenter	Wages per hour	1170	39.03	10.27	15.86	106.97
	Distance of worker to project	1173	34.41	40.96	0.0004	667.97
Ironworker	Wages per hour	147	43.87	34.39	20.67	299.36
	Distance of worker to project	147	87.27	93.67	0.0004	597.31
Laborer	Wages per hour	295	34.79	24.99	4.94	402.13
	Distance of worker to project	296	51.41	78.61	0.0004	667.97

Operating_ engineer	Wages per hour	94	38.44	12.79	4.77	69.86
	Distance of worker to project	94	60.27	80.87	0.0007	175.05
Plaster_ Drywall	Wages per hour	311	48.61	10.22	19.28	82.45
	Distanceof worker to project	312	50.40	61.34	0.0004	522.29
Roofer	Wages per hour	65	32.00	11.28	14.21	68.74
	Distance of worker to project	65	71.45	67.46	4.61	294.11
Electrician	Wages per hour	58	48.89	14.34	18	91.92
	Distance of worker to project	58	63.51	97.06	0.0004	501.04
Mason	Wages per hour	110	37.72	7.99	19.65	71.26
	Distance of worker to project	111	32.47	26.56	0.0004	97.42
Plumber fitter	Wages per hour	35	70.10	30.71	8.36	198.15
	Distance of worker to project	35	46.85	37.05	0.0007	155.29
Sheetmetal	Wages per hour	32	47.00	19.79	21.12	91.64
	Distance of worker to project	32	84.05	147.36	0.0007	532.06

The data in Table 7 shows that, if we only look at the indicator of average distance, the ranking of occupation is as below:

Ironworker> Sheetmetal> Roofer > Electrician> Operating engineer>Laborer> PlasterDrywall>Foreman > Plumber fitter > Journeyman > Apprentice> Carpenter> Mason

However, we think the indicator (i.e. Distance of worker to project/Wages per hour) is a good indicator to measure the workers' ability to endure the commute costs. According to the data in the Table 7, we compute the ratio of distance of worker to project to wages per hour, based on this ratio, the ranking of occupation is as below

Roofer >Ironworker > Sheetmetal > Operating engineer > Laborer >Apprentice > Electrician >Journeyman >Plaster Drywall > Foreman > Carpenter > Mason> Plumber fitter

From the above ranking, we can see that the more professional occupations' workers with relatively narrow market demand can endure the high commute cost, such as Roofer, Ironworker, and Sheetmetal.

The workers of occupations with a wider market demand like low commute cost, such as Carpenter, Mason, and Plumber fitter.

Laborer and Apprentice can endure a little high commute cost.

Table 8 with regard to apprentice

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	19	25.19	8.08	15.66	47.48
	Distance of worker to project	19	159.43	85.15	112.03	501.04
2	Wages per hour	175	29.01	9.71	11.54	68.04
	Distance of worker to project	175	62.60	14.62	39.55	97.86
3	Wages per hour	187	29.96	9.54	8.36	83.50
	Distance of worker to project	187	11.69	11.32	0.0004	36.50

Viewing from the Table 8, we can know that 49.08% of apprentices chose job opportunities close to their residence, 5% of apprentices chose job opportunities far to their residence. However, the data in the Table 8 does not show a positive relationship between the wage level and the ability that can endure commute cost, this means the apprentices more cherish learning chance, and less care about the commute costs.

Table 9 with regard to journeyman

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	21	53.35	17.02	35.05	91.64
	Distance of worker to project	21	563.01	177.53	348.57	1127.70
2	Wages per hour	1027	48.54	23.38	6.48	299.36
	Distance of worker to project	1027	86.56	40.49	48.32	311.40
3	Wages per hour	1847	42.29	12.97	4.94	142.82
	Distance of worker to project	1847	18.77	17.50	0.0004	52.49

According to the calculation of the data in Table 9, we can know that the proportion of journeyman construction workers locatedin the hierarchy of the ability that can endure low commute cost is 63.80%; the proportion of journeyman construction workers located in the hierarchy of the ability that can endure medium commute cost is 35.47%; the proportion of journeyman construction workers located in the hierarchy of the ability that can endure high commute cost is 0.73%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the journeyman construction workers should be standard pyramidal.

Table 10 with regard to foreman

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	6	43.78	17.03	31.51	76.98
	Distance of worker to project	6	236.87	38.22	175.82	273.91
2	Wages per hour	52	47.41	9.90	29.66	76.58
	Distance of worker to project	52	63.72	22.63	39.55	133.93

3	Wages per hour	56	47.65	8.83	29.65	65.28
	Distance of worker to project	56	11.53	11.62	0.0004	34.83

Viewing from the Table 10, we can know that 49.12% of foremen chose job opportunities close to their residence, 5.26% of foremen chose job opportunities far to their residence. However, the data in the Table 10 does not show a positive relationship between the wage level and the ability that can endure commute cost, this means the foremen more cherish jobs, and less care about the commute costs.

Table 11 with regard to carpenter

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	2	48.28	3.71	45.66	50.9
	Distance of worker to project	2	561.46	46.22	528.78	594.15
2	Wages per hour	81	48.16	16.20	24.3	118.5
	Distance of worker to project	81	83.13	34.25	54.77	238.1
3	Wages per hour	88	45.90	11.84	24.32	91.58
	Distance of worker to project	88	22.84	17.39	0.0004	52.23

According to the calculation of the data in Table 11, we can know that the proportion of carpenter construction workers located in the hierarchy of the ability that can endure low commute cost is 51.46%; the proportion of carpenter construction workers located in the hierarchy of the ability that can endure medium commute cost is 47.37%; the proportion of carpenter construction workers located in the hierarchy of the ability that can endure high commute cost is 1.17%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the carpenter construction workers should be standard pyramidal.

Table 12 with regard to ironworker

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max

1	Wages per hour	16	35.63	1.99	31.51	40.28
	Distance of worker to project	16	304.1	113.91	236.59	597.31
2	Wages per hour	27	36.39	11.28	20.67	63.77
	Distance of worker to project	27	129.83	29.89	87.07	201.31
3	Wages per hour	104	47.07	40.1	21.42	299.36
	Distance of worker to project	104	42.86	23.50	0.0004	80.56

According to the calculation of the data in Table 12, we can know that the proportion of ironworker construction workers located in the hierarchy of the ability that can endure low commute cost is 70.75%; the proportion of ironworker construction workers located in the hierarchy of the ability that can endure medium commute cost is 18.37%; the proportion of ironworker construction workers located in the hierarchy of the ability that can endure high commute cost is 10.88%.

Above data do not show that the relationship between the wage level and the ability that can endure commute cost is positive, but the diagram of the hierarchical division of the ability to endure the commute costs of the ironworker construction workers is standard pyramidal. It indicates that ironworker is a relatively professional job with relatively small market demand, and then ironworkers cherish job opportunities more, and can endure higher commute costs.

Table 13 with regard to laborer

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	7	44.82	4.56	35.05	47.93
	Distance of worker to project	7	494.27	99.72	348.57	667.97

2	Wages per hour Distance of worker to project	124 124	36.46 74.29	34.63 24.82	6.48 44.50	402.13 148.08
3	Wages per hour Distance of worker to project	164 164	33.10 15.28	14.52 14.76	4.94 0.0004	142.82 44.50

According to the calculation of the data in Table 13, we can know that the proportion of laborer construction workers located in the hierarchy of the ability that can endure low commute cost is 55.59%; the proportion of laborer construction workers located in the hierarchy of the ability that can endure medium commute cost is 42.03%; the proportion of laborer construction workers located in the hierarchy of the ability that can endure high commute cost is 2.37%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the laborer construction workers is standard pyramidal.

Table 14 with regard to operating engineer

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour Distance of worker to project	18 18	51.63 147.69	13.36 20.08	28.94 372.32	69.64 175.05
2	Wages per hour Distance of worker to project	37 37	33.21 66.01	10.35 13.75	6.41 43.85	43.35 100.93
3	Wages per hour	39 39	37.32 14.46	10.42 12.92	4.77 0.0007	69.86 40.40

	Distance of worker to project					

According to the calculation of the data in Table 14, we can know that the proportion of operating engineer construction workers located in the hierarchy of the ability that can endure low commute cost is 41.49%; the proportion of operating engineer construction workers located in the hierarchy of the ability that can endure medium commute cost is 39.36%;

The proportion of operating engineer construction workers located in the hierarchy of the ability that can endure high commute cost is 19.15%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the operating engineer construction workers isstandard pyramidal.

Table 15 with regard to plaster drywall

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	3	50.43	5.93	43.58	53.85
	Distance of worker to project	3	520.40	1.63	519.46	522.29
2	Wages per hour	162	49.17	11.02	20.18	82.45
	Distance of worker to project	162	76.68	30.36	44.30	180.83
3	Wages per hour	146	47.95	9.33	19.28	80.34
	Distance of worker to project	146	11.47	23.26	0.0004	39.55

According to the calculation of the data in Table 15, we can know that the proportion of plaster drywall construction workers located in the hierarchy of the ability that can endure low commute cost is 46.95%; the proportion of plaster drywall construction workers located in the hierarchy of the ability that can endure medium commute cost is 52.09%; the proportion of plaster drywall construction workers located in the hierarchy of the ability that can endure high commute cost is 0.96%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the plaster drywall construction workers is not standard pyramidal.

Table 16 with regard to roofer

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	6	36.31	17.70	14.21	68.74
	Distance of worker to project	6	272.83	11.12	260.86	294.11
2	Wages per hour	39	29.19	8.62	16.85	52.77
	Distance of worker to project	39	60.74	15.48	44.50	136.79
3	Wages per hour	20	36.18	12.55	16.83	55.37
	Distance of worker to project	20	31.93	11.47	4.61	44.78

According to the calculation of the data in Table 16, we can know that the proportion of roofer construction workers located in the hierarchy of the ability that can endure low commute cost is 30.77%; the proportion of roofer construction workers located in the hierarchy of the ability that can endure medium commute cost is 60%; the proportion of roofer construction workers located in the hierarchy of the ability that can endure high commute cost is 9.23%.

Above data do not show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the roofer construction workers is not standard pyramidal. It indicates that roofer is a relatively professional job with relatively small market demand, then roofers cherish job opportunities more, and can endure higher commute costs.

Table 17 with regard to electrician

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max

1	Wages per hour Distance of worker to project	2 2	47.49 495.38	9.60 8.01	40.7 489.71	54.27 501.04
2	Wages per hour Distance of worker to project	18 18	51.35 117.98	18.18 29.20	18 66.56	91.92 148.85
3	Wages per hour Distance of worker to project	38 38	47.81 14.98	12.57 13.23	23.85 0.0004	64.45 48.32

According to the calculation of the data in Table 17, we can know that the proportion of electrician construction workers located in the hierarchy of the ability that can endure low commute cost is 65.52%; the proportion of electrician construction workers located in the hierarchy of the ability that can endure medium commute cost is 31.03%; the proportion of electrician construction workers located in the hierarchy of the ability that can endure high commute cost is 3.45%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the electricians have higher wage levels, so that the electricians have higher ability to endure the commute costs.

Table 18 with regard to mason

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour Distance of worker to project	31 31	41.05 68.70	9.01 13.59	31 49.46	66.22 97.42
2	Wages per hour Distance of worker to project	46 46	37.18 29.35	6.33 7.25	21.82 17.71	71.26 44.30

3	Wages per hour Distance of worker to project	33 33	35.36 3.63	8.26 2.96	19.65 0.0004	53.58 13.37

According to the calculation of the data in Table 18, we can know that the proportion of mason construction workers located in the hierarchy of the ability that can endure low commute cost is 30%; the proportion of mason construction workers located in the hierarchy of the ability that can endure medium commute cost is 41.82%; the proportion of mason construction workers located in the hierarchy of the ability that can endure high commute cost is 28.18%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the mason construction workers will not be standard pyramidal.

Table 19 with regard to plumber fitter

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour Distance of worker to project	16 16	88.50 74.17	35.64 31.87	20.98 55.64	198.15 155.29
2	Wages per hour Distance of worker to project	8 8	59.26 47.40	4.41 14.06	52.25 30.99	64.66 66.88
3	Wages per hour Distance of worker to project	11 11	51.22 6.72	16.16 6.17	8.36 0.0007	65.28 17.71

According to the calculation of the data in Table 19, we can know that the proportion of plumber fitter construction workers located in the hierarchy of the ability that can endure low commute cost is 31.43%; the proportion of plumber fitterconstruction workers located in the hierarchy of the ability that can endure medium commute cost is 22.86%; the proportion of plumber fitter construction workers located in the hierarchy of the ability that can endure high commute cost is 45.71%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the plumber fitters have high wage levels, so that plumber fitters have higher ability to endure the commute costs.

Table 20 with regard to sheet metal

Clustering group	Clustering Variables	Obs	Mean	Std. Dev.	Min	Max
1	Wages per hour	3	91.64	0	91.64	91.64
	Distance of worker to project	3	513.86	15.77	504.13	532.06
2	Wages per hour	9	42.02	20.45	21.5	91.64
	Distance of worker to project	9	101.25	30.01	72.50	152.81
3	Wages per hour	20	42.55	10.41	16.2	85.79
	Distance of worker to project	20	11.84	14.99	0.0006	50.52

According to the calculation of the data in Table 20, we can know that the proportion of sheet metal construction workers located in the hierarchy of the ability that can endure low commute cost is 62.50%; the proportion of sheet metal construction workers located in the hierarchy of the ability that can endure medium commute cost is 28.13%; the proportion of sheet metal construction workers located in the hierarchy of the ability that can endure high commute cost is 9.38%. Above data show that the relationship between the wage level and the ability that can endure commute cost is positive, and the diagram of the hierarchical division of the ability to endure the commute costs of the sheet metal construction workers should be standard pyramidal.

5. Conclusion

We analyze the structure of commute costs, commute costs consist of safety cost, time cost, societal cost, money cost, and cost of comfort and convenience, which include subjective costs and objective costs. We have simplified the commute cost as a function of commuting distance. As the abilities to acceptance of commuting distance for construction workers are mainly relative to their wage levels, so we choose wages per hour and commute distance as clustering variables to do clustering analysis of construction industry data, and get the following conclusion:

(1) From the overall perspective of construction workers, the relationship between the wage level and the ability that can endure commute cost is positive, and a large proportion of construction workers can only or only willingly endure low commute cost.

(2) From the ethnicity perspective of construction workers, we can know that the abilities of construction workers of different ethnicity to endure commuting costs are different, which rank as follows: African American> White> American Indian> Asian or Pacific Islander> Other> Hispanic> Mixed races. The three largest ethnicity groups working in the construction industry are White, Other races, and Hispanic race. Their ability to endure commuting costs is ranked as follows: White race > Other races > Hispanic race.

(3) From the occupation perspective of construction workers, we can know that the abilities of construction workers of different occupation to endure commuting costs are different, which rank as follows: Roofer > Ironworker > Sheetmetal > Operating engineer > Laborer > Apprentice > Electrician > Journeyman > Plaster Drywall > Foreman > Carpenter > Mason> Plumber fitter

(4) From the above ranking, we can see that the more professional occupations' workers with relatively narrow market demand can endure the high commute cost, such as Roofer, Ironworker, and Sheetmetal;

(5) The workers of occupations with a wider market demand like low commute cost, such as Carpenter, Mason, and Plumber fitter;

(6) Laborer and Apprentice can endure a little high commute cost.

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