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The Heinrich Model: Determining Contemporary Relevance

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THE HEINRICH MODEL: DETERMINING CONTEMPORARY RELEVANCE

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DEDICATION

This thesis is dedicated to
the men and women
of the safety profession.
Their tireless dedication to improving
worker and workplace safety
is worthy of recognition.

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I would like to thank my loving wife Jade for constantly challenging me to go farther than I thought I could, not only in my academic pursuits, but in my life as a whole. Without her constant, unwavering support, all of my pursuits would be vastly more difficult to obtain, and a lot less fun!

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ABSTRACT

For as long as his work has been at the core of the safety profession, Herbert William Heinrich has been a staple of debate. His 1931 work Industrial Accident Prevention: A Scientific Approach has sparked worldwide debate on the effectiveness or ineffectiveness of his safety theories, as well as the accuracy or inaccuracy of his research and methods.

Heinrich's work is undoubtedly cited time and again as the foundational teaching for behavior-based safety, as well as countless other teachings in the safety profession as a whole. Despite the continued challenges to the validity of his work, there has been little research done to verify the accuracy or inaccuracy of his research and work.

Nine years of data from the US Bureau of Labor Statistics (BLS) was compiled, spanning from 2006 to 2014. The BLS data is broken down by ten (10) major categories reported to the BLS, which include Natural Resources and Mining, Construction, Manufacturing, Trade, Transportation and Utilities, Information, Finance, Insurance, and Real Estate, Professional and Business Services, Educational and Health Services, Leisure, Entertainment, and Hospitality, and Other Services. This data was organized and charted in a way in which a descriptive statistical analysis could be performed to provide an industry-specific comparison of Heinrich's theories versus real life. Findings from this research established the value of Heinrich's Model in modern safety management.

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Introduction

Background

Herbert William Heinrich was an employee of the engineering and inspection division of Traveler's Insurance Company. Heinrich drew his data from insurance claims he collected over his career with Traveler's Insurance Company and compiled the data to form a theory, which he outlined in the first edition of his book. In 1931, he published the book, *Industrial Accident Prevention: A Scientific Approach*, in which he outlined a theory that for every incident that causes a major injury or fatality, there are 29 incidents that cause minor injuries, and 300 that cause no injuries, which include property damage incidents and near-miss incidents. His graphical representation of the data took the form of a pyramid, which has been referred to as "Heinrich's Triangle", "Heinrich's Pyramid", and also "Heinrich's Law".

Heinrich believed that the vast majority of accidents were the result of "man failure", or the unsafe acts of the worker. His research surmised that such failure was the case 88% of the time. In 10% of incidents, unsafe mechanical and/or physical conditions were believed to be the cause, while the remaining 2% of cases were unpreventable. While in many cases, the root cause of an accident or incident can be traced back to the unsafe act of a worker, there are times that there was a factor that was beyond their control that led to the accident or incident occurring.

Many who report on the work of Heinrich focus solely on the results of these "man-failures", and have used these results as the basis for behavior-based safety. What is often overlooked by those concerned solely with controlling the workers is that Heinrich himself encouraged those involved in safety to focus on making the workplace safer as well. In his 4th edition, Heinrich encouraged those involved in safety to not only educate the workers in a location on the need for them to do their jobs safely, but also for those involved in safety to focus on improving the safety level of the work environment for those workers.

Statement of the Problem

The theory presented by Herbert Heinrich was taken from data collected from insurance claims filed with Traveler's Insurance Company in the 1920's. Heinrich's 300-29-1 ratio has been widely accepted and regarded as law. Unfortunately, the original data used for Heinrich's research has been lost, so a true statistical analysis to confirm or refute his findings cannot be done. Because there is no data against which a true statistical analysis and comparison can be made, many safety professionals have taken one of two stances on his research.

In the first group are the safety professionals who have taken Heinrich's theories and applied them as law, using them as the foundation of modern safety teaching. While they have seemingly done this with the best of intentions, their rigid application of Heinrich's work has left little room for improvement upon those teachings.

In the second group are those who disagree with the Heinrich's premises. This group of safety professionals tend to find the work of Heinrich to be flawed, and prefer to focus their safety efforts on developing a culture of safety in an organization in order to reduce the number of injuries and fatalities.

The problem is that there has been little or no research done to try to fully confirm or refute the work of Herbert Heinrich. Proponents of behavior-based safety attribute as much as 95% of work-related injuries to the unsafe acts of people. Something that is often neglected is that the information on which Heinrich based his theory was obtained from documents that were filled out by supervisors, who generally blamed the worker for the injury that occurred, and did little investigation into the root-cause of the incident.

Purpose of the Study

The purpose of this study is to determine the degree to which the work of Heinrich can be applied in modern safety management. There has been much discussion as of late on the validity of Heinrich's safety pyramid and its significance to the safety profession. Heinrich theorized that for every major injury or fatality event, there were 29 events that resulted in minor injuries and 300 events that resulted in no injury, including property damage and near-miss events. His theory has stood as the foundation of behavior-based safety, and has been taught abundantly in industry. This study aims to take Heinrich's model and use modern data collection to provide an industry-specific descriptive statistical analysis to determine whether or not his theory applies to today's work environment.

Potential Significance

This study can assist in determining the applicability of the work of Heinrich in a contemporary environment. The findings of this study can impact the future of behavior-based safety and can help define the trajectory of safety training in the future.

Definition of Terms

Bureau of Labor Statistics: The principal data collecting agency for the US government in the broad field of labor economics and statistics and serves as a principal agency of the US Federal Statistical System.

Behavior-based safety: A process designed to influence employee actions toward safer outcomes, ideally by preventing an accident or injury before it occurs

North American Industry Classification System (NAICS): The standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy (US Census Bureau, 2016).

Assumptions

It is assumed that the data compiled by the Bureau of Labor Statistics was reported accurately by those responsible for reporting injury and fatality data. It is also assumed that the data was correctly entered into the database from which the data was collected.

Limitations

1. The original data and research used by Herbert W. Heinrich is unavailable for further review, aside from the books written by Heinrich.
2. Only injury and fatality data from the United States was used within the scope of this research.
3. Only injury and fatality data from claims represented by Traveler's Insurance Company were analyzed in Heinrich's original work.
4. Injury and fatality data in Heinrich's original research were from claims that took place in the 1920's.

Organization of the Study

This study is presented in chapters as follows:

1. The introduction section provides the background for the study, along with an introduction that establishes the purpose of the study and the relevance of the research, analysis, and results.
2. The literature review section provides a review of literature pertinent to the study. This literature is comprised of works from members of the safety community, as well as researchers who have presented similar studies claiming to refute the validity of the work of Heinrich.
3. The methodology section explains the methodology of the study, including how the data were collected and what methods were used to analyze them.
4. The research findings and implications section includes statistical data that brings conclusion to this study. This chapter presents the significance of the findings of the study, as well as recommendations for the safety profession moving forward.
5. The discussion and implications section presents the implications of the study and their potential significance to the safety profession.

Chapter Two

Literature Review

Heinrich was one of the pioneers of modern industrial safety. His work has been cited countless times throughout the history of the safety profession. The ideas he presented in his book, *Industrial Accident Prevention: A Scientific Approach* have prevailed in the safety profession for decades, being the foundation of modern theories of behavior-based safety. Smith (1999) questioned the validity of not only Heinrichian thought, but the concepts of behavior-based safety as a whole.

The goal of behavior-based safety (BBS) is to transform the behaviors of workers from at-risk acts to safe acts (Smith, 1999). Much of the logic behind BBS is derived from the psychological works of B. F. Skinner, who found consequences can either encourage or discourage certain behaviors. The theory is that “punishment decreases the probability a behavior will be repeated” (Smith, 1999, p. 1). Both positive and negative reinforcement can be used in BBS to change behaviors of workers. It is theorized that negative reinforcement only encourages the minimum level of compliance, whereas positive reinforcement can encourage workers to exceed the minimum (Smith, 1999).

One of the greatest problems with Heinrich’s theory is that it would not withstand the test of modern science (Smith, 1999). Heinrich believed the vast majority of accidents occurred as a result of the unsafe action of a worker. By focusing on this, and reducing the unsafe actions, the number of accidents should also decline. According to Smith, however, faults in the elements of a system are the cause of most accidents. By focusing on quality, rather than quantity, “the mental labor of all employees is needed to fix the system.” (Smith, 1999, p. 5) When all parties involved work together, including all levels of employees and stakeholders, the flaws in the system can be more easily identified and rectified, reducing the number of incidents, thereby reducing the overall number of accidents and injuries.

According to Smith, BBS relies too heavily on external motivators to change behaviors, and that the “extrinsic motivators destroy the intrinsic motivation which is inherent in people to do good work and work safety.” (Smith, 1999, p. 5) A proponent of systems (and quality) management, Smith feels that BBS has run its course, and the theories of Heinrich should be removed from the language of modern safety professionals. The theories of quality management can be easily translated to the safety realm, such as in quality management everyone works together to achieve a common goal.

Safety research continues to rely on the tenet that by reducing the number of "no harm" or "near miss" incidents, the overall number of major incidents will decrease as well. Gallivan et al. (2008) studied the theory of Heinrich's 1-29-300 ratio. They tried to show whether or not the Heinrich ratio could be viewed as a constant, and whether or not the concept of his ratio was sound. They disagreed with Heinrich's theory that "introducing measures to reduce the incidence of minor incidents will not inevitably reduce the incidence of major incidents", further stating that, "any safety policies based on the assumption that the Heinrich ratio is true needs to be rethought (p. 637)."

Health and Safety Practices on Christchurch's Post-Earthquake Rebuild Projects: How Relevant is Heinrich's Safety Pyramid

Christchurch, New Zealand was struck by a major earthquake in 2011. Seward and Kestle (2014) conducted a study on the relevance of the Heinrich Safety Pyramid in modern reconstruction projects, reiterating that Heinrich's work was a theory, not a law as it has been referred to many times. Heinrich supposed that a worker fatality most often would not have occurred without a foundation of less-severe incidents that led to the fatality. By reducing the number of less-severe incidents, Heinrich believed that there would be a lower likelihood of the more severe incidents occurring.

Reviewing accident data from rebuilding projects in Christchurch from 2013, Seward and Kestle felt that Heinrich's safety pyramid was still relevant to the safety practices on construction sites. Heinrich promoted two approaches to accident prevention, noting that, "accident prevention is both a science and art, and that a strict concentration on mathematical formulas and models do not create a safe environment." (Heinrich, 1941, p. 364) The ratio revealed by Seward and Kestle was 1-5-20, much higher than the original Heinrich ratio. At first glance, it would appear that the Heinrich ratio is not valid. Heinrich's original data was taken from insurance claim data that spanned several different industries. It is not uncommon for the construction industry to have a higher rate of injury than other industries and first-aid type injuries are not always reported. Both of these issues could have had an effect on the final results of the study (Seward & Kestle, 2014). Of particular note in the Seward & Kestle study was that nearly 70,700 safety conversations were reported, and self-reporting by survey respondents revealed that near-miss reporting was not always consistent, which could be another reason that the resulting ratio was not as close to the original Heinrich Theory.

Frontline site workers and supervisors were asked during the study if they felt that the Heinrich pyramid was a useful visual tool to stress the importance of safety on the jobsite (Seward & Kestle, 2014). They indicated the pyramid helped bring into perspective how important it is to accurately and fully report near-miss incidents, along with major and minor incidents, so as to help paint a fuller picture of the overall safety of the job site, and what the workers can do to help improve safety on-site.

There have been calls industry-wide for the removal of Heinrich's theories from safety teaching. Many of those who are calling for this removal feel that the heavy emphasis on reducing minor incidents is leading down a path where there is not enough focus on major injuries and fatalities. This is causing the safety profession to be back-loaded in prevention by not focusing on reducing the low-frequency, high-impact events.

Lander et al. (2011) disagree with this new theory, feeling that from an injury prevention standpoint, it is essential to view near-miss incidents, minor injuries, and major injuries as having a common underlying cause and by preventing the near-miss incidents, safety professionals may in turn reduce the overall number of major incidents and fatalities. They revealed a significant decrease in the proportion of near miss and minor injuries between 2002 and 2005, encouraging reporting of all incidents by not assigning blame to anyone who reported an incident. They also noted a significant trend for the proportion of OSHA recordable injuries compared to near-miss incidents.

By using a near-miss reporting system, Lander et al. (2011) noted an overall decrease in the number of minor injuries and OSHA-recordable incidents, while noting a significant increase in near-miss incidents. They did note that contrary to Heinrich's theory, the vast majority of events that were noted were minor injury cases, not no-injury cases, which Heinrich proposed with his 300-21-1 ratio. Even with noting that the Heinrich Model may not be valid in its entirety, the focus shown by the near-miss reporting system held true with the spirit of Heinrich's work. The study revealed the need to study the causes of all events, and since near-miss and minor injuries occur more frequently, it is essential to ensure accurate reporting of these events in order to investigate the root cause of the events, thereby working to reduce the number of events, which will in turn reduce the number of major events.

Johnson (2011) wrote that what is still under debate, however, is whether or not the influence of Heinrich is a good thing or a bad thing. She found that many safety professionals are calling for the debunking of the Heinrich Theory and for its removal from all safety language and training, citing its age and the continual question of whether his research would hold up to modern methods and peer-review. She cited Manuele's 2002 work "Heinrich Revisited: Truisms or Myths", where Manuele noted that Heinrich revisited his 300-29-1 ratio in subsequent editions of his work, but failed to explain it outside of his 1931 first edition. Also noted by Manuele was that Heinrich's original data no longer exists, effectively preventing a true analysis of the work he performed.

Some of the biggest opponents to Heinrich's work note that focusing on "man-failure", as is supposed by Heinrich suggesting that 88% of accidents occur due to the unsafe acts of man, lead safety professionals to focus too heavily on workers, rather than the systems in which they operate (Johnson, 2011). Accidents often have multiple causes, not solely the failure of one person or piece of equipment, and should be investigated more diligently by safety professionals.

Dislodging the long-held beliefs that Heinrich's theories were laws is a daunting challenge for modern safety professionals. Heinrich's work should serve as a guideline for planning safety initiatives, but should not be the sole focus, as it leaves out an entire realm of possible hazards, including system design and overall culture (Johnson, 2011). The belief that the majority of accidents are the fault of the worker enables upper-level management to simply insure against major losses as a result of an inevitable incident, and further keeps the safety profession from doing what it needs to do, which is better ensure the safety of the worker. Because of this, many professionals call for the complete removal of Heinrich's ideas. Some professionals, however, feel that more research needs to be done, using Heinrich as a litmus test, but striving to advance the profession through professional research (Johnson, 2011).

The work of Herbert Heinrich, although referred to as theory by himself, has been treated and referenced as a law by many safety professionals (Ward, 2012). The title of "Law" vastly over-reaches the original intentions of Heinrich's work, and in many cases can lead to confusion over just what Heinrich intended with his research. Many opponents to Heinrich's theories forget that Heinrich himself, though indicating that 88% of accidents are a result of man-failure, recognized and noted that accidents result from a sequence of factors, not necessarily a single point of fault (Ward, 2012). Something that is also of interest to note is that Heinrich's ratios have been so ingrained in modern safety thinking that they are treated as absolute constants. Heinrich's ratios only apply to the average case of a similar incident occurring to the same person (Heinrich, 1941). Heinrich's ratios are also often thought to be completely transcendent, applying to a small factory the same as a large factory, and a small sample size the same as a large sample size (Ward, 2012). This is often not the case, which is why more research needs to be done to see how/if these ratios are still applicable to today's workforce and workplace.

The central question Ward (2012) addressed regarding Heinrich's theory is if something has been missed. From Heinrich's work, much of which remained unchanged through four editions of his book, we can deduce that he held that a reduction in the minor incidents will result in a reduction in the major incidents. Perhaps what has been missed by stating Heinrich's theories as law is a way of seeing what Heinrich was saying: "if you have 300 near-misses, something more serious is probable; if you can reduce that number of minor incidents the probability of serious injury or damage is reduced; if the number of minor events reaches zero that probability tends to zero - - - probably never reaching zero, but getting close." (Ward, 2012, p. 5)

Perhaps what Heinrich was trying to convey is that those responsible for safety need to be ever-vigilant, working to reduce the number of minor incidents, encouraging the reporting of near-miss incidents, and helping to find the root-cause of any incident, whether major or minor (Ward, 2012). What many who want Heinrich's ideas removed from safety nomenclature get pigeonholed into remembering is the arithmetic of Heinrich's model. What they often fail to do is look deeper than the numbers and realize that Heinrich himself did not just focus on the numbers, but the people represented by those numbers (Ward, 2012).

Safety practitioners have a long-held belief that frequency breeds severity (Mattis, 2011). This belief has morphed into many ideologies in the safety profession, but stems from the work of Heinrich. Modern safety professionals place major injuries and fatalities at the top of the pyramid model used by Heinrich, and strive to reduce the number of minor incidents and no-injury incidents that are displayed at the bottom of the pyramid, all with the hope of reducing or eliminating the major incidents and fatalities (Mattis, 2011).

Mattis (2011) goes on to cite Manuele (2006), a well-respected researcher, author, and safety professional. Taking from Manuele's work, Mattis noted there was a 23% increase in cases of more than 31 days away from work from 1995 to 2001, despite significant decreases in cases where days away from work were anywhere from 1 to 20 days. This seems to be contrary to what Heinrich was proposing with his triangle.

Many executives often rely solely on OSHA injury rates, or large penalties, to assess their overall safety performance. When something catastrophic does occur, especially at a location with a low overall injury rate, many of the executives are caught off-guard and chalk it up to chance (Krause, 2011). What is often cited is that the company was operating under the premise of Heinrich's 1931 theory that by reducing the number of minor incidents, the company would be able to eliminate, or at least drastically reduce, the occurrence of major incidents.

Krause (2011) stated that the root cause for major incidents lies not in the Heinrich Theory of frequency breeds severity, but rather in the entire metric by which safety is measured as a whole. Heinrich's theories have been debunked by current Bureau of Labor Statistics (BLS) data, which has shown a decrease in the number of minor incidents, but the more serious injuries and fatalities rates' have remained constant, even showing increases in some cases (Krause, 2011).

Krause (2011) also noted that proper identification of factors leading up to a serious injury or fatality (SIF) needs to be a priority. According to Krause, many SIF's have identifiable precursors, and assuming that the conditions that led to the SIF have never previously occurred is a fatal flaw in the thought process of safety professionals. Safety professionals should look beyond the numbers, realize that Heinrich was wrong, and work to develop new and better methods of prevention. Process safety needs to be better understood, and the culture of the organization should reflect the desire for top leadership to do more to prevent SIF's (Krause, 2011).

Despite efforts of safety professionals and corporate leadership to reduce the number of accidents in the workplace to zero, accidents still occur. More often than not, the cause is not as simplistic as the failure of one person on the job, but rather a series of minor failures, or lapses in judgement or enforcement, that lead to a greater failure down the line (Freibott, 2012). For the modern, proactive incident manager or safety professional, the message needs to be that learning from past mistakes gives only a small view of what is truly needed in a company. A better understanding of what is going on throughout the company is needed in order to evolve the safety culture at the company (Freibott, 2012).

Heinrich's Law states that for every incident that results in a major injury or fatality, there will have been 29 incidents that caused a minor injury, and 300 incidents that resulted in no injury (Freibott, 2012). Frank Bird took Heinrich's model a little farther, noting that a pyramid with a ratio of 1-10-30-600 was more likely to appear, with one reported major injury for every 10 reported minor injuries, 30 incidents resulting in property damage, and 600 near-miss incidents (Freibott, 2012). Conoco Phillips Marine also further studied the issue, revealing that for every fatality, there was an underlying number of 300,000 at-risk behaviors (Freibott, 2012).

The most important thing for safety practitioners to take from the three studies is that proactive safety management must be in place and prepared to analyze all incidents. Transparent reporting is essential, and safety management cannot be satisfied with merely lopping off the top of the iceberg; they should focus on getting to the root of the iceberg and attacking it from below (Freibott, 2012).

Accident Losses Elimination By Means of Safety Pyramid Analysis

While safety professionals continue to call for the debunking of the work of Heinrich, it is difficult to discount the foundation that was laid by Heinrich. Many safety practitioners and safety management professionals have held the theories of Heinrich as law, believing that the ratios presented in the Heinrich safety pyramid of 300:29:1 will hold true in any event. Those who are against this line of thinking feel that the time for focusing on high-frequency, low-risk events has passed, and more focus needs to be on preventing high-risk, low-frequency events. Radvanska (2010) stated the focus needs to be a more balanced approach, and that focusing too heavily on the major incidents is also a cause for concern, when there are many more significant opportunities to provide a better basis and better control of major incidents at the bottom of the pyramid.

Since Heinrich's original 1931 study, there has been more and better data accumulated, and research continues to be done to this day on safety-related incidents. As this data has been accumulated, it has revealed that the triangle model presented by Heinrich may not actually be an equilateral triangle, depending on the safety culture of the individual company in which it is used (Radvanska, 2010). A great example lies within a company that places blame on its workers for incidents. They may have far fewer minor injuries, but in turn may have a higher rate of major injuries, as the culture at the company discourages reporting of the minor incidents, thereby effectively eliminating opportunities for subsequent events to be investigated and solved (Radvanska, 2010).

The top-down focus of management in relation to Heinrich's pyramid is a cause for concern. Safety management needs to be a balanced approach of preventing fatal accidents, in addition to preventing the unsafe acts that often lead to fatal incidents. Heinrich theorized that all accidents occur as a result of multiple causes, and after determining the physical circumstance that led to the injury event, investigation needs to continue upstream from the event to reveal all of the factors that led to it. Many companies, however, choose to stop at the physical cause of the incident to avoid litigation, doing a disservice to the employees and families affected by the incident (Radvanska, 2010). The numbers used in the pyramid presented by Heinrich have never been scientifically validated, even though the concept has been held in high regard by safety professionals for many years. Those who are skeptical of the validity of the Heinrich Model feel that the data shown by the Bureau of Labor Statistics (BLS) refutes the Heinrich Theory (Nash, 2008).

The BLS data showed an increase in the number of fatal work injuries between 2005 and 2006, but showed a fatality rate that remained constant for the same period (Nash, 2008). Based on the Heinrich Model, one would have expected the rate to increase along with the number of fatalities. Because of this discrepancy, it is important for safety professionals to change their view on incident investigations and subsequent corrective actions, employee behavior and risk management, and engineering controls (Nash, 2008). Manuele has written extensively on the field of safety. His 2011 work called for the removal of Heinrich's theories from the safety profession. Manuele noted that Heinrich's original sources have been lost to time, and only the first four editions of his book *Industrial Accident Prevention: A Scientific Approach* remain. There is no way to determine how Heinrich gathered his information, the quality of the information he obtained, or how effective his data analytics were. The work of Heinrich would not stand up to modern peer-review, and much of his terminology he used would be considered sexist by today's standards (Manuele, 2011).

Manuele also noted that Heinrich's work focused very heavily on applied psychology, noting that many safety practitioners could effectively apply the psychological emphasis of Heinrich in their daily accident prevention efforts (2011). Heinrich attributed 88% of the causes of accidents to "man-failure," and felt that psychology was an important element in remedying those problems (Heinrich, 1931). Heinrich advocated for prevention of the first proximate cause, which was generally the easiest to correct, of an accident (Heinrich, 1931). Manuele (2011) noted that this focus does not account for the dynamic, complex environment in which incidents occur, and that focusing only on the first cause of an accident does a disservice to those affected by the accident, citing the complex natures of both the Columbia incident in 2003 and the *Deepwater Horizons* explosion from 2010.

Heinrich stated, "The natural conclusion follows, moreover, that in the largest injury group-the minor injuries-lies the most valuable clues to accident causes (Heinrich, 1931, p. 95)." When the focus is placed too heavily on the failures of workers as a root-cause of an accident, management is often let off the hook as a causal factor, as blaming the workers is the path of least resistance. There are often several causal factors of an accident, including cultural factors within the organization that are not often accounted for by a superficial investigation (Manuele, 2011). It is true that human errors at the worker level do account for a large portion of the incident causes, but what is not often taken into consideration is the failures of management that have allowed both unsafe environments and unsafe practices to continue. There are also maintenance factors and design factors that need to be accounted for, and a comprehensive incident investigation is the only way to uncover all of these causes, not just those of "man failure" (Manuele, 2011).

Heinrich's work has major flaws, not the least of which being the lack of availability of his original data and research. Heinrich worked for an insurance company, and his data was taken from insurance claims files and the records of plant owners. Manuele stated from his own research that insurance claim forms and supervisors' reports were used as possible sources for data, but in more than 80% of the reports, there was insufficient data to glean any causal data (2011). Another weakness in Heinrich's work lies in the revision of data in his fourth edition in 1959 from his first edition, in which Heinrich changed the statement "a most interesting and absorbing study" to "a study of over 5,000 cases" when he explained how he reached his 300-29-1 ratio (Manuele, 2011).

Heinrich also made several changes, subtle revisions, to his original data in subsequent editions, leading Manuele (2011) to question the validity of his original data. Manuele stated, “How does one support using the ratios without having explanations of the differing interpretation Heinrich gives in each edition?” (p. 58) Also, Heinrich himself put limitations on his research, with the need for so many incidents of the same type occurring to the same person, and Maneuel doubted that there was a database of the more than 4,500 no-injury cases that would be necessary in order to make the Heinrich ratios plausible from Heinrich’s research.

Manuele (2011) noted that a 2005 paper from the National Council on Compensation Insurance (NCCI) stated “There has been a larger decline in the frequency of smaller lost-time claims than in the frequency of larger lost-time claims,” which would run counter to the argument of Heinrich, which would have supposed an equal proportionate reduction in larger lost-time claims. In relation to major incidents, Manuele notes that when small incidents are managed effectively, the small incident rate improves, but the large incident rate may remain the same, or increase in some instances.

Because there is no sound basis to the 300-21-1 ratio presented by Heinrich, the issue is whether or not the ratio has substance. The complex nature of the accident sequence must be accounted for, and it must stand to reason that not all hazards have an equal potential for harm. Many safety practitioners have misconstrued Heinrich’s original intentions and terminology, and have adapted his theories as laws. It is also of note that Heinrich indicated that any injury requiring more than first aid was considered to be a major injury (Manuele, 2011). The culture of an organization is a major factor in incidents, and only if the culture as a whole improves will any major changes occur. Systemic problems must be identified and addressed, and employee training and empowerment are essential factors to the culture change. Those who refer to Heinrich’s premises as fact are doing a great disservice to the safety profession (Manuele, 2011).

Chapter Three

Methodology

Context of the Study

The work of Heinrich has been under fire for the last several years. His 1930's research has been lost, but his principles and axioms have been used as the foundation of modern safety teaching. Due to the questions being raised about Heinrich's research, this researcher complied data from the Bureau of Labor Statistics (BLS) for the years of 2006 to 2014 regarding the rates of other recordable incidents, restricted work, lost time, and fatality incidents. Descriptive statistics were used to determine whether or not the work of Herbert Heinrich has any degree of applicability to today. This researcher hopes to show ways in which safety teaching and methods can be improved upon.

Research Question

The overarching question of this research was: To what degree does the Heinrich Model apply to modern safety management?

Data Collection

The data collected for this research was extracted from BLS data collected from 2006 through 2014 from the BLS website using the primary industry sector from the North American Industry Classification System (NAICS). Using these NAICS codes, rates were collected for other recordable incidents, restricted work, lost time, and fatality incidents across ten primary industry sectors. As opposed to utilizing Heinrich's categories, BLS categories provided data that remains in the spirit of escalating categories of severity. The ten primary industry sectors were:

1. Natural Resources and Mining
2. Construction
3. Manufacturing

4. Trade, Transportation, and Utilities
5. Information
6. Finance, Insurance, and Real Estate
7. Professional and Business Services
8. Educational and Health Services
9. Leisure, Entertainment, and Hospitality
10. Other Services

Rather than using the total number of occurrences in each of the four types of incidents across all ten industries, incident rates were used in order to provide a more appropriate comparison of data from year to year. BLS rates shown for fatalities are based on a constant of 200,000,000 hours worked, whereas the constant of 200,000 was utilized in calculating other recordable, restricted work, and lost time rates.

Data Analysis

Descriptive statistics were used to determine the percentage of improvement or regression in the overall rate of other recordable, restricted work, lost time, and fatality incidents over the nine-year period covered by this research. The BLS data calculated the rates as follows:

For injuries, the rates represented the number of injuries and illnesses per 100 full-time workers, calculated as (N/EH) x 200,000, where N= the total number of injuries and illnesses, EH= the total number of hours worked by employees in each category in the calendar year, and 200,000 serves as the base for 100 full-time-equivalent (FTE) workers. FTE workers represent workers working 40 hours per week for 50 weeks during the year (Bureau of Labor Statistics, 2012).

For fatalities, the rates represented the number of fatal occupational injuries per 100,000 full-time workers, calculated as (N/EH) x 200,000,000, where N= the number of fatal work injuries, EH= the total number of hours worked by all employees during the calendar year, and 200,000,000 serves as the base for 100,000 FTE workers (Bureau of Labor Statistics, 2015).

Chapter Four

Research Findings and Analysis

When evaluating the percentage of improvement across the four categories of other recordable, restricted work, lost time, and fatality rates within each of the ten industry categories, the following percentages of improvement across the nine-year period investigated within the scope of this research were found (See Table 1):

Table 1: *Percentage of Improvement across Incident Categories*

Industry Sector	Other Recordable	Restricted Work	Lost Time	Fatality
Natural Resources and Mining	32%	0%	24%	22%
Construction	41%	40%	41%	13%
Manufacturing	37%	37%	29%	15%
Trade, Transportation, and Utilities	33%	23%	19%	14%
Information	33%	50%	14%	37%
Finance, Insurance, and Real Estate	13%	0%	20%	8%
Professional and Business Services	36%	25%	29%	18%
Educational and Health Services	27%	27%	21%	30%
Leisure, Entertainment, and Hospitality	25%	14%	9%	23%
Other Services	20%	20%	0%	4%

Source: Bureau of Labor Statistics, 2015

Looking first at the major Bureau of Labor Statistics (BLS) category of Natural Resources and Mining, the data revealed a 32% improvement in the rate of other recordable incidents over the nine-year period. This was followed by no change in restricted work incident rate, but the rate of lost time incidents improved by 24% and the fatality rate improved by 22%.

It is interesting to note that Natural Resources and Mining contains industries that are often viewed as inherently more dangerous than many other industries. While there was no improvement in the restricted work incident rate, there were strong improvements in the rates of other recordable, lost time, and fatality incidents. As Heinrich surmised, the improvements at the base of the pyramid (other recordable incidents within the scope of this research) does appear to correspond with a decrease in serious (lost time) and fatal incidents.

In Construction, there was a 41% improvement in other the recordable incident rate, a 40% improvement in the restricted work incident rate, a 41% improvement in lost time incident rate, and a 13% improvement in fatality incident rate.

In much the same manner as Natural Resources and Mining, Construction is an industry that is viewed as inherently more dangerous than many other industries. There have been major improvements in the safety practices in the construction industry, which is evidenced by the strong improvements in incident rates across all four categories. The reduction in the number of less-severe incident rate appears to correspond with a reduction in more severe incident rates.

In Manufacturing, there was a 37% improvement in the other recordable incident rate, a 37% improvement in the restricted work incident rate rate, a 29% improvement in the lost time incident rate, and a 15% improvement in the fatality incident rate.

The trend in Manufacturing is much the same as those demonstrated in the categories of Natural Resources and Mining and in Construction. Once again, strong improvements in the incident rate in the less severe incidents appear to have a corresponding decreases in the rates of the more severe incidents.

In Trade, Transportation, and Utilities, there was a 33% improvement in the other recordable incident rate, a 23% improvement in the restricted work incident rate, a 19% improvement in the lost time incident rate, and a 14% improvement in the fatality rate. Again, there appears to a corresponding reduction in more severe incident rates with a reduction in the less severe incident rates.

Information experienced a 33% improvement in the other recordable incident rate, a 50% improvement in the restricted work incident rate, a 14% improvement in the lost time incident rate, and a 37% improvement in the fatality incident rate.

For the category of Information, the rates of incidents are considerably lower than the rates of other industries, but the reductions in rates are just as interesting to see. As has been seen in the other industry categories, the improvements in the rates of other recordable and restricted work incidents appear to have corresponding improvements in the more severe categories of lost time and fatal injury incident rates.

In Finance, Insurance, and Real Estate, there was a 13% improvement in the other recordable incident rate. There was no improvement in the restricted work incident rate, but there was a 20% improvement in the lost time incidents rate and an 8% improvement in the fatality incident rate.

In this category, there is a bit of an interesting trend in the fatality rate. Overall, there has been an improvement, but in recent years in the data, there was a spike in the fatality rate. Until newer data is available, it is unclear if this is indeed a trend, or an anomaly in the data.

In Professional and Business Services there was a 36% improvement in the other recordable incident rate. There was a 25% improvement in the restricted work incident rate, a 29% improvement in lost time incidents, and an 18% improvement in the fatality incident rate.

Professional and business services appears to indicate a corresponding reduction in the more severe incidents with a reduction in the less severe incidents. This experience is within the spirit of the Heinrich Model.

Educational and Health Services yielded a 27% improvement in the other recordable and restricted work incident rates. There was a 21% improvement in the lost time incident rate and a 30% improvement in the fatality rate.

Leisure, Entertainment, and Hospitality realized a 25% improvement in the other recordable incident rate. In the restricted work incident rate, there was a 14% improvement. There was a 9% improvement in the lost time incident rate and a 23% improvement in the fatality rate.

In Services, there was a 20% improvement in the other recordable incident rate. The restricted work rate improved 20%, but there was no improvement in the lost time rate. The fatality rate improved 4%.

Chapter Five

Discussion and Implications

One of Heinrich's premises supported by this research is that by working to reduce the number of less-severe incidents, there can be a reduction of more severe incidents and fatalities. While the reason for this is a topic for additional research, one can reasonably infer that a reduction in the rate of the less severe incident rate (other recordable), more severe incident rate reductions tend to occur. This conclusion is supported by taking a closer look at the data as broken out in the tables below.

Though there is not a uniform reduction in rates across all four categories as might be expected by the Heinrich Model, these data do point to corresponding reductions in rates building from greater reductions in other recordable rates to smaller reductions in fatality rates. This finding is at least within the spirit of what the Heinrich Model was designed to communicate (See Table 2).

Table 2: *Industry Sectors most Closely Aligning with the Heinrich Model*

Industry Sector	Other Recordable	Restricted Work	Lost Time	Fatality
Construction	41%	40%	41%	13%
Manufacturing	37%	37%	29%	15%
Trade, Transportation, and Utilities	33%	23%	19%	14%

Source: Bureau of Labor Statistics, 2015

These four industry categories demonstrated improvement in all four categories of incidents, but there is no consistency in the improvement as the data are evaluated beginning with other recordable rates moving up through the categories to the most severe, fatality rates. For example, Information data present a “see-saw” effect in that the other recordable rate indicates a 33% improvement, the restricted work rate improvement increases to 50%, the lost time rate improvement dips to 14%, and the fatality rate improvement rebounds to 37%. Still, in keeping with the spirit of the Heinrich Model, these industry categories do indicate that when lesser incident rates improve, there is a corresponding improvement in other categories of incidents (See Table 3).

Table 3: *Industry Sectors with Moderate Alignment with the Heinrich Model*

Industry Sector	Other Recordable	Restricted Work	Lost Time	Fatality
Information	33%	50%	14%	37%
Professional and Business Services	36%	25%	29%	18%
Educational and Health Services	27%	27%	21%	30%
Leisure, Entertainment, and Hospitality	25%	14%	9%	23%

Source: Bureau of Labor Statistics, 2015

The industry categories in Table 4 appear to indicate a lesser alignment with the Heinrich Model in that they each experienced no improvement in one measured category. However, there does appear to be a corresponding improvement in fatality rates when there is an improvement in other recordable rates (See Table 4).

Table 4: *Industry Sectors with Less Alignment with the Heinrich Model*

Industry Sector	Other Recordable	Restricted Work	Lost Time	Fatality
Natural Resources and Mining	32%	0%	24%	22%
Finance, Insurance, and Real Estate	13%	0%	20%	8%
Other Services	20%	20%	0%	4%

Source: Bureau of Labor Statistics, 2015

This research opens many doors for further research. First, further research would help explain the apparent spikes in fatality rates in industries that are viewed as inherently less dangerous than others. One example would be the spikes in fatalities in Information; Finance, Insurance, and Real Estate; and Professional and Business Services.

Another point for further research would be the effectiveness and methods of training in the industries that revealed significant and consistent reductions in the rates in all four categories, such as Construction, Manufacturing, and Trade, Transportation, and Utilities.

Additionally, safety and health management system and risk assessment inclusion could be investigated to determine the degree to which such tools have impacted the data collected in this research. It could be assumed that the Heinrich Model is predicated on the concept that organizations are actively working to protect workers. Investigating the manifestation of such activity (or lack thereof) within various industrial sectors could explain the variances from the Heinrich Model that are indicated in the data.

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