An Analysis of Workplace Injury and Job Tenure in the Manufacturing Sector Using Tennessee Workers' Compensation Claims from 2014-2016

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1 Introduction

The Construction Industry Research and Policy Center (CIRPC) at the University of Tennessee, Knoxville received a grant from the Centers for Disease Control - National Institute of Occupational Safety and Health (NIOSH) to use Tennessee workers' compensation (WC) claims data for occupational injury[1] surveillance and prevention. This report provides a brief overview of the private industry WC claims filed within the Tennessee manufacturing sector for 2014-2016.

A NIOSH initiative exists to provide statistical information regarding workplace injuries that may supplement the Survey of Occupational Injuries and Illnesses (SOII) information currently assembled by the Bureau of Labor Statistics (BLS) since the SOII is only a sampling survey. Since 2015, NIOSH has awarded a number of grants to states to encourage the additional utilization of WC claims information in those states. In the summer of 2016, such a grant was awarded to CIRPC which resulted in an agreement with the Tennessee Bureau of Workers' Compensation to make this information available subject to agreed-upon confidentiality limits. By combining the WC information with unemployment insurance records, it is possible to perform injury surveillance with respect to the injured employee's industry, employer size, age, and several injury characteristics including job tenure.

This report will examine several of these injury dimensions and their relationship to job tenure.[2] When tenure is mentioned in safety research, it is generally found that new workers are more likely to be injured on the job than those with greater experience. Unfortunately, in these studies details are frequently missing that would help in understanding this phenomenon and in documenting a possible remedy. For the most part, the studies and available data relate to economy-wide issues and fail to consider injury cause or impact.

It is our hope that this report will be used by the manufacturing sector[3] to better understand the major sources (causes) of injury, the most prevalent nature (type) of injuries sustained, the most frequently injured body parts, and the relationship between job tenure and injury. A better understanding of these factors can better inform the Tennessee manufacturing sector's safety initiatives.

2 Key Findings and Recommendations

The key findings of this report include:

1. Lifting and the object being lifted were the leading sources/causes of injury in manufacturing. Strains[4] were third. Recommendation: Emphasize training on lifting techniques and use work modifications to reduce strains on the bodies of workers.

2. Fingers were injured more than any other body part. Hands and eyes also ranked high. Since lacerations were a frequent type, cuts to the hands and fingers may be a significant contributor. Recommendation: Redesign work processes where practical. Provide quality personal protective equipment (PPE) and enforce proper utilization.

3. About twelve percent of all claims required an emergency room visit. Recommendation: Have protocols in place to ensure injured workers requiring emergency care receive rapid and safe transport.

4. Manufacturing had eighteen fatalities with no predominate cause. Recommendation: Utilize best practices (e.g. near miss investigations, employee safety councils, etc.) to reduce all types of non-fatal and fatal injuries.

5. Workers were especially vulnerable to injury during their first year. Thirty-two percent of all claims were made by such workers. Smaller employers generally had higher first-year injury proportions. Recommendation: Provide company orientation 'onboarding' and consider assigning new employees a trusted employee as a 'mentor' in their early weeks.

6. As a proportion of all injuries, non-fatal severe injuries were approximately thirteen percent and over one-third occurred to first-year employees. Recommendation: Every firm is either self-insured with its own safety resources or has a WC insuror with loss control expertise. The firm should engage all available resources to institute and maintain best practices in occupational safety and pre-employment screening.

[1] In this document, the term 'injury' may mean injury and/or illness.

[2] In this study, the concept of 'job tenure' relates to employment with a given employer and not employment with any employer or in a particular craft or occupation with a given employer.

[3] North American Industry Classification System - the two-digit sector(s) 31, 32, 33 represent(s) manufacturing.

[4] We differentiate between strain as a cause and strain as a type. The former is an overexertion and the latter can be defined as an overstretching of some part of the musculature.

Table 1: NAICS Industry Injury Rates - 2016 BLS Rates vs. 2014-2016 Work Comp Rates*

Naics2	Sector Description	2016 BLS Rate	2014-2016 Work Comp Rate
10	All Industries	2.9	2.5
11	agriculture	1.9	3.5
21	mining	1.6	2.4
22	utilities	6.3	7.5
23	construction	2.6	2.8
31-33	manufacturing	3.7	2.7
42	wholesale trade	2.8	2.8
44-45	retail trade	3.1	2.8
48-49	transportation	4.7	3.9
51	information	1.7	0.8
52	finance	0.4	0.5
53	real estate	1.7	2.3
54	professional	NA	1.3
55	management	0.5	3.2
56	administrative	2.2	2.9
61	educational services	2.3	1.7
62	health care	3.9	2.9
71	arts	4.3	3.3
72	food services	2.6	2.1
81	other services	1.9	1.8

* Workers' compensation rates reflect only the matched portion (78.3 percent) of compensable, private claims in the WC universe.

3 Background

The BLS already publishes SOII injury rates for many industries but rates calculated with WC data can be an important supplement. Table 1 lists the Tennessee private sector BLS rates and the 2014-2016 WC counterparts. The BLS and WC composite rates for all Tennessee private sector employees are shown at the top of the table as 2.9 and 2.5 per 100 full-time equivalent (FTE) workers respectively. In making comparisons, differences in the two calculations must be considered. They differ in several ways. Here are a few:

- BLS rates are sample estimates and are subject to sampling error.
- WC industry rate numerators/counts in this report contain 'matched' claims only and are understated unless extrapolated to compensate.
- WC industry rates are adjusted upward/downward according to the industry's average annual working hours.[5]

Since the WC 'All Industries' rate represents only the matched portion of private sector claims, the true rate will be larger. Using linear extrapolation to adjust for unmatched claims (of 22 percent) yields an estimated rate of 3.2 per 100 FTE.

In 2016, the BLS rate per 100 FTE in the manufacturing sector was 3.7 per 100 FTE. By comparison, the rate using the Tennessee 2014-2016 WC claims data was 2.7. Adjusting with linear extrapolation as before yields a rate of 3.4 per 100 FTE. The WC rates include all self-reported claims and are more comprehensive than a sample estimate.

4 Data and Data Limitations

State WC systems generally collect First Report of Injury Information (FROI) in a standardized electronic format. The first report contains sixty-eight data fields to identify characteristics of the claimant and employer as well as specific details of the injury. Often a short narrative is also included. Tennessee follows this IAIABC electronic protocol for claim submission.[6]

[5] Data on industry annual working hours from the 2016 American Community Survey (ACS) PUMS.

[6] The International Association of Industrial Accident Boards and Commissions, or IAIABC, is an association of workers' compensation jurisdictional regulatory agencies.

During 2014-2016, there were 263,580 compensable claims received for all industries.[7] Of these, 22 percent could not be matched to a specific industry and therefore not included in the analysis. Of the matched claims, 29,621[8] are manufacturing sector claims (NAICS 31, 32, 33) within the private sector.[9] Over 73 percent of the manufacturing claimants were male.

Though more comprehensive than the BLS sampling, these WC data have limitations of their own. In addition to the unmatched claims mentioned previously, there are missing data within claims. In fact, certain data fields have significant numbers of missing observations. For example, in the manufacturing sector, 11percent of the claims have missing values needed to determine employee tenure at the time of injury. Report results, including those related to tenure, should not be affected significantly assuming that missing values occur randomly. Some injuries go unreported, and it is not known how this affects results.

There are at least two other important limitations of the data. First, older workers and those with longer tenure may not be exposed to the same hazards as new workers. Second, the WC claim data can be used to profile only injured workers. Though there is some public information on workforce age distribution and median tenure, we know little about other characteristics of workers not injured.

5 Investigative Focus

This study examined specific injury information and related that to a number of factors traditionally examined, such as nature and cause of injury, but also allowed consideration of tenure with the employer. In addition, it related these reported injuries to the size of the employer and other employment characteristics.

The WC data include all industries but this report focused on the manufacturing sector. Of all injuries, a substantial proportion were reported by new workers during the first year of employment with their current employer. Recognition of this fact, along with other relationships found in the data (such as employer size, NAICS code, and initial treatment), may have relevance, for example, to the nature of new worker training or onboarding.

The data available from the FROI allowed consideration of the following characteristics:

- Body part injured along with injury cause and type
- Age group
- NAICS industry and firm size
- Tenure with employer

6 Findings on Injury-Tenure Relationship

In BLS publication USDL 16-1867, the January 2016 median tenure reported for the national manufacturing industry was 5.3 years and 23 percent of workers (across all industries) had one year or less of tenure. Figure 1 shows that a substantial proportion (32 percent) of Tennessee manufacturing injuries occurred during the first year with an employer. Assuming the Tennessee tenure distribution approximates the national distribution, the proportion of early injuries is significant.

[7] See the Appendix for the structure of the claim transactions.

[8] Sector tables throughout this document may sum to less than 29,621 claims because of missing observations or smaller subcategories that are not shown for brevity.

[9] Since 22 percent of all claims received could not be matched to a specific industry, the total claims in the private manufacturing sector likely exceeded 29,621 by a similar percentage.

Figure 1: Cumulative Proportion of Injuries By Tenure With Employer

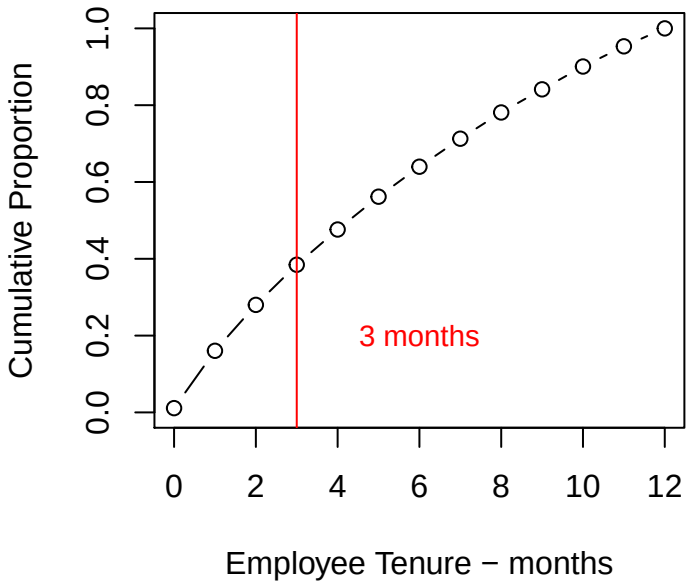

Figure 2: Cumulative Proportion of First-Year Injuries By Tenure With Employer (0 to 12 Months only)

Table 2: Claims by Age

	Tenure - 1 Year or Less	All Tenure Lengths	
Age Group	Count	Total Count	First Year Prop.
16-19 years	357	399	0.89
20-24 years	1516	2386	0.64
25-34 years	2544	5712	0.45
35-44 years	1983	6204	0.32
45-54 years	1435	6731	0.21
55-64 years	502	4360	0.12
65+ years	54	549	0.1

Table 3: First-Year Injuries by Firm Size

	Tenure - 1 Year or Less	All Tenure Lengths	
Firm Size	Count	Total Count	First Year Prop.
0-4	278	741	0.38
5-9	92	265	0.35
10-19	272	907	0.30
20-49	951	2389	0.40
50-99	1073	2803	0.38
100-249	1883	5470	0.34
250-499	1101	3821	0.29
500-999	984	3507	0.28
1000+	1768	6465	0.27

To further illustrate the increased risk to new employees, consider the injury distribution within the first year. Figure 2 includes only first-year injuries and shows that about 38 percent of the first-year injuries occurred during the first three months. Clearly the initial months with an employer were critical.

Table 2 shows injuries that occurred for short-tenured (i.e. less than one year) employees by age group as a proportion of all injured employees in the group. That proportion generally decreased by age. Workers under 35 suffered a greater proportion of first-year injuries than the first-year baseline proportion of 0.32 but this does not necessarily mean that shorter tenure was less significant for older employees. Since we know little about the tenure distribution of the uninjured employees, these proportions indicate nothing about the relative risk of short-tenured employees within a particular age group. For example, if short-tenured employees in a particular group suffered 30 percent of the injuries but composed only 15 percent of the total, their relative risk would have been quite high. Therefore, the effect of tenure combined with age cannot be determined with these data. Other studies have shown that though older workers have lower total rates of injury, their new-worker rate is higher than the youngest workers.[10] A companion analysis to this report,[11] found that the 45-54 age group had the greatest injury risk among new workers.

The data show that size of the employer may make a difference for injuries to new employees. Table 3 indicates the proportion of first-year injuries is generally smaller as the firm size reaches 100 employees. Larger firms are usually thought to expend more effort in training new employees. Surprisingly, firms with 10-19 employees had first-year employees reporting injuries in lesser proportions than other groups.

The fact that job tenure is a factor suggests that cumulative industry experience may also have an effect. In other words, are older (and more experienced) employees injured less frequently than their proportion in the workforce?

Using age as a proxy for experience, Figure 3, shows both the manufacturing industry's age distribution for workers in Tennessee[12] (dashed line) and the proportion of injuries by age (solid line). Workers 55 and older suffered fewer injuries than their proportionate share while the opposite was true for those younger than 55. Older workers seem to fare better overall when tenure is not considered.

[10]Morassaei, Sara, et al. "Examining job tenure and lost-time claim rates in Ontario, Canada, over a 10-year period, 1999–2008." Occup Environ Med 70.3 (2013): 171-178.

[11]Taylor, Edward. "An Old Problem for New Workers, 2014-2016", July 2019

[12]Age data from the 2016 American Community Survey (ACS) PUMS data.

Figure 3: Proportion of Injuries and Workers By Age

Table 4: Injuries by Body Part - Top 10 Categories

	Tenure - 1 Year or Less			Tenure - More than 1 Year		
Body Part	Count	Freq.	Rank	Count	Freq.	Rank
FINGER(S)	1231	0.147	1	2220	0.124	1
SHOULDER(S)	593	0.071	5	1726	0.096	2
LOWER BACK AREA (MUSCLES)	714	0.085	3	1627	0.091	3
HAND	784	0.093	2	1572	0.087	4
KNEE	383	0.046	7	1008	0.056	5
EYE(S)	636	0.076	4	931	0.052	6
WRIST	425	0.051	6	884	0.049	7
MULTIPLE BODY PARTS	269	0.032	12	737	0.041	8
LOWER ARM	357	0.042	9	731	0.041	9
THUMB	375	0.045	8	683	0.038	10

It is informative to categorize injuries across various other dimensions to see if tenure affects the category rank order. Consider the dimensions body part, injury type, and cause. The ten most commonly injured body parts are shown in Table 4 for workers with more and less than one year tenure. Note the rank order is slightly different for first year workers. They suffered proportionately more eye injuries and fewer shoulder injuries.

For type of injury (e.g. sprain, laceration, etc.) and cause of injury (e.g. fall, slip, exertion, etc.), see Tables 5 and 6. In the former, first-year rankings closely approximate the ranking structure for other periods. In the latter, there is more rank variation. Not surprisingly, sprains, strains, lacerations, and contusions rank among the most frequent injury types and fingers led all body parts. It is interesting that lifting was first or second depending on tenure. One possible interpretation is that workers lifting heavy objects resulted in strains/overexertions that became musculoskeletal injuries to the lower back.

Table 5: Injuries by Type - Top 10 Categories

	Tenure - 1 Year or Less			Tenure - More than 1 Year		
Injury Nature	Count	Freq.	Rank	Count	Freq.	Rank
STRAIN	2320	0.276	1	5556	0.309	1
LACERATION	1545	0.184	2	3019	0.168	2
CONTUSION	1292	0.154	3	2491	0.139	3
SPRAIN	482	0.057	5	1261	0.070	4
ALL OTHER SPECIFIC INJURIES NOC	564	0.067	4	1077	0.060	5
FRACTURE	325	0.039	7	773	0.043	6
FOREIGN BODY	471	0.056	6	737	0.041	7
INFLAMMATION	173	0.021	10	422	0.023	8
PUNCTURE	255	0.030	8	414	0.023	9
BURN	251	0.030	9	380	0.021	10

Table 6: Injuries by Cause - Top 10 Categories

	Tenure - 1 Year or Less			Tenure - More than 1 Year		
Injury Cause	Count	Freq.	Rank	Count	Freq.	Rank
LIFTING	701	0.083	2	1667	0.093	1
OBJECT BEING LIFTED OR HANDLED	787	0.094	1	1435	0.080	2
STRAIN OR INJURY BY, NOC	551	0.066	3	1278	0.071	3
PUSHING OR PULLING	481	0.057	5	1199	0.067	4
ON SAME LEVEL	277	0.033	9	919	0.051	5
REPETITIVE MOTION CARPAL TUNNEL SYNDROME	269	0.032	11	845	0.047	6
FALLING OR FLYING OBJECT	482	0.057	4	782	0.044	7
CUT, PUNCTURE, SCRAPE, NOC	348	0.041	7	607	0.034	8
FOREIGN MATTER (BODY) IN EYE(S)	425	0.051	6	606	0.034	9
FALL, SLIP OR TRIP, NOC	212	0.025	15	578	0.032	10

It is useful to know that the rank order of injuries sustained by short-tenured employees do not appear to have varied significantly from those with longer tenure with respect to body part, nature, and cause of injury.

Figure 4: Word Cloud of Injury Narratives

Most claims in the data contain an associated injury narrative and the word cloud in Figure 4 features the most common words found in the narratives. The cloud reinforces the Table 4 results by showing 'finger' and 'hand' prominently. The nouns 'shoulder' and 'back' appear as does the verb 'fell.' The last two words suggest that lifting injuries and falls are major concerns in manufacturing.

7 Injury Severity

To explore, non-fatal injury severity, Table 7 shows the various initial treatment modes given in the claims data. Using these modes as a proxy for severity, we assumed those claims associated with future major medical, hospitalization, and emergency evaluation represent the most severe injuries. For emergency evaluation, the first-year injury proportion exceeded that of the first-year baseline of 0.32.

As stated earlier, 11 percent of manufacturing sector claims are missing job tenure information. For claims containing such information, Table 7 indicates that first-year employees received more than one-third of all emergency evaluations.

For fatal injuries, there were 18 incidents during the study period. In this sector, only 1 (6 percent) fatality had employer service of less than one year. Table 8 indicates no predominate fatality cause.

Table 7: Injuries by Initial Treatment Type

	Tenure - 1 Year or Less	All Tenure Lengths	
Type Treatment	Count	Total Count	First Year Prop.
Emergency Evaluation	1051	2831	0.37
Hospitalization	30	110	0.27
Future Major Medical	11	62	0.18
Minor Clinic	5119	15948	0.32
Minor Onsite by Employer	344	1693	0.20
No Medical Treatment	535	2120	0.25
Unknown	1312	3601	0.36

Table 8: Fatal Injuries by Cause

	Tenure - 1 Year or Less	All Tenure Lengths
Type	Count	Count
REPETITIVE MOTION CARPAL TUNNEL SYNDROME	1	1
OTHER - MISCELLANEOUS, NOC	NA	3
GUNSHOT STRUCK BURNED DEAFENED	NA	2
MACHINE OR MACHINERY	NA	2
VEHICLE UPSET (OVERTURNED OR JACKKNIFED)	NA	2
CAUGHT IN, UNDER OR BETWEEN, NOC	NA	1
CUMULATIVE, NOC (ALL OTHER)	NA	1
FROM DIFFERENT LEVEL	NA	1
MOTOR VEHICLE	NA	1
OBJECT BEING LIFTED OR HANDLED	NA	1
OTHER THAN PHYSICAL CAUSE OF INJURY	NA	1
PUSHING OR PULLING	NA	1
STRUCK OR INJURED, NOC	NA	1

8 Other Considerations

For some industries (e.g. construction, agriculture, etc), there can be seasonality in the pattern of injuries or variation by day of the week. A quick review of Figures 5 and 6 indicates a seasonal effect during the holiday months of November and December when manufacturing activity generally slows.

9 Final Thoughts

From the 2014-2016 Tennessee WC claims data, we highlight these items for consideration by the manufacturing sector.

1. Among two-digit NAICS industries, manufacturing was slightly above average for WC injury frequency with a rate of 2.7 per 100 FTE (extrapolated rate is 3.4 per 100 FTE).
2. Except for holiday seasonality (see Figure 5), injuries did not have much variablility month-to-month.
3. Strains of the musculature were the most common type of injury and happened at more than one and one-half times the rate of the second most common (lacerations). Fingers and hands were the most commonly injured body parts.
4. Employees with job tenure of less than one year sustained 32 percent of all injuries in manufacturing.
5. The job injury-tenure relationship varied with the size of employer. Firms with less than 100 employees had higher injury rates for first-year employees than larger firms.
6. First-year injuries had rank orders for injury type almost identical to those of the set of all injuries. Injury cause was more variable between the groups but lifting and strains were within the top three of both groups.
7. Workers older than 55 had lower overall rates of injury than their younger peers.

Overall manufacturing had lower first-year injury proportions than most industries. The greater median tenure of 5.3 years also means proportionately fewer first-year employees exist so it's hard to draw a conclusion about first-year injury rates relative to other sectors. Other thoughts are that large numbers of hand, finger, and eye injuries suggest lack of attention to use of PPE and employees in smaller firms have a higher risk of injury.

The industry should develop practices (e.g. new employee onboarding, mentorship, etc.) that target its at-risk workers.

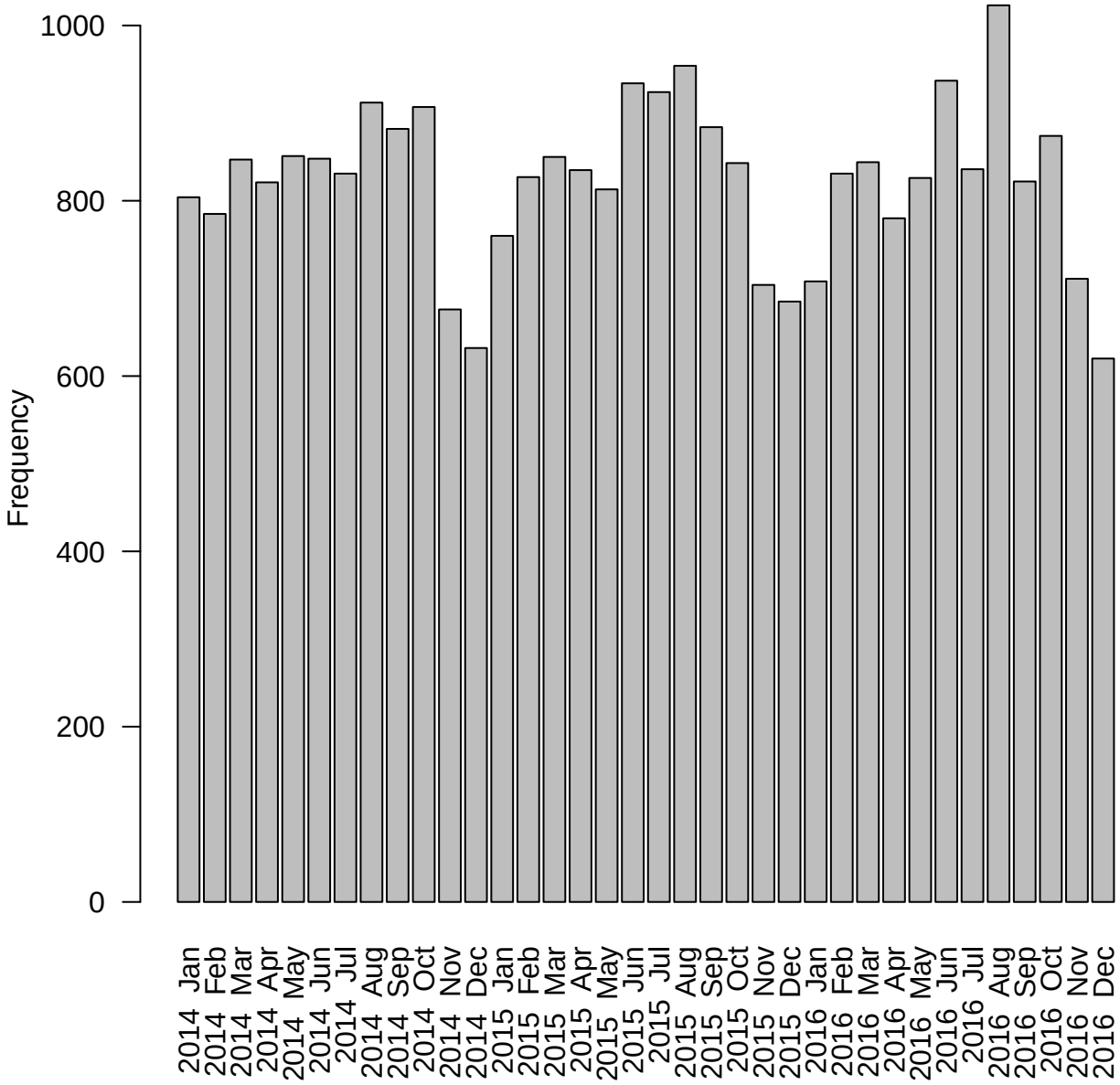

Figure 5: Monthly Distribution of Injuries

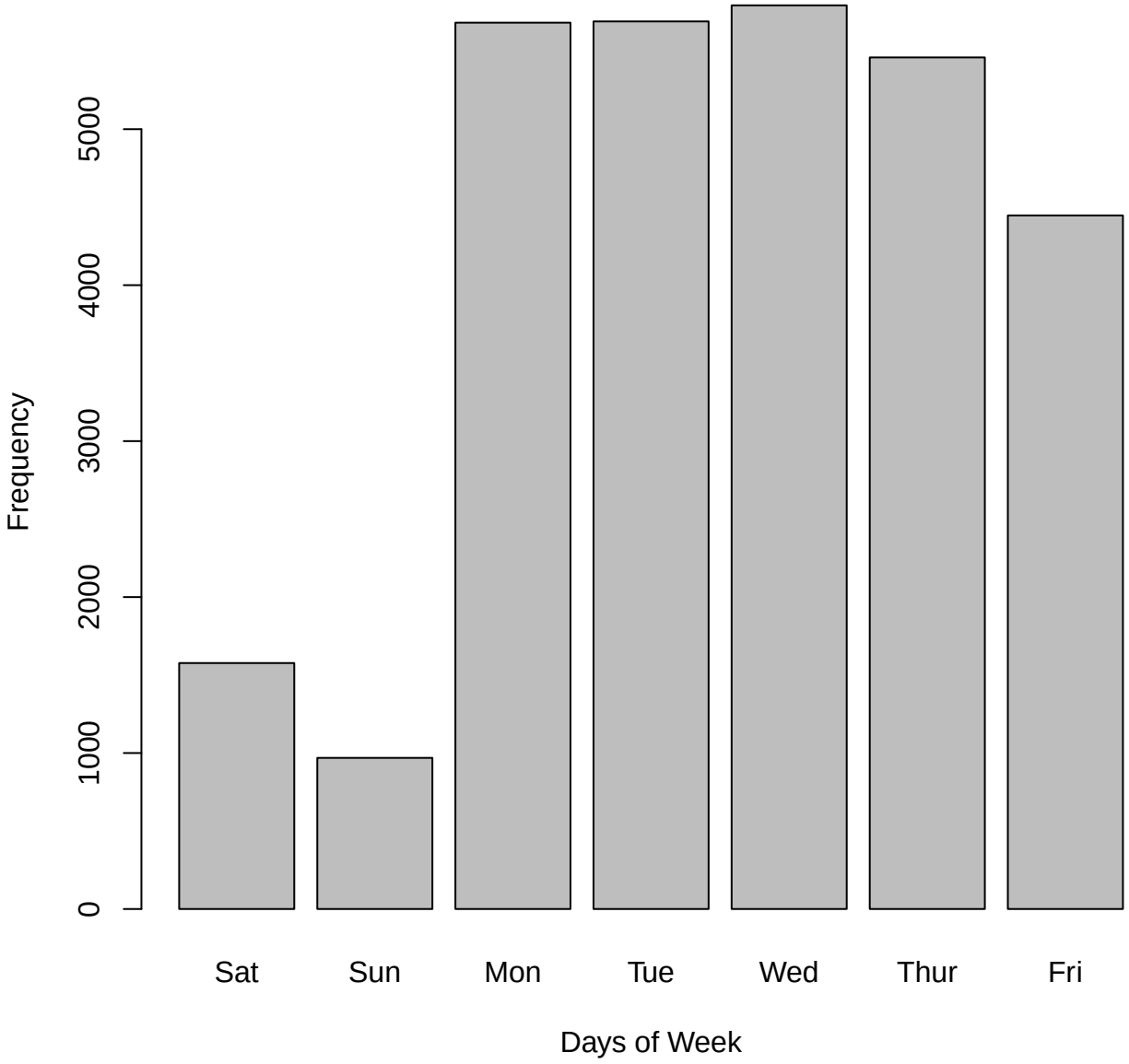

Figure 6: Weekday Distribution of Injuries

10 Appendix

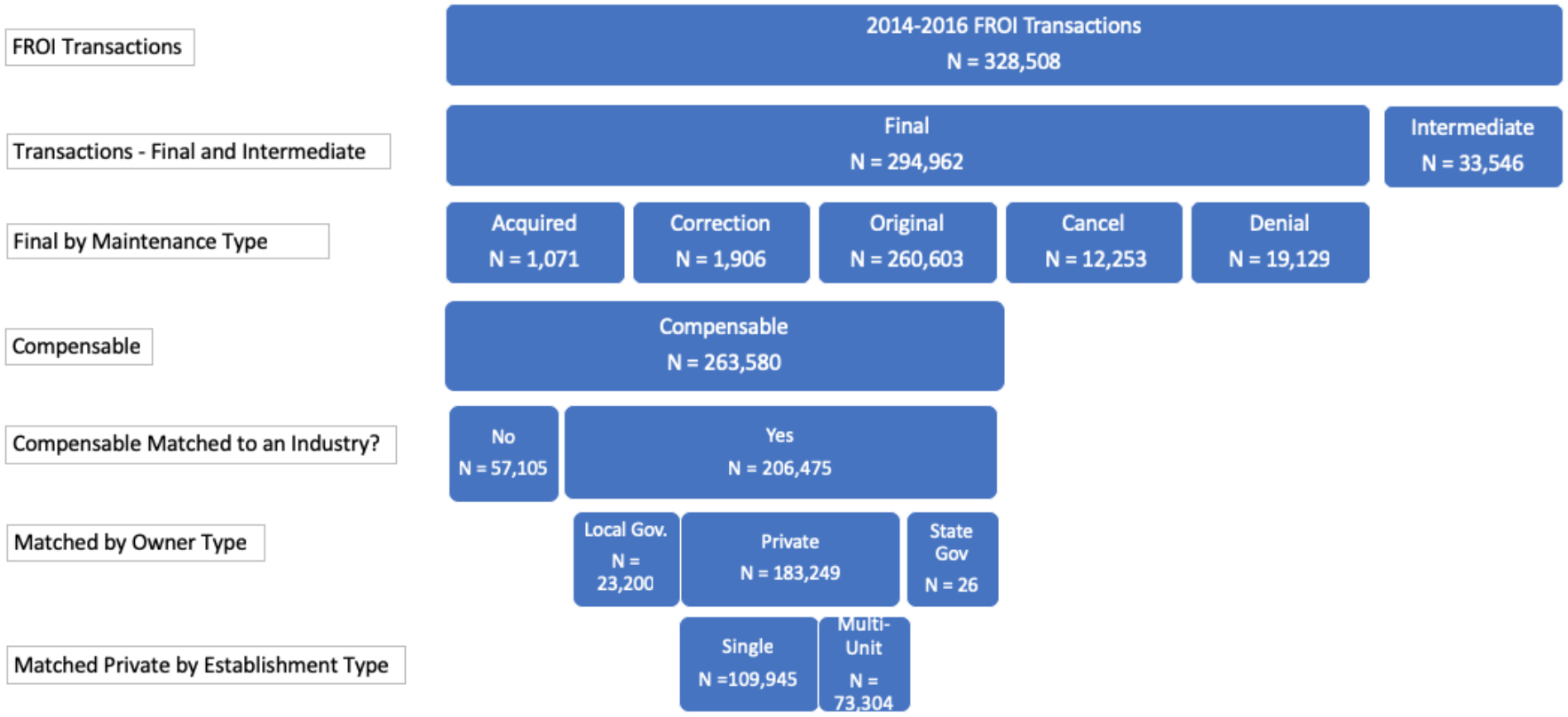

Figure 7: Structure of 2014-2016 FROI Claim Transactions