PROVIDING TOOLS TO BENCHMARK DISABILITY MANAGEMENT AND RETURN TO WORK PERFORMANCE IN THE CONSTRUCTION INDUSTRY

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Providing tools to Benchmark Disability Management and Return to Work Performance in the Construction Industry

Final Report Submitted to Research and Workplace Innovation Program Workers Compensation Board of Manitoba

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Executive Summary

In industrialized countries like Canada, it is predicted that the construction industry will face a serious shortfall of skilled workers in the next decade. A poignant way to address this, is the prioritization and investment in fostering safe work environments. This not only implies safe work practices but having robust Disability Management (DM) and injury management strategy and policies in place to ensure higher worker retention rates, job security but also provides a needed leverage to attract and retain potential skilled employees into the industry. There has been gradual prioritization within the construction industry of not solely focusing on safety management, but also efficiently dealing with the aftermath of an injury, the safe and effective reintegration of inured and disabled employees back into the workplace. This is indispensable if the industry intends to avoid the exodus of employees, which other industries are currently contending with.

The study uses this gradual revolution as a catalyst to to build on previous research by Quaigrain and Issa (2018), funded by the Workers Compensation Board of Manitoba, investigating DM within the construction industry. This previous project aimed to provide the construction industry with theoretical version of tools (i.e., the Construction Disability Management Maturity Model and Metrics) that would enable construction workplaces to benchmark their disability management (DM) and return to work (RTW) performance. The goal of the current project is to develop refined, validated web-based free versions of these tools and use them to evaluate the DM and RTW performance of the construction industry in Manitoba at large. To achieve the set objectives, the project established the Project's Advisory Committee (PAC) made up of key stakeholders in the construction industry, whose main aim is to provide strategic guidance on the project.

First, the project refined the disability management indicators and practices within the maturity explain model developed in the previous project and additionally conceptualized DM metrics. These refined indicators, practices and metrics were validated via surveys using expert judgement. The refined practices, indicators and the newly developed metrics were validated by two technical working groups (TWGs), one for the building sector and one for the heavy sector. The results of the validation showed that, all 11 indicators were validated by both the building and heavy construction sectors. Of the 98 refined practices, 91 were validated for the building sector and 75 for the heavy sector. Also, of the 26 metrics proposed, 25 were validated for the building sector and 15 for the heavy sector. Secondly, these validated indicators, practices and metrics were used to develop web-based DM benchmarking tools for the building and heavy sectors. The tool was then piloted by the TWGs, with the results analyzed and the feedback incorporated into the developed tools. A meeting with the Project Advisory Committee was organized to conduct a comprehensive review of the final versions of the tool, discuss the integration of the tool into the partners website and discuss promotional strategies for the tool. The tool was then successfully integrated into the partners Construction Safety Association of Manitoba (CSAM), and Manitoba Heavy Construction Association (MHCA) websites and actively deployed within the industry.

Although 26 companies created accounts on the "Building Sector DM Benchmarking Tool" only 15 completed the DM survey and thus included in the analysis of the industry DM performance. Also, in the "Heavy Sector DM Benchmarking Tool", although 8 companies set up accounts, only 6 fully completed the DM survey and thus included in the analysis of the industry DM performance. No company assessed their performance using the validated DM metrics mostly due to limited time window for the project. The tool is expected to remain on the association websites and continue to be promoted within the industry after the conclusion of the project.

The analysis of the online of the DM benchmarking tool result showed that:

- On average, at the construction industry level, companies analyzed operated largely at the standardized maturity level (3-4).
- Building sector averagely had a slightly higher level of DM maturity operating at the quantitatively managed maturity level (4-5), than the heavy sector who operated at the standardized level (3-4).
- Spearman' correlation analysis found a statistically significant very strong positive relationship between the average maturity score at the industry level and that of building sector and heavy sector.
- At the industry level small-sized companies implemented more mature DM practices, followed by large-sized companies then medium-sized companies.
- At the sector levels, building sector small companies outperformed both large and medium-sized companies. However, in the heavy sector, large-sized companies had more matured DM practices, outperforming small-sized companies.
- Companies classified under "Roofing and eavestroughing" had the most matured DM practices, followed by companies under "Building construction".
- Companies under "Roadwork" and "Pipeline construction" all under the heavy sector, had the least matured DM programs.
- Companies operating mostly in rural regions had more matured DM programs than companies located in urban areas.
- Further analysis showed statistically insignificant effects of company size, industry classification and geographic region on overall DM program maturity.
- At the industry and sector levels, "Disability Injury prevention", "Senior management support", and "Return to work" were the most mature indicators.
- While "Physical accessibility", and "Recruitment and retention" indicator were the least mature.
-
- Statistically significant strong correlations were found between the analytical hierarchy process (AHP) critically rankings of the indicators in the building and heavy sectors and industry maturity score rankings of the indicators respectively.

- The analysis found consistently across the industry, indicators that were deemed most critical to DM performance (AHP weightings), in practice performed better and had high maturity and vice versa.

This research is the first in Canada to develop and deploy an online DM/RTW benchmarking tool which construction companies can use to evaluate the maturity and performance of their programs, receiving assessment results immediately with tailored recommendations for continuous improvements. The research contributes to the existing body of knowledge by providing evidence-based guidance for stakeholders in the construction industry and provides third party assessment of DM measures to make the industry more inclusive. The project enabled the practical application of existing knowledge within DM in new ways that foster the rehabilitation and RTW of injured construction workers. It provides creative technological solutions that construction workplaces can use to evaluate and benchmark their DM and RTW performance. The online benchmarking tools are recommended to be promoted and continuously used throughout the industry as a proven way to track performance and encourage companies to improve their programs. This translates to better workplace outcomes such as: higher productivity, retention of valuable skilled labour, lower injuries, lower costs, motivated workforce, and a better overall workplace culture.

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1.0 INTRODUCTION

This chapter provides background information about the research with a specific focus on the conceptualization of construction industry, explaining the building and heavy construction sectors and disability management (DM). The chapter also describes the goal, objectives, and scope of the project.

1.1 Conceptualizing the Construction Industry

The construction industry, and its broader ecosystem, erects buildings, infrastructure, and industrial structures that are the foundation of our economies and are essential to our daily lives (Pheng and Hou 2019). It has successfully delivered ever more challenging projects, from undersea tunnels to skyscrapers emissions (McKinsey and Company, 2020). Today, construction projects, are high-tech, highly mechanized, and complex. A typical construction project is characterized by the consumption of numerous types of materials, variety of tools, equipment, plants, and machinery all working in tandem. Furthermore, several different contracting agencies, large and small, sub-contractors, petty contractors, vendors and suppliers, area specialists, consultants, supervisors, and managers, each with independent organizational setups, participating with complex interactions, working in cooperation and at times cross purposes *(ibid).* In addition, a construction site is highly interactive and complex environment with thousands of activities each of different nature arranged simultaneously. Many actions are undertaken sequentially or at random. Thus, the construction project today is much more complex than any other production process, manufacturing, or service industry (Adhikari et al., 2020).

Increasingly, construction projects are complex, and logistics must deal with heavy weight and many different parts. The construction industry is highly regulated, subject to everything from permits and approvals to safety and work-site controls, and lowest-price rules. Tenders make competition based on quality, reliability, or alternative design offerings more complicated (Pheng and Hou 2019, Adhikari et al. 2020). In response to these market characteristics, the industry contends with several dynamics that impede productivity and make change more difficult. Tailored projects with unique features and varying topology have a limited degree of repeatability and standardization. Local market structures and ease of entry have resulted in a fragmented landscape (both vertically and horizontally) of mostly small companies with limited economies of scale emissions (McKinsey and Company 2020, Cheruku et al. 2020). An important characteristic of the construction industry is its “one-of” nature. Each construction project is a "unique" project, vastly different in nature and type. In general, the employment pattern and working conditions are significantly different and unsophisticated when compared with other industries (Pheng and Hou, 2019). The working environment at these construction sites (temporary factories) is far more hazardous and demanding due to the rapidly changing nature of work sites, uncertainties of the natural environment, and fluctuating levels of heat, light, and sound. This is in complete contrast with the working conditions and controlled environment of manufacturing and other industries (Gamil and Alhagar 2020).

Working conditions in the construction industry have improved in many developed countries over past decades however, hard physical labor with frequent lifting and carrying heavy weight, static work, exposure to vibrations, climatic influences, noise, and dust still pose considerable difficulties for construction workers and may negatively affect their health. Construction work is also known for its high risk of fatal and non-fatal injuries. According to a survey conducted in Ontario, Canada,

the loss due to accidents in a particular year to the construction industry in a particular year was more than the total profit of all the contractors in Canada in that year (Abdalla et al. 2017). It is, therefore, imperative that a safe environment and hence, the safety precautions and safeguards must be very carefully studied, researched, and strictly enforced at construction sites. In Manitoba, the construction industry slowed in 2020 due to the broad economic impacts of COVID-19 and a lower demand for infrastructure. The decline marks the end of enduring expansion that outlasted many other provinces (Buildforce 2020). Declines in major-project requirements, alongside lower anticipated levels of institutional building and new-home construction are expected to limit employment growth for much of the decade. Modest growth in road, highway, and bridge construction, industrial buildings, and other infrastructure projects will partially offset these declines. Although overall employment is expected to see little change and over the next decade, the construction industry must remain focused on hiring, training, and retaining workers to replace workers, or nearly 20% of the current labor force, expected to retire by 2030 (ibid).

1.2 Building verses Heavy Construction Industries

The Canadian construction market is 5th largest market in the world and contributes to the 7% of the Canadian GDP. According to statistics-Canada, 'residential, commercial and infrastructure development' currently employs more than 1.2 million people and Ontario construction industry has a workforce of approximately 600,000. Owing to substantial differences in the types of projects, equipment, budgets, work force skills, and other inputs required by different sectors within the industry, the construction industry is divided into two main categories These subsectors are 'Construction of Buildings' and 'Heavy and Civil Engineering Construction', depending on whether the firms are primarily engaged in the construction of buildings or in heavy construction

and civil engineering projects. Establishments in these two subsectors are known by a variety of designations such as: general contractor, builder, construction manager, for example.

Building construction subsectors include: all general contractors and operative builders primarily engaged in the construction of residential, farm, industrial, commercial, or other buildings. Commercial construction involves the designing, renovating and building of commercial structures. Projects use heavy equipment funded by developers, as well as local and national governments (Ahiaga-Dagbui and Smith 2014). Developers and contractors compete for construction contracts by submitting proposal bids. The more detailed and accurate the plan, the better chances of winning the project. The size, budget and scope determine how much money it will cost to break ground and complete a build. Value engineering can also be used to predict the most accurate and cost-efficient project plan (Adhikari et al. 2020).

The heavy and civil construction subsector is made up of companies whose primary activity is the construction of entire engineering projects (e.g., highways and dams), and specialty trade contractors, whose primary activity is the production of a specific component for such projects. The heavy construction industry is comprised of companies engaged in large-scale building projects, chiefly infrastructure. A wide variety of corporations provide the planning, design, engineering, consulting, and construction expertise to complete such initiatives. Examples of construction projects include highways, ports, dams, cable and wireless networks, bridges, tunnels, water and sewer facilities, hydroelectric energy plants, railroads, and subways. Companies in the industry are also engaged in infrastructure repair and maintenance, as well as specialized projects such as the building and decommissioning of nuclear plants (Pheng and Hou, 2019). Specialty

trade contractors in this sector generally are performing activities that are specific to heavy and civil engineering construction projects and are not normally performed on typical buildings projects. The work performed may include new work, additions, alterations, or maintenance and repairs. Specialty trade activities are classified in this subsector if the skills and equipment present are specific to heavy or civil engineering construction projects. For example, specialized equipment is needed to paint lines on highways. This equipment is not normally used in building applications, so the activity is classified in this subsector. Construction projects involving water resources (e.g., dredging and land drainage) and projects involving open space improvement (e.g., parks and trails) are included in this subsector (Ahiaga-Dagbui and Smith 2014).

Moreover, due of the size of typical projects, the heavy sector exhibits several unique characteristics. The clients of heavy construction and engineering firms tend to be federal and state governments, cities, and municipalities. Procurement, the process by which such organizations bid out and award projects, can be exceedingly complex (and competitive) at this scale. Profits are realized in some cases over a span of years, and final profit margins can be slim, averaging just 2.5%. To a greater degree than in related industries (e.g., residential construction), work proposals require extensive estimates. Proposals based on a company's best guess as to costs of labor, materials, and subcontractors often get submitted years in advance of performance and are typically signed as "fixed-price contracts." As a result, long-term revenue and profit in this industry involve inherent uncertainty. For example, when discussing the risk of cost overruns in its 2013 annual report, Fluor Corp. stated that approximately 20% of its backlog value was tied to fixed-price contracts. Needless to say, successful companies develop fairly precise pricing and economic models to provide a margin of safety in project proposals.

The heavy construction sector in Canada is responsible for the building and subsequent maintenance of large-scale infrastructure, including mass transit systems, hydroelectric plants, outdoor facilities and areas, tunnels and various marine structures, among others. Industry performance is largely dependent on government investment in public infrastructure, private sector investment and, increasingly, demand from the energy sector. Over five years to 2020, operators have benefited from continuous government assistance in the form of stimulus spending, as well as investment in local and regional infrastructure. Growth in Canada's energy sector, particularly in hydro power, has also contributed to industry demand.

1.3 Analysis of the Construction industry: Relational Analysis to Safety, Innovation and Change

The longstanding reputation of the construction industry is that it operates in a somewhat traditional environment and generally retains a conservative corporate culture Source. The widespread perception is, that construction companies are not sufficiently progressive or forward-thinking (WEF, 2016) and this is unfortunately reflected in its injury management and return to work procedures. Source The construction industry’s strong cultural adherence to traditional ways of working, even though this sometimes has serious consequences for workers’ health or safety, is also reflected by low levels of innovation and the industry’s slow adoption of new perspectives, new tools, technologies, materials, and work methods (Von der Heyde et al. 2015, Lingard and Wakefeild, 2019). However, the spread of the digitalization has the potential to transform the whole industry. According to Chen et al. (2018), the construction continues to budget the least for information technology compared to other industries. It indicates that stakeholders have least

interest in investing in new technologies for their company. Although, some might argue that the extent of its contribution is not important and not as powerful as the other sectors. However, it has direct and significant contribution to GDP. In a nutshell, construction is a flat industry that supports the development of other industry (*ibid*).

Furthermore, the construction industry is increasingly affected by other emerging issues associated with the changing nature of work and demographic trends. These issues require that a broader view of the factors that impact workers' health and safety is taken (Lingard and Wakefeild, 2019, Borsting-Jacobsen et al. 2013). A report by WEF (2020) details that, the image that people have of the construction industry as an employer is a relatively poor one, with inadequate gender diversity and little job security, partly owing to the cyclical nature of the business. As a result, companies often struggle to attract and retain talented recruits to their workforce. Relative to companies in other industries, construction companies engage less often and less effectively in internal people-development initiatives (WEF, 2016, Chen et al. 2018). Skilled-labor shortages have become a major issue in several markets, and retirements will drain talent. For example, about 41 percent of the current US construction workforce is expected to retire by 2031. The impact the COVID-19 crisis will have on this dynamic in the long term is unclear currently. Requirements for sustainability, work-site safety and retaining workers through effective return to work (RTW) management are increasing. In the wake of COVID-19, new health and safety procedures will be required (McKinsey and Company, 2020).

The construction industry is well known as a male-dominated industry with a strongly masculine culture (Loosemore and Galea 2008; Nielson et al. 2015). Mearns and Yule (2009) and Nielson et al. (2015) report that industries characterized by a male-dominated, 'macho', 'can do' culture tend

to attract, accept, and retain workers who are inclined to take greater risks. The construction industry follows traditional work patterns and is characterized by a culture of long hours and weekend work, especially for site-based workers (Lingard and Wakefield, 2019, Lingard et al 2017a). This demanding work environment impacts construction workers' WHS and non- work life in a negative way. Lingard and Wakefield (2019) found that project-based construction workers experience high levels of work–family conflict and emotional exhaustion as a result of excessive job demands, including long and irregular work hours. Lingard et al. (2017b) reported Australian construction employees showed higher mean scores for time-based, strain-based, and behaviour-based work-interference with family (WIF) compared with scores reported in other international studies. They found those who work onsite in direct construction activity had higher levels of time-based and strain based WIF than salaried workers.

1.4 Construction Disability/Injury Management

Construction sites have specific work conditions that may lead to dangerous situations for employees, resulting in severe accidents and injuries (Chen et al. 2017, Eppenberger and Haupt 2003, Clarke et al. 2009, Tshobotlwane 2005) and temporary or permanent disability (Clarke et al. 2009). Statistics show that although time-loss injury rates of the construction industry in Manitoba have declined over the past decade from 5.8 in 2011 to 3.7 in 2019, the rates are still higher than the overall average records (WCB 2020).

The economics of human capital support an important role for disability management practice. Employees are often not easily replaced, and there are economic benefits in viewing and treating employees as valued resources (Caldwell, 1996). Work-related disability results in substantial costs to employers (Jetha et al. 2021), which can largely be minimized by implementing a

comprehensive safety program and having laid down procedures to manage injured workers, early intervention to tailored return to work program. Studies suggest that employees with disabilities are excluded from the industry mostly due to the industry's organization rather than the employees' disabilities (cf. Newton and Ormerod 2005, Clarke et al. 2009, Lingard and Saunders 2004). This emphasizes the need for appropriate measures to deal with the possible consequences and accommodate the affected employees (Quaigrain and Issa, 2021). In this context, Disability Management (DM) is defined as a set of needed measures and actions aiming to prevent disability and facilitate intervening after disability occurrence through prevention and remediation strategies. Although disability management (DM) in construction aims to address the industry's poor safety performance, the concept originally evolved out of a need to address discrimination against disabled people and their systematic under-representation in key areas of society, restricting their access to meaningful employment (Tshobotlwane 2005). The concept originated from that of older vocational rehabilitation programs for injured workers and gradually progressed to incorporate the return to work (RTW) model.

Some empirical evidence has been provided regarding the value of disability management in industry. Habeck et al. (1991) found that an organization's workers'-compensation experience may be affected by organizational factors and behaviors that can be controlled or at least influenced. More specifically, they found a lower incidence of workers'-compensation claims in organizations that were more actively involved in safety, in the prevention and management of work disabilities, and in open and participatory relationships with employees. In a subsequent study of a larger random sample of employers selected from a wider variety of industries, Habeck et al. (1998a) and Habeck et al. (1998b) found fewer incidents resulting in lost work days, fewer lost work days, and

fewer workers'-compensation claims in organizations that were more diligent and thorough in their safety efforts, devoted management time and resources to support prevention, took a proactive approach to return to work (beginning early and involving all concerned parties in the process), and created a work climate that values people. Disability management programs offer a mechanism by which business and industry may operationalize such policies, facilitating reductions in injuries and workers' compensation claims (Scully et al. 1999).

Detailed DM program covers all aspects of prevention, early intervention and proactive return to work (RTW) policies (Rosenthal et al. 2007). Therefore, DM works to accommodate employees with disabilities by guaranteeing successful job maintenance or RTW (Akabas et al. 1992, Westmorland and Buys 2004). The Accessibility for Manitobans with Disabilities Act aims to promote and integrate disability issue cross all sectors of the economy. Along with a number of service models, it lays out expectations for a comprehensive model for an integrated approach to disability management (Creen 2018). Recent changes to the Workplace Safety and Insurance Act will likely see employers facing increased overlapping occupational and nonoccupational cases in complex chronic mental health situations (Creen 2018). It may be a challenge to identify if the injury is substantially a work-place stressor and the predominant case of the diagnosis, or not. As these changes occur, it is important to have improved communication between those managing occupational and nonoccupational injuries/illness, and to have one integrated disability management approach.

RTW consists of off work, work re-entry, work retention, and work advancement phases (Young et al. 2005), and helps employees to stay at work, decreases work absence or helps employees

return to productivity. Researchers argue that an RTW program has been the most effective way to minimize the losses after the occurrence of an accident (Quaigrain and Issa 2021a, Waddell and Burton 2006). Through implementing successful RTW programs, injured workers reap health, well-being and financial benefits (Waddell and Burton 2006), workplace morale is improved, and costs are reduced (Shrey and Hursh 1999). In spite of the crucial role, the cost of workplace accommodations has made companies reluctant or unable to implement RTW (Tshobotlwane 2005, Rosenthal et al. 2005, Angeloni 2013). To establish an efficient DM model and RTW program, the constitutive elements need to be validated.

1.5 Goal and Objectives

The project goal is to provide the construction industry with free, accessible web-based tools that enable construction workplaces to benchmark their disability management (DM) and return to work (RTW) performance in order to support continuous improvement. Specific objectives of the project include:

1- Refine and validate the tools (i.e. the Construction Disability Management Maturity Model (CDM3) and metrics) developed in the previous research project

2- Develop free, accessible web-based versions of these tools that construction workplaces in MB can use to benchmark their DM and RTW performance

3- Deploy and promote the adoption of these tools by construction workplaces in Manitoba (MB)

4- Use these tools to evaluate the actual DM and RTW performance of the construction industry in Manitoba and disseminating results to the industry

1.6 Scope of Research

The project will focus on evaluating the MB construction industry. The project partnered with the Construction Safety Association of Manitoba (CSAM) and the Manitoba Heavy Construction Association (MHCA) to achieve these objectives given their strong support for the project. The tools were thus deployed and promoted within the building and heavy construction sectors in MB and adopted by local building and heavy contractors. The tools that were be refined and validated focuses on evaluating DM at the organizational rather than at the project level.

2.0 LITERATURE REVIEW

This chapter provides a detailed review of the relevant literature in the field. More specifically, this chapter includes a discussion of construction health and safety as well as the disabling nature of the construction industry. The chapter also discusses practical and empirical evidence of disability management (DM) as it pertains to the construction industry. The chapter also describes the history, theoretical foundations, and application of the concept of maturity modelling to the construction industry. This is preceded with a review of the methods used to benchmark construction safety and DM performance, focusing on the use of leading and lagging indicators of performance. The chapter concludes by reviewing in detail validation methods for leading and lagging indicators of performance.

2.1 Construction Health and Safety: Theoretical and Empirical Conceptualization

Nearly all construction sites are temporary in nature, and, during the construction process, people process, and structures are constantly changing (Pheng and Hou 2019). Construction processes involve hazard prone activities, such as working at height, manual handling, exposure to hazardous materials, demolition, frame erection, lifting operations, scaffolding and ground works, bulk materials and heavy equipment handling, as well as the varying jobsite personnel and the regularly changing worksites (Lingard et al. 2018, Sherratt 2016). The sector is fragmented, with projects characterized by substantial number of independent companies. For instance, a typical project would involve several sub-contractors, trades and firms, with varying influence on the overall project setup, working conditions and project outcomes. This organizational system often makes coordination, management and synergy difficult and complex. Roberts et al. (2013) and Lingard

and Wakefield (2019) characterize the industry as prototype in nature, symbolized by transient work and processes, low education levels of workforce, and high levels of subcontracting. According to the research, these elements are major contributing factors to the poor safety records within the construction industry.

The industry in developed economies such as USA, Australia, and the UK, have witnessed a steady downward trend in rates of non-fatal injury in the construction industry (Lingard and Wakefield 2019), which can be attributed to the standardization, prioritization and high regulation of safety practices. Conversely, the industry in developing countries continue to see disproportionately high work-related injuries and death as industrialization expands and the demand for infrastructure rapidly increases (Kheni et al. 2010, Lingard and Wakefield 2019). Interestingly, in both developed and developing economies, the same injury mechanisms and incident classifications are prevalent, meaning workers are still being injured in ways that are well-known and documented in national and international statistical reports (*ibid*). Although work-related injuries have decreased in many countries, on average, the construction industry's fatality rate remains relatively high, and some types of incidents have been resistant to change (Lingard 2017, Quaigrain 2019).

A review of the literature shows that in Canada, the construction industry at large was responsible for 28,111 time-loss injuries in 2019 and was thus the industry with the third highest number of time-loss injuries for that year (Association of Workers' Compensation Boards of Canada 2020). In Manitoba (MB) as a whole, the number of injuries decreased 18% in 2020 compared to 2019. Most of this decrease is likely due to the decline in economic activity resulting from COVID-19. The provincial time loss injury rate decreased from 3.2-time loss injuries per 100 workers in 2011

to 2.5 starting from year 2019 to 2020, which is a 22% decrease. The all-injury rate has also decreased from 6.8 in 2011 to 4.8 in 2020, which is a 29% decrease. The construction industry was responsible in 2020 for 1430 time-loss injuries, a decrease from 1596 time-loss injuries in 2019 (Safe Work Manitoba 2020).

Of those, the building industry accounted alone for 1187 and was thus the industry with the highest number of time-loss injuries on that year, whereas the heavy construction industry accounted for only 243. 26 fatalities related to the construction industry were reported in 2020 (ibid). These represented 22.4% of all fatalities in Manitoba even though the construction industry represented only 8.3% of the total workforce in Manitoba in 2020 (Safe Work Manitoba 2020). Despite a decrease in all injury rates from 4339 2011 to 2998 in 2020 for heavy and building construction respectively in MB, these rates were still higher than the overall average of 462 injured per industry in 2020. Building and heavy construction's all injury rates were also a lot higher than the provincial averages in 2020 and amounted. Ideally all construction organizations strive to achieve zero injuries, but incidents still occur. Snashall (2005) and Lingard and Wakefield (2019) purport that, because of the diversity of construction jobs and activities, almost every occupational illness has been recorded among construction workers. In designing safe (and healthy) systems of work, it is important to understand and address the interactions between people, equipment, structural components of buildings and other aspects of the built environment, including underground services, and the processes of construction.

Construction organizations are beginning to devote more effort to preventing occupational illnesses (Hopkinson et al. 2015). However, at the point of design decision making, significant

barriers remain impacting the effective control of occupational health hazards at source and through identification of risk mitigation measures. A systematic approach to managing OHS is critical to ensuring things are not left to chance and all hazards are identified, analyzed, and properly addressed. Glendon et al. (2006) argue the challenge lies in better understanding how technology, systems, and culture can be simultaneously considered, thereby creating the possibility of a more integrated approach to improving workers' health and safety.

2.2 Disabling Nature of Construction: Empirical and Practical Evidence

The construction industry, when compared with other labour-intensive industries, has historically experienced a disproportionately high rate of disabling injuries and fatalities for its size (Hinze et al. 2013, Lingard and Turner 2017). Despite improvements in occupational safety over the last decade, work-related accidents are still prevalent. According to Hopkins et al. (2015), there are a number of reasons why accident records within the construction industry compare poorly with those of the manufacturing industry.

The major cause of accidents is related to the unique nature of the construction industry, human behaviour, difficult work-site conditions, and poor safety management, which result in unsafe work methods, equipment, and procedures. The dynamic nature of construction is one of the major causes for various types of incidents resulting in injuries and fatalities in the construction industry (Hinze et al. 2013). In Contrast, within manufacturing, there is normally a controlled working environment, with little change in the working procedures and equipment over long periods; additionally, the labour force usually remains fairly constant. Hazards can be remedied with relative ease, and the danger mitigated. However, construction industry is quite different in the

working environment is constantly changing. The major cause of accidents is related to the unique nature of the industry, human behaviour, difficult work-site conditions, and poor safety management. This combination of factors results in unsafe work methods, equipment, and procedures. The dynamic nature of construction is one of the major causes for various types of incidents resulting in injuries and fatalities in the construction industry (Jespersen and Hasle 2017).

The argument has also been made that indicator of occupational safety performance are not good measures of how effectively process safety risks are being controlled (see, for example, Baker 2007). The point is often made by people studying high-risk production processes, such as those found in the oil and gas or nuclear energy industries, that unlike the majority of occupational safety risks, process safety risks have the potential to cause harm to workers and the general public on a very large scale. While these arguments have some validity, many work-related injuries and illnesses experienced by construction workers are very high in frequency yet are non-fatal (for example musculoskeletal issues). These injuries and illnesses cause significant pain, disability, and hard- ship for workers. They need to be the focus of concerted prevention efforts at the same time as managing risks associated with high-consequence failures (Lingard and Wakefield, 2019).

There has been growing support for an integrated approach to prevent injury and to advance health and wellbeing in the workforce (Anger et al. 2015; Pronk 2013; Sorensen et al. 2011). The move towards an integrated model of worker health recognizes that preventive occupational health programmes seek to manage specific components of workers' health which arise due to occupational health hazards (Lingard and Wakefield, 2019). The incidence of musculoskeletal disorders (MSDs) among construction workers is disproportionately high and contributes

significantly to work disability (Inyang et al. 2012). Between 2010 and 2019, acute and chronic MSDs declined from 41.1% to 33.6% (WCB 2020).

Risk factors commonly associated with work-related MSDs in construction workers are repetition, force, awkward posture, vibration, and contact stress. Despite the prevalence of occupational health risks in construction, the industry's health and safety management efforts remain heavily focused on preventing acute effect accidents; that is, the focus is on safety rather than health issues. The incidence of mental distress among construction workers is reported to be twice the level of the general male population (Borsting Jacobsen et al. 2013). Peterson and Zwerling (1998) similarly report construction workers experience a significantly higher incidence of emotional and psychiatric disorders than other manual, non-managerial workers in other industries. Psychosocial risk factors and work-related stress are a significant occupational health issue.

The presence of work-related psychosocial risk factors in the construction industry has been recognized for some time and could therefore be said to have well and truly emerged as an occupational health and safety phenomenon (Turner and Lingard 2016). For example, a six-year cohort study of bridge and tunnel construction workers who worked round the clock, long hours, and long weeks, had mortality com- parable to other construction workers but were treated more often in hospitals for infectious and parasitic diseases, diseases of the nervous system, diseases of the circulatory system, diseases of the respiratory system, diseases of the digestive system, and diseases of the musculoskeletal system and connective tissue (Tüchsen et al. 2005). Construction workers' concerns about job insecurity have also been linked to poor self- reported levels of mental

and physical health (Turner and Lingard 2016, Borsting Jacobsen et al. 2013, Lingard and Wakefield 2019)

2.3 Disability Management in Construction: Empirical Research

Empirical data are critical to understanding the practice of disability management in construction. Such data make it possible to describe the major functions, performance standards, and knowledge domains that are requisite to competent practice of DM (Jetha et al 2021, Lane et al. 2017). Empirical research on DM within construction is evolving within the industry, moving towards its prioritization as part of the overall health and safety strategy. Progress is needed regarding the inclusion of disabled employees as its generally perceived that people with disabilities do not have a place in the construction industry. This is due to its complexity and physical nature (Pheng and Hou 2019, Quaigrain and Issa 2021, Lingard and Saunders, 2004; Newton and Ormerod, 2005; Tshobotlwane, 2005).

Eppenberger and Haupt (2003) argue that construction workers were confronted with hazardous, life-threatening work environment that could lead to serious accidents and injuries. Most studies investigating DM used surveys to explore perceptions about the topic and investigate the use of specific DM accommodations. Using a survey, Lingard and Saunders (2004) investigated the DM practices of construction companies in Victoria, Australia. The study showed that small construction firms were less likely than medium-to-large ones to have formal DM practices in place. Responding firms found it difficult to provide appropriate alternate or light duties for workers following an injury. Most found DM practices to have increased operating costs while yielding little to no benefits in terms of reducing lost workdays.

Surveying the top 100 construction companies in the UK, Newton and Omerod (2005) found little to no formal practices in place to support construction workers with disabilities. However, most companies expressed their willingness to comply with existing legislation provided adjustments to do so were minor and inexpensive. A follow-up study by Ormerod and Newton (2013) investigated barriers faced by young disabled people entering the construction industry. The study revealed these young people were unlikely to think about a career in construction without proactive encouragement and support (Ormerod and Newton 2013). The study found that jobs for workers with disabilities automatically excluded "ladder climbing, walking on rough ground, tunneling, working at height, working in confined spaces, [and] working on the railways". The study revealed the need for an inclusive approach that would treat workers with disabilities equally rather than favourably. The industry also needs to raise awareness concerning the range of opportunities available to young workers with disabilities to address the myths that construction work was only for able-bodied, fit men. Another study by Tshobotlwane (2005) in South Africa recommended the incorporation of modified duties to gradually reintegrate workers on site.

This research is based on studies by Quaigrain (2019) and Issa and Quaigrain (2018). Using a web-based survey of 88 Manitoba building construction companies their work involved evaluating DM and RTW within the construction industry for injured workers returning to the work with a disability, in (Issa and Quaigrain 2018, Quaigrain 2019, Winter et al. 2015). The analysis of responses showed that only 4% of surveyed organizations employed more than 5% disabled workers. Musculoskeletal injuries were the most common disability encountered, followed by mobility and hearing impairments. The research also identified the lack of suitable modified or

alternate work to be the most significant barrier to DM yet identified.

Quaigrain (2019) also developed a maturity model: the Construction Disability Management Maturity Model (CDM3) to evaluate the maturity of construction organizations' DM and RTW practices using leading indicators of performance. It also defined new DM and RTW metrics to evaluate related performance using lagging indicators of performance (*ibid*). The model assessed 12 different DM and RTW indicators, using for each, a set of best practices that represented the performance benchmarks are compared against construction company practices. An assessment worksheet was developed to assess the 12 indicators making up the CDM3 using a total of 134 close-ended, Likert scale questions, with each indicator assessed using a specific number of questions. Each question represented a specific best practice, with each responding organization required to rate the extent to which it implemented this best practice using a range of responses ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). In line with those responses, the CDM3 defined five distinct maturity levels for each best practice and indicator. These maturity levels ranged from level 1 where a practice is ad-hoc and chaotic to level 5 where a practice has achieved highest maturity and is continuously improving.

The study implemented two tools (i.e. the CDM3 and the metrics) by applying them to a sample of ten building construction companies in MB. The study results revealed that of the ten companies evaluated, "Return to Work" and "Disability and Injury Management" practices were the most important DM and RTW indicators whereas "Physical Accessibility" and "Claims Management" practices were the least important. The ten construction companies operated at the quantitatively managed maturity level. The findings also revealed that smaller-sized companies were more

mature on average with respect to DM and RTW than larger companies. “Senior Management Support” and “Disability and Injury Prevention” were found to be the most mature DM and RTW indicators while “Retention and Recruitment” and “Communication” practices were the least mature. The findings also showed that companies with higher DM and RTW maturity tended to record lower recordable injury rates, lower severity rates and lower lost time case rates, and thus have higher safety performance than companies with lower DM and RTW maturity. Nevertheless, the relationships between various DM and RTW performance indicators, and various safety performance indicators were not statistically significant for the most part, most probably because of the small number of companies evaluated. The study however had number of limitations, the indicators, and practices inherent in the CDM3 were not formally validated within the industry. Also, the 12 DM metrics did not adequately cover all areas within DM and the proposed metrics were also not formally validated.

2.4 Performance Benchmarking: Using Leading and Lagging Indicators

The regular measurement of DM performance enables the regular identification and resolution of safety issues. This enables proactive DM decision-making and drives continuous improvement (Lingard et al. 2017a). One method to evaluate DM performance is the use of metrics. Lingard et al. (2017b) noted that health and safety (H&S) performance metrics can measure different aspects of the safety process such as positive safety actions, individual behaviours and the effectiveness of safety management tasks. The performance metrics derived from these safety preventive actions can help fix weaknesses or address precursors before incidents occur (Guo et al. 2016, Hinze et al. 2013, Orogun 2020) noted that H&S performance metrics can be active or passive. Passive metrics of H&S performance are those that provide an indication of the potential H&S performance to be

realized on a project. For instance, a passive metrics of potential H&S 155 performance could be the percentage of subcontractors selected, in part, on the basis of satisfactory historical safety performance. Such metrics provide little information about the day-to-day activities taking place to assess and improve jobsite safety. On the other hand, active measures of H&S performance are those that are subject to change within a short period and can provide warning on the deteriorating state of safety and thus the need for interventions

The terms ‘lag’ and ‘lead’ have been applied to different types of performance indicators for workplace health and safety. These terms were borrowed from economic and financial modelling. In economics, a lead indicator is something that changes before the economy changes; for example, building permit approvals and stock prices (Wreathall 2009). Incident or injury frequency rates, lost time injury frequency rates (LTIFRs) are the most frequently used lagging indicator of safety performance in the construction industry. The usefulness and validity of so-called lag indicators, including injury frequency rates, have been challenged. However, these measures have been criticized as being statistically meaningless and focusing too much attention on the absence of negatives rather than the presence of positives in relation to workplace health and safety (Dekker and Pitzer 2016). There has been a shift in emphasis towards measures of system safety that are expected to lead changes in the incident rate. These measures are sometimes based on the frequency or quality of health and safety management activities, and sometimes based on workers’ perceptions of the state of safety in the work environment (Lingard and Wakefield, 2019). Fundamentally, incident/injury rates are retrospective indicators capturing factors that have already gone wrong. They measure the absence, rather than the presence, of safety (Arezes and Miguel 2003). The reliance on incident rates as the method of monitoring safety and DM

performance can have serious consequences. For example, Lofquist (2010) describes how relying on incidents as a safety indicator resulted in the failure to recognize a marked deterioration in safety that occurred in the Norwegian civil aviation industry during a period of organizational change. Decisions about which indicators should be used to measure an organization or project's health and safety performance are ultimately informed by one's understanding or beliefs about what constitutes and explains workplace health and/or safety (Reiman and Pietkäinen 2012).

Alternative measures take various forms. For example, third-party audits have been used to measure the extent to which organizational safety and DM management systems are compliant with pre- existing standards. Other measurement approaches involve quantifying the direct causes of accidents, such as hardware failures or operational errors (Mohaghegh and Mosleh 2009), measuring the prevailing safety climate, and predicting safety behaviour and outcomes using leading indicators (Quaigrain and Issa, 2021b, Lingard et al. 2017, Mearns et al. 2003, Nielsen et al. 2015). These measures are less prevalent in the measurement of DM performance. Composite measures of workplace health and safety performance that combine traditional lag indicators with positive indicators of management activity (leading indicators) and safety climate measures have been developed and used to evaluate the health and safety performance of large infrastructure construction projects (Lingard et al. 2017a, 2017b, Quaigrain and Issa 2021a:2021b, Orogun 2020). Positive indicators of health and safety management activities have been labelled lead indicators.

Orogun (2020) suggests safety incidents may be considered as lag indicators of organizational safety performance, but as lead indicators when they are reported to a safety regulator and used to

inform policies for prevention. Lead indicators of safety, and thus DM have also been described as 'precursors to harm that provide early warning signs of potential failure' (Shea et al. 2016). Salas and Hallowell (2016) used lead indicators to develop a predictive model for providing early warning signs of changes in a construction contractor's safety management performance. These approaches show that lead indicators can be both positive (for example, management activity) or negative (for example, early warning signs)

2.5 Maturity Modelling Conceptualization

The concept of maturity modelling was developed by the Software Engineering Institute to improve the way software is built and maintained (Paulk at al. 1995). The concept has since been used in other areas such as project management, human resources, quality management and construction (Kerrigan 2013, Domingues et al. 2016, Tahria and Drissi-Kaitouni 2015, Klimko 2001). Maturity modelling involves defining different maturity stages that evaluate the completeness of analyzed processes in an organization via different sets of multi-dimensional attributes (Wendler 2012). Quality Management Maturity Grid (QMMG) was first developed by Philip Crosby in 1979 (Wendler 2012). In the QMMG, Crosby argued that organizations evolve through five stages of quality maturity as they approach the maximum level of quality in all phases of organizational activity. The QMMG was later adapted for process improvement and used to develop the Capability Maturity Model (CMM) by the Carnegie-Mellon Software Engineering Institute in 1986, (Paulk et al. 1995). The CMM enables software companies to select process improvement strategies by determining current process maturity and process improvement using five levels. These five maturity levels provide the foundations for continuous process improvement (Paulk et al. 1995).

2.6 Maturity Modelling Application within Construction

Maturity modelling has been adopted in the construction industry for various purposes, one of which is to improve the industry's health and safety performance. Integrating the maturity modelling concept into construction health and safety, and specifically DM is important because of the heterogeneity in DM/RTW standards and practices. Maturity modelling can help companies in the early stages of developing a DM program to develop practices and standards that are comprehensive. It can also help organizations with established DM programs to develop practices and standards that are continuously improving (Fleming 2001, Quaigrain and Issa 2021a). A maturity model can help these companies determine the maturity level of their DM programs and identify areas in need of improvement.

In the construction industry, a review of the literature reveal that a number maturity models have been developed as tools of organizational development. Vaidyanathan and Howell (2007) developed the Construction Supply Chain Maturity Model (CSCMM) to improve the performance of construction supply chains. The CSCMM defines four maturity levels: 1) Ad-hoc, 2) defined, 3) managed, and 4) controlled and assesses the construction supply chain business process based on the four key dimensions of process, technology, strategy and value. Sarshar et al. (1998) developed the Standardized Process Improvement for Construction Enterprises Model (SPICE) to improve the management of construction processes by assessing an organization's key processes against the five process elements of commitment, ability, verification, evaluation and activities. The SPICE consists of five maturity levels: 1) "initial", 2) "planned and tracked", 3) "well defined", 4) "quantitatively controlled" and 5) "continually improving".

Willis and Rankin (2011) defined the Construction Industry Macro Maturity Model (CIM3) to assess management practices within the construction industry based on the three maturity levels of 1) “immature”, 2) “transitional mature “and 3) “mature”. The CIM3 was based on the concept of process improvement used in the CMM. One of the first maturity models proposed to assess safety was the Dupont Bradley Curve. The model defined four stages: 1) reactive, 2) dependent, 3) independent and 4) interdependent (Foster and Hoult 2013). In the “reactive” stage, people do not take responsibility. In the “dependent” stage, there is emphasis on management control with focus on written rules and procedures. In the “independent” stage, there is strong focus on personal responsibility for safety whereas in the “interdependent” stage, the focus is on team commitment to safety, which requires everyone to have a shared sense of responsibility for safety (Foster and Hoult 2013). Maturity modelling has also been applied in the field of construction H&S in a limited manner. For instance, Goggin and Rankin (2009) proposed a H&S maturity model using AHP and expert judgement and applied it to four construction organizations to evaluate the maturity of their H&S practices. The study assessed six key factors such as “policy and standards”, “management commitment”, ‘worker involvement”, “Hazard management”, “working environment” and defined four maturity levels which are: 1) failing maturity, 2) low maturity, 3) intermediate maturity and 4) high maturity. However, the model focused on assessing organizational rather than projects’ H&S performance

Also, Karakhan et al. (2018) developed a decision-making maturity framework based on factor analysis to evaluate, on a quantitative basis the safety maturity of construction contractors before the award of a contract. The framework assessed seven safety maturity factors: “safety leading

indicators", "safety lagging indicators (i.e. LTCR, RIR)", "safety and supervisory personnel", "system maturity and resiliency", "preconstruction services and technology", "innovation" and was applied to assess five construction companies. The maturity scale of the framework was based on the "importance of advantage (IoA)" score which places the competing companies on a maturity scale ranging from "most preferred" to "least preferred.

Additionally, Oswald and Lingard (2019) developed a Frontline Health and Safety Leadership Maturity Model to assess the ability of construction frontline leaders to ensure that H&S practices are implemented onsite. The model focuses on evaluating three key areas influencing frontline leadership at the project site. The key areas include the foreman and subcontractor supervisor relationship, the foreman and workers relationship, and the leadership styles of the foreman and supervisor. The model defined three maturity stages which are: 1) "lacking in H&S preparation", 2) "adopts a cooperative approach", and 3) "actively participating in H&S". A major limitation of the model is that it has limited application because it focuses on just one aspect of site safety management which is project leadership commitment while ignoring other important aspects such as safety training, workers' behaviour and safety communication.

Also, Endroyo et al. (2017) developed a Maturity Index of Pre-construction Safety Planning (MIPSAP) to evaluate the maturity of safety planning on design-bid-build medium-rise projects. The MIPSAP evaluates the maturity of safety planning using four levels which are 1) "not very mature", 2) "not mature", 3) "mature" and 4) "very mature". The index bases its assessment on 27 elements of pre-construction safety planning. The elements were defined with respect to the roles of owners, consultants, contractors and stakeholders in pre-project safety planning.

A major limitation of the model is that it does not consider other important elements of site safety management such as risk and hazard management, safety communication, workers behaviour and safety control. Again, Albert et al. (2013) developed a safety meeting quality measurement (SMQM) maturity model to improve hazard recognition performance and encourage communication based on the plan-do assess-adjust progression of hazard management. The model focused on assessing nine elements of hazard identification which are: gravity, motion, electrical, mechanical, temperature, pressure, chemical, radiation and sound, using three maturity levels: 1) "least mature", 2) "less mature" and 3) "mature". However, the maturity model has very limited application, as it does not consider other vital aspects of site safety management such as site safety behaviour, safety control and management commitment.

Poghosyana et al. (2020) developed a Design for Occupational H&S Capability Maturity Model to assess the ability of design consultants to implement design for safety. The model defined five maturity levels: from Levels 1 to 5 and assessed 18 designs for safety attributes grouped into six categories: "corporate experience", "competence", "collaboration", "infrastructure', "strategy' and "systems". A major limitation of the tool is that it has limited application during a project's construction phase as it ignores factors that influence site safety management. Also, Santoso et al. (2018) developed the Safety Maturity Model for Construction Organizations which used the Delphi approach and a questionnaire survey to assess construction organizations' safety maturity based on the five maturity levels of 1) "basic", 2) "reactive', 3) "compliant", 4) "proactive" and 5) "resilient". The model assessed safety maturity based on five factors such as "HSE documentation", "document control", "accident investigation", "leadership' and "skill development". However, the model has very limited application, similar to the one proposed by

Goggin and Rankin (2009). Orogun (2020) noted that maturity models can be used both as an assessment tool and as an improvement tool. Focus groups, interviews, or questionnaires can be used to develop maturity models that would function as an assessment or diagnostic tool. The assessment of maturity is structured around a matrix or grid, where levels of maturity are allocated against key aspects of performance or attributes. However, when the maturity model is not applied, it falls short of being an effective improvement tool. When applied, it generates recommendations for improvement that can be used to reach higher maturity levels and performance (Quaigrain 2019).

2.7 Validation Methods for Practices, Indicators and Metrics

Validation reflects the generalizability of the results achieved through the implemented research tools (Lucko and Rojas 2009). Validation methods widely used in the literature and in the construction industry in particular include face validity, content validity, criterion validity, and construct validity (Lucko and Rojas 2009). Face validity relies on experts to assess and evaluate the practicality, relevance and applicability of the research tools using surveys or interviews. Surveys are conducted by distributing one-off questionnaires (one round of surveying) or implementing the Delphi method (Expert judgement/Face validity).

Content validity is a non-statistical procedure which assesses the relevance of the research tools and data in regard to the established theory within the field. In criterion validation, researchers evaluate the correlation between the results obtained by their research instrument and the outcomes of other related studies. Construct validity addresses a critical question: whether the research

method is working as claimed and measuring the items it is supposed to measure. Conducting a pilot study is one of the main methods used to assess construct validity (Lucko and Rojas 2009).

Rajendran and Gambatese (2009) developed a rating system for sustainable construction health and safety and collected data from 25 construction projects to validate the system using construct validity by evaluating the correlation between the companies' records and the developed system. The study collected injury rate data and tested whether there was a negative correlation between that data and the total credits achieved using the developed rating system. In another study, Hughes et al. (2004) developed a survey to investigate project managers' perception of project success. The study evaluated the survey's validity by collecting data from three completed construction projects for which objective success metrics (i.e., actual cost, schedule, and safety performance data) were available. The project managers of these projects were asked to participate in the survey and rank the level of success in their projects. The researchers compared the metrics and the subjective assessment results and concluded that their proposed tool was valid and reliable.

Hwang et al. (2008) developed a set of metrics to benchmark the performance of pharmaceutical construction projects. The study validated the metrics by collecting data from 40 projects, as well as using expert's judgment (face validity). The validation process showed that the metrics were reliable, and the results of the data collected were consistent with the industry's expectations. Experts were used to assess the distribution of data collected for the metrics based on criteria such as means, medians, and quartiles. The study assumed the metrics were reasonable and valid if those statistical measures were within the industry's acceptable ranges. As an additional validity, 29 experts participated in a short survey to assess the completeness, applicability, relevance, and

effectiveness of the metrics. In the study, construct validity involved evaluating the statistical distribution of collected data, and face validation entailed surveying experts to confirm the metrics. Rankin et al (2008) developed project performance metrics and validated them by collecting data from 37 projects through interviewing the owners. Although they concluded that the metrics were defined reasonably, obtaining historical data was a concern. Unlike metrics such as cost, time, scope and safety information, data for other metrics like quality, innovation and sustainability were not always available. Similarly, Rui et al. (2017) developed 47 metrics related to cost, schedule, safety, production, and quantity to evaluate the performance of offshore oil and gas projects. They assessed the applicability and credibility of metrics by collecting data from 62 projects and surveying 40 industry experts. In the next step, they refined the initial metrics based on the received feedback. This feedback showed that participants agreed on the effectiveness of most metrics. Orgut et al. (2018) developed metrics to predict the performance of projects and validated them by collecting data from 44 projects, including the difference between actual and planned cost and duration. The study applied the Delphi method to refine the initial metrics and determine core ones. The results showed that applying more core metrics correlated with better cost operation??.

The Delphi validation method seeks strong consensus of experts' judgment through a series of surveys or interviews (Rajendran and Gambatese 2009). At least two rounds of data collection are conducted to achieve agreement on the importance and relevance of items (Lucko and Roja 2009). In the first round, experts participate in a survey or interview to assess items based on their judgment. Next, the researchers provide the aggregate collected data to each expert to review, in order to generate a consensus (Lucko and Rojas 2009). This means that each expert can see the result of other experts' answers and decide on whether to change their opinion accordingly.

Researchers suggest that the minimum number of experts and rounds should be seven and two respectively (Alomari et al. 2018), respectively. To obtain independent feedback, the panel of experts are anonymous throughout the process. The iterative procedure of receiving initial feedback and recirculating it helps reduce or remove variation of answers (Tengan and Aigbavboa 2018). Accurate selection of qualified panelists (e.g., managers, academics, and industry professionals) based on their knowledge and expertise is critical (Chan et al. 2001).

While Delphi is used in different contexts such as health, social, and behavioural sciences (Boateng et al. 2009), this is one of the main validation methods implemented in construction research. It has been used mainly when evaluating construction projects' performance and safety levels. For example, Zahhor et al. (2015) invited 20 experts and performed two rounds of Delphi to investigate the relationship between safety climate and safety performance in the construction of multi-story buildings in Pakistan. This research showed that aspects such as "safety training and safety budget", "diverse perspective of stakeholders and ineffective communication", and "productivity versus safety" were ignored on construction sites.

Tengan and Aigbavboa (2018) applied the Delphi technique to validate the items affecting monitoring and evaluation of construction sites, in Ghana. A total of 11 participated in a two-step process and agreed on 14 elements affecting the monitoring and evaluation procedure. Alomari et al. (2018) implemented the Delphi technique to study the impact of risk factors on workers' safety. Twenty-one specialists identified site conditions, human, ergonomic, organizational, environmental, psychological, social, and economic factors as the most to least important

elements, after three rounds. Gao et al. (2018) administrated a two-round Delphi to rank barriers to safety in international construction projects. Overall, 26 experts mostly from Southeast Asia, the Middle East, and Africa participated in this research. The study found such barriers to include "labor-only subcontracting and complex labor structure", "low safety awareness of local workers", and the "inability of Chinese workers who work far from home to adapt to a boring lifestyle in overseas projects".

3.0 METHODOLOGY

This chapter provides an overview of the overall methodology adopted for this research. This is followed by a detailed description of the methods used to accomplish each of the four research objectives.

3.1 Overall Research Philosophy and Approach

The study reviewed methodologies of previous studies and uses them as a guide for research design and methodology. A review of methodologies is useful for examining research methodologies of previous related published and unpublished literature, thereby giving some direction, and understanding to the study. It also helps to widen the researcher's understanding in research design, as it guides the selection of a suitable research methodology.

The philosophical approach adopted for this research is positivist. Adopting a positivistic stance not only means embracing certain approaches to the design of research studies, but it also implies that the results of the research will tend to be presented as objective facts and established truths (Edwards et al. 2020). The project used a mixed-method approach based on quantitative and qualitative data collection methods. Using mixed research approach often enables the researcher the opportunity to compensate for inherent method weakness of one method, with the inherent strengths of the other method, and thus offsetting inevitable method biases posed when either method is used separately (Quaigrain and Issa, 2019). The project established a Project Advisory Committee (PAC) of six members to guide the team through key project activities. The PAC was made mainly of representatives from the University of Manitoba, the CSAM and the MHCA. The project formed in consultation with the PAC two technical working groups (TWGs) of five to eight

members each to work on specific project activities. One adopted the perspective of the MB building sector and be made of local building sector representatives; the other represented the MB heavy construction sector and include local heavy construction sector representatives.

3.2 Refinement and validation of the Construction Disability Management Model and DM Metrics

The project involved validating and refining the CDM3 and DM metrics developed in the previous research project conducted by Quaigrain and Issa (2021a). The validation of the developed tools was conducted from two distinct perspectives, that is, from the building construction and heavy construction sectors. This is to ensure the finalised indicators, practice and metrics inherent in the finalized tools reflect the unique characteristics of these respective sectors within the construction industry. This was an underlying limitation of the previous study by Quaigrain (2019), who assessed DM performance of the industry as a whole without accounting for the uniqueness in these two sectors, which intrinsically affects their respective approaches to DM and RTW.

3.2.1 Overview of the Construction Disability Management Model

The Construction Disability Management Maturity Model (CDM3) aims to define key DM best practices and evaluate the maturity of construction company's DM practices. The model has 12 indicators. These indicators symbolize clusters of related activities and regulations, known as practices, which when performed and adhered to should enable the achievement continual and progressive performance. The model assumes that higher maturity of the indicators and its practices translates to higher levels of RTW performance. The CMD3 has five distinct levels of maturity and is determined by the level of implementation of the specific practices. The five

distinct maturity levels are; level 1-Ad-hoc and Chaotic, level 2-Planned and Managed, Level 3-Standardized, Level 4-Quantitatively Measured, and level 5-Continuously Refined (Quaigrain and Issa, 2021).

3.2.2 Refinement Criteria

The refinement of the DM indicators and practices uses constant comparative analysis based on Grounded theory (Glaser and Strauss 1967, Strauss and Corbin, 1990). Constant comparative analysis is a method for analyzing data in order to develop a Grounded theory. The goal of the Grounded theory approach is to generate theories that explain how some aspect of the social world works, in this case DM (Glaser and Strauss 1967, Strauss and Corbin, 1990). Glaser and Strauss (1967) developed classical Grounded theory as an inductive approach to challenge the restrictiveness of the hypothetico-deductive approach by allowing theory to be developed from organizing and reducing data. The hypothetico-deductive approach simply, is a research method which theorizes about how things function and derives testable hypotheses from it (Strauss and Corbin, 1990). Constant comparative analysis method is an iterative and inductive process of reducing the data through constant recoding (Glaser and Strauss, 1967). Incidents or data are compared to one another during the coding process. This process begins with open coding to develop categories from the first round of data reduction, followed by further reducing and recoding to allow possible core categories to emerge (Glaser and Strauss, 1967, Strauss, 1987). By using this approach, the researcher is able to do develop more condensed practices more or less inductively by categorizing, coding, delineating categories and connecting them (Boeije 2002).

In conducting constant comparative analysis, Morse and Field (1998) state that each piece of data, in this case "practice", must be compared with every other piece of relevant data. According to Strauss and Corbin (1998), the art of comparison involves a creative process signified by an interplay between the data. The data or practices reduction aspect of the process involves selection, simplification, abstraction and transformation of the raw data (Miles and Huberman 1994). This is a form of analysis that can be used to combine pieces of information into categories (Kolb 2012). The benefit of using this method is that although the researcher begins with raw data; through constant comparisons, a substantive theory emerges (Glaser & Strauss 1967). Therefore, constant comparative analysis is a labor-intensive task that requires the researcher to invest time in the data collection and analysis processes (Quaigrain and Issa, 2018).

3.2.3 Validation Criteria

Researchers have used criteria such as 'completeness', 'applicability', 'relevance', and 'appropriateness' to assess the validity of their developed research tools using experts' judgement (Hwang et al. 2008). 'Relevance' has been the most studied criterion, while 'applicability', 'appropriateness' and 'comprehensiveness' have been less discussed. Schamber et al. (1990) conducted a study about the definition and assessment of 'relevance'. One of the main definitions covered by the study was the gage (e.g., degree, extent) of an aspect (e.g., matching) existing between an object judged (e.g., metrics) and a frame of reference (e.g., DM benchmarking in this study), judged by an assessor (e.g., experts). Therefore, assessing 'relevance' involved judging the quality of the relationship between the object to be judged and a frame of reference. Barry (1994) and Barry and Schamber (1998) categorized 'obtainability' and 'availability' as 'relevance' criteria. However, these two items should be considered as applicability measures as they are

linked to the extent to which it is possible to collect data for a series of developed indicators and metrics. Hearnshaw et al. (2001) considered ‘appropriateness’ to be part of ‘relevance’ and listed different components such as criteria definition and data collection feasibility as desirable characteristics of reviewing criteria. Pulcini et al (2006) described ‘comprehensiveness’ as the degree to which the criteria were complete and included all needed components. Also, they measured ‘relevance’ based on a four-point scale, from 1 “not relevant” to 4 “highly relevant.” Dunn at al (1999) explained that, ‘relevance’ is the degree to which the content to be tested is representative of the "targeted construct".

3.2.4 Refinement of Indicators and Practices

As discussed, the refinement of the DM indicators and practices uses constant comparative analysis. The overall aim was to generate DM practices that explained how DM works in specific industries, which are concise and easy to understand and implement. The process sort to assess the relevance and appropriateness of the practices against the nature and characteristics of the construction industry, whilst comparing practices applicable in each indicator and across indicators. This generally involved analyzing which practices assessed and encompassed similar characteristics, narrow them down and merge them where appropriate. In refining the practices, the study used the following steps: (1) comparing practices applicable to each indicator, (2) categorizing the practices where appropriate, (3) determining the limits and boundaries of the practice categories, and (4) re-writing the practices” (Glaser and Strauss 1967). Throughout the four stages of refining the practices, the study continually sorted through the DM practices and indicators, analyzing and coding the DM practices through the process of theoretical sampling. These steps were repeated 5 times until the researchers were content with the finalized practices

to be validated by experts within the industry. As a result of the process, the study went from 134 previously developed DM practices categorized under 12 DM indicators (Issa and Quaigrain 2018) to 98 refined practices categorized under 11 DM indicators. Table 2 shows the refined DM practices to be validated under the indicator. Table 1 shows the 11 refined DM indicators to be validated.

Table 1: Refined DM Indicators

Indicators	**Definition**
Communication practices (CP)	These practices aim to provide information to all employees on disability, injury and safety in the workplace, along with specific information about the strategy of the organization with respect to health and safety.
Case management practices (CMP)	These practices aim to plan, implement, coordinate, monitor and evaluate the options and services required to meet employee health and rehabilitation needs.
Return to work and accommodation practices (RAP)	These practices aim to integrate injured or disabled employees back to the workplace by providing services such as job needs assessment and modified work.
Claims management practices (CLP)	These practices aim to manage claims related to occupational and non-occupational injuries or illnesses that may entitle individual employees to long-term disability benefits.
Disability and injury prevention practices (DIP)	These practices aim to provide preventative measures to alleviate injuries and educate employees on these aspects before the occurrence of disabling injuries.
Physical accessibility management practices (PAP)	These practices aim to improve the physical accessibility of construction workplaces to employees with disabilities and as such cover physical workplace accessibility requirements.
Senior management support practices (SMP)	These practices aim to provide continuous and consistent support from senior management to ensure the effective implementation of DM programs.
Program evaluation practices (PEP)	These practices aim to assess DM procedures, regulations and practices within the organization.
Regulatory and compliance policies (RCP)	These policies aim to ensure the compliance of practices developed by construction workplaces to accommodate injured and disabled employees with existing guidance at the federal and provincial levels.
Recruitment and retention policies (RRP)	These policies aim to assess the recruitment process of employees by construction workplaces as well as the procedures in place to ensure the retention of injured employees. The principle of non-discrimination should be respected throughout the process.
Ergonomic practices (EP)	These practices aim to ensure the design of work processes and spaces that minimize injuries, complaints, staff turnover and work absenteeism.

Table 2: Finalized Refined DM Practices

Code	DM Practices
	Communication Practices (CP)
CP1	A DM/RTW communication plan is defined as part of the organization's DM/RTW program.
CP2	DM/ RTW in the workplace is brought to the attention of all employees in a language that can be easily understood.
CP3	Communication is open and employees feel free to voice their concerns and make suggestions about DM/ RTW.
CP4	Employees affected by the DM/ RTW program are provided with appropriate information in a timely manner.
CP5	Employees receive regular DM/ RTW training/ education.
CP6	Employees are informed of DM/ RTW program changes in a timely manner.
CP7	Employees are involved in the development of the DM program, specifically parts that directly affect them.
CP8	Employees' knowledge about DM/ RTW is assessed on a regular basis.
CP9	Effectiveness of the DM/ RTW communication plan is assessed and improved based on the outcomes.
	Case Management Practices (CMP)
CMP1	Injured employees are contacted shortly following an injury and offered DM/ RTW services and support.
CMP2	Regular communication is maintained with injured employees' physicians to facilitate their RTW.
CMP3	An initial functional abilities assessment is conducted for injured employees following their injuries in a timely manner.
CMP4	A job assessment is conducted for injured employees following their injuries in a timely manner.
CMP5	When off work, injured employees are contacted on a regular basis to assess their ability to RTW.
CMP6	There's a process in place for finalizing rehabilitations decisions when there are disagreements about them.
CMP7	A case manager is appointed for severe injured employee cases.
CMP8	For active injured employee cases, the DM/ RTW practitioner maintains regular communication with all relevant stakeholders (e.g. DM/ RTW committee, work supervisors).
CMP9	Case management processes for injured employees are evaluated and improved on a regular basis.
CMP10	Case management processes for injured employees comply with governing legislation.
	Return to Work Practices (RAP)
RAP1	The organization has a written RTW program that is clear and simple to understand.
RAP2	The organization involves employees in formulating its RTW program.
RAP3	The organization has a person responsible for DM/RTW or hires third parties' entities (EAP)

RAP4	The DM/ RTW practitioner receives regular DM/ RTW training/ education.
RAP5	DM/RTW role candidates/ or third parties' entities (EAP) are assessed prior to hiring to ensure they have the required knowledge and skills.
RAP6	The job description of the DM/ RTW practitioner position emphasizes DM/ RTW duties.
RAP7	A functional abilities assessment is conducted for injured employees to develop a tailored rehabilitation and/ or RTW plan.
RAP8	A collaborative approach is used to develop a tailored rehabilitation and/ or RTW plan for injured employees.
RAP9	A general job assessment is completed for each job in the workplace to facilitate the development of RTW plans for injured employees.
RAP10	An individual job assessment is conducted for injured employees as part of their RTW plan to determine the specific physical and mental demands of jobs.
RAP11	Job modifications/alternative job placements are identified in line with injured employees' functional abilities assessment results.
RAP12	The organization provides productive and meaningful modified work to injured employees in a timely manner.
RAP13	Modified work provided to injured employees aims to eventually move them to their regular positions.
RAP14	A vocational assessment is conducted for injured employees who are unable to return to their regular positions to identify alternative job placements for them.
RAP15	The organization actively monitors injured, ill or at-risk employees to determine if they should be referred to the DM/ RTW program.
	Claims Management Practices (CMP)
CLP1	Claims management practices are clearly defined in the workplace DM program.
CLP2	Claims management is well coordinated from initial injury to claim resolution.
CLP3	Long duration claims are evaluated to determine whether more intensive services are required.
CLP4	The current claims management program is designed to support early intervention and RTW.
	Disability and Injury Prevention Practices (DIP)
DIP1	DM prevention goals and strategies are clearly defined in the organizations' health and safety/DM program.
DIP2	The DM program includes interventions aimed at reducing workplace injuries and accidents.
DIP3	The organization provides first-aid services to employees and ensures the availability of first-aid kits
DIP4	The organization has qualified first-aid attendants available during regular working hours.
DIP5	The organization has a program promoting employee health and wellness/ stress management.
DIP6	The employee health and wellness/stress management program provides incentives to encourage participation in them.
DIP7	The organization has an injury prevention program.
DIP8	The organization allocates a budget for its injury prevention program.
DIP9	Employees participate in training programs designed to enhance workplace safety.

DIP10	The organization's health and safety policy complies with governing legislation.
DIP11	The organization has a formal reporting system that encourages employees to report their safety concerns.
DIP12	The organization frequently reviews employee's knowledge and understanding of health and safety procedures.
DIP13	The organization responds to health and safety issues promptly and initiates required changes.
DIP14	Equipment, Materials and Resources (EMR) health and safety requirements are considered during health and safety planning.
DIP15	Defective EMR is replaced/repaired immediately upon detection of defects, with the cause investigated.
DIP16	The organization implements and monitors a hazard prevention program.
DIP17	Safety hazards are investigated in order to reduce/eliminate them.
DIP18	Hazard management procedures are communicated to employees in a timely manner.
DIP19	Hazard statistics and incident data are tracked and reviewed regularly.
	Physical Accessibility Management Practices (PAP)
PAP1	The organization has well trained staff to safely evacuate the workplace in an emergency.
PAP2	Staff training programs include evacuation techniques and assistance for disabled and elderly employees.
PAP3	The organization investigates additional physical support that will help accommodate a new recruit.
PAP4	The organization modifies workstations in advance of a new disabled employees' starting date.
PAP5	The organization modifies the workstations of injured/disabled employees to enable RTW.
PAP6	The organization's office premises incorporate physical accessibility features such as lifts, ramps and rails.
	Program Evaluation Practices (PEP)
PEP1	The organization maintains injury and illness data.
PEP2	The organization uses the injury and illness data to identify problem areas and address them accordingly.
PEP3	The organization evaluates the outcomes of their employee health and wellness/ stress management program.
PEP4	Periodic meetings are held for managers whereby injury and illness data patterns are reviewed.
PEP5	The organization tracks costs associated with its DM/RTW program.
PEP6	The organization uses its injury and illness data and tracked costs to improve its DM/RTW program.
PEP7	The organization monitors and evaluates injured employees who RTW.
PEP8	Employees have access to their RTW evaluations.
PEP9	The organization evaluates the effectiveness of their DM/RTW program at regular intervals and make improvements where required.
PEP10	to the organization evaluates the impact of its DM/RTW interventions.

PEP11	The organization ensures the confidentiality of injured employees' data when evaluating its DM/RTW program.
	Senior Management Support Practices (SMP)
SMP1	Senior management is actively involved in the DM/RTW program.
SMP2	The DM practitioner receives support from senior management.
SMP3	Senior management spends time and money on improving DM/RTW performance.
SMP4	Senior management considers DM/RTW as much as other project goals in the execution of projects.
	Regulatory and Compliance Polices (RCP)
RCP1	The organization considers DM/RTW an integral part of its human resource development strategy.
RCP2	The DM/RTW program is formulated in accordance with governing legislation.
RCP3	The DM/RTW program accommodates employees who are already disabled.
	Recruitment and Retention Polices (RRP)
RRP1	The organization hires people with disabilities.
RRP2	The organization ensures that all possible accommodations are in place, when hiring employees with disabilities.
RRP3	Alternative ways of testing candidate's skills are available to enable equal/fair opportunities.
RRP4	Recruitment staff are trained to handle issues involving equal opportunity, diversity and disability.
RRP5	A disabled employee or DM expert is part of the recruitment panel.
RRP6	During interviews, applicants with disabilities are invited to identify any specific accommodations they might require at work.
RRP7	The same recruitment assessment process is used for disabled and non-disabled candidates.
RRP8	Recruitment process is assessed as to whether people with disabilities are overrepresented in rejection decisions for positions.
RRP9	The organization ensures confidentiality when dealing with employees' disabilities.
	Ergonomic Practices (EP)
EP1	Ergonomic interventions are used to improve workstations/ work areas.
EP2	Jobs are designed to reduce heavy lifting.
EP3	Jobs are designed to limit repetitive movement.
EP4	Work rotations or changes in job responsibilities are used to minimize exposure to ergonomic risks.
EP5	Ergonomic factors are considered when purchasing new tools, equipment, or furniture.
EP6	Ergonomic factors are considered when providing modified work to injured employees.
EP7	The organization provides training on ergonomics to minimize the risk of injury.
EP8	The organization evaluates ergonomic interventions to determine if they were successful.

3.2.5 Refinement and Development of New DM Metrics

In regards metrics development, Guo et al. (2016) postulated that performance metrics should not be chosen because they are easily observable and available, but because they are functional. They further advocated that the development of these metrics should be knowledge driven, based on model (i.e. CDM3) that is appropriate for the construction industry. Consequently, in the process of refining and analyzing the practices and indicators inherent in the model CDM3, the study used the model indicators and practices as a foundation to generate and conceptualize measurable quantitative measures to benchmark DM performance using lagging indicators. In deriving the DM performance metrics from the CDM3, there was a need to take into consideration the causal relationships between the DM practices and DM outcomes. The CDM3 adopts a socio-technical system view of DM. In this context, DM requires the presence of certain key critical practices from which the DM performance metrics were derived. Because the performance metrics were developed from the indicators constituting the CDMS, their conceptual validity depended on the validity of the indicators. These indicators were based on a detailed literature review and thus based on solid and sound empirical evidence. The DM performance metrics validation was done by expert judgement as suggested by Bockstaller and Girardin (2003). The validation process addressed the conceptual and end use dimensions of the performance metrics (Rajendran 2013, Guo et al. 2015). Therefore, the previously developed 12 metrics (Quaigrain, 2019: Quaigrain and Issa, 2021b) were revised and simplified, with new metrics developed and added to them, resulting in a total of 26 DM metrics conceptualized and developed for the study. Table 3 shows the developed DM metrics categorized under their respective DM indicators.

Table 3: Refined and Conceptualized DM Metrics

Metric	Definition	Formula	Indicators
DM1	Percentage of employees who are DM/ RTW practitioners	(Total number of DM/RTW practitioners/ Total number of employees*100)	Communication Practices
DM2	Percentage of employees involved in DM/ RTW planning	(Total number of employees involved in DM/ RTW planning/ Total number of employees) *100	Communication Practices
DM3	Percentage of employees who received DM/ RTW training	(Total number of employees who received DM/ RTW training/Total number of employees*100)	Communication Practices
DM4	Percentage of DM/RTW practitioners who received training	(Total number of DM/RTW practitioners who received training/ Total number of DM/RTW practitioners *100)	Return to Work and Accommodation Practices
DM5	Percentage of employees who returned back to work from injury leave	(Total number of employees who returned from injury leave / Total number of injured employees) *100	Return to work and accommodation Practices
DM6	Percentage of injured employees who required case management	(Total number of injured employees who required case management/ Total number of injured employees) *100	Case management, Program evaluation
DM7	Percentage of injured employees who are away on injury leave	(Total number of injured employees who are away on injury leave / Total number of employees) *100	Return to work and accommodation, Program evaluation
DM8	Percentage of injured employees who actively participated in the development of their individual RTW plans	(Total number of injured employees who actively participated in the development of their individual RTW plans/ Total number of injured employees who require RTW plans *100)	Return to Work and Accommodation Practices
DM9	Percentage of injured employees who were placed on modified work	(Total number of injured employees placed on modified work/ Total number of injured employees) *100	Return to work and accommodation, Program evaluation
DM10	Percentage of employees who transitioned from temporary work to their original work	(Total number of employees who transitioned from temporary work to their original work / Total number of employees placed on temporary work) *100	Return to work and accommodation, Program evaluation
DM11	Percentage of injured employees whose job were modified	(Total number of injured employees whose job were modified / Total number of injured employees who required job modifications *100)	Return to Work and Accommodation Practices

DM12	Frequency of how quickly injured employees were contacted following the onset of injury	(Sum of total time taken to contact injured employees following their injuries/ Total number of injured employees *100)	Case Management Practices
DM13	Percentage of injured employees whose functional abilities form was filled out	(Total number of injured employees whose functional abilities form was filled out / Total number of injured employees *100)	Case Management Practices
DM14	Percentage of employees who received any type of physical accommodation	(Total number of employees who received any type of physical accommodation / Total number of employees who required any type of physical accommodation *100)	Physical Accessibility Management Practices
DM15	Percentage of injured employees whose workstations were physically modified	(Total number of injured employees whose workstations were physically modified / Total number of injured employees who required physical workstation modifications *100)	Physical Accessibility Management Practices
DM16	Percentage of employees who received health and wellness/stress management training	(Total number of employees who received health and wellness/stress management training / Total number of employees *100)	Disability and Injury Prevention Practices
DM17	Frequency of overall DM program evaluations	(Number of DM program evaluations conducted per year)	Program Evaluation Management
DM18	Ratio of cost of DM/ RTW claims against number of claims	(Cost of DM/ RTW claims/Number of claims)	Claims management Practices
DM19	Percentage of disabled employees in the organization	(Total number of disabled employees/ Total number of employees *100)	Recruitment and Retention Polices
DM20	Percentage of hiring committees that include a DM/RTW practitioner	(Total number of hiring committees that include a DM/RTW practitioner/ Total number of hiring committees *100)	Recruitment and Retention Polices
DM21	Percentage of hiring staff trained in Equity Diversity and Inclusion (EDI Training)	(Total number of hiring staff trained in EDI / Total number of hiring staff *100)	Recruitment and Retention Polices
DM22	Percentage of injured workers retained following the onset of injury	(Total number of injured employees retained following the onset of injury/ Total number of injured employees *100)	Recruitment and Retention Polices
DM23	Percentage of employees doing physical work who are trained on ergonomic practices	(Total number of employees doing physical work who are trained on ergonomic practices/ Total number of employees doing physical work	Ergonomic Practices

		*100)	
DM24	Percentage of employees who received ergonomic accommodations	(Total number of employees who received ergonomic accommodations / Total number of employees who required ergonomic accommodations *100)	Ergonomic Practices
DM25	Percentage of jobs designed to reduce heavy lifting and repetitive movement	(Total number of jobs designed to reduce heavy lifting and repetitive movement/ Total number of jobs that include heavy lifting and repetitive movement *100)	Ergonomic Practices
DM26	Percentage of new tools, equipment, or furniture that incorporate ergonomic principles	(Total amount of money spent to buy new tools, equipment, or furniture that incorporate ergonomic principles/ Total amount of money spent to buy new tools, equipment, or furniture *100)	Ergonomic Practices

3.2.6 Validation Surveys: Development and Data Collection

In this study, the target construct is DM benchmarking, and the content to be tested are the developed DM indicators, practices and metrics. The model indicator, practices and DM metrics were validated conceptually using expert judgement to determine their content validity. Expert judgement has been extensively used to conduct validation within constriction management research (cf. Guo et al. 2016, Mohammadi et al. 2018). In line with the literature review of relevant materials, surveys were developed to validate the DM indicators, practices and metrics based on a 5-point Likert scale ranging from “Strongly disagree” to Strongly Agree”. The study developed three separate surveys to validate the indicators, practices and metrics, respectively. The corresponding surveys will be filled out for each of the indicators, practices and metrics. The validation surveys for the indicators and metrics encompassed four validation criteria: ‘relevance’, ‘practicality’, ‘appropriateness’, and ‘uniqueness’. ‘Relevance’ refers to the extent to which the metrics or indicators measure and reflect DM and RTW performance in construction (Schamber

et al. 1990). 'Practicality' is the extent to which the metrics or indicators can be easily applied and tracked in practice (Barry and Schamber 1998). 'Appropriateness' indicates the extent to which the metrics or indicators are reliable and verifiable (Hearnshaw et al. 2001). Lastly, 'uniqueness' evaluates the extent to which the metrics or indicators do not replicate other defined DM metrics or indicators. The DM indicators and metrics validation surveys include 16 and 15 questions, respectively. The questions were adapted from existing validation questions in the health sciences (Hearnshaw et al. 2001, Barry and Schamber 1998, Pulcini et al. 2006), given their leadership in the area of validation. Table 4 and 5 below illustrate the validation questions used to assess the indicators and metrics respectively. The validation survey for the refined practices used the criteria of 'relevance', 'conciseness' or 'clarity', 'appropriateness' and 'uniqueness'. 'Conciseness' or 'clarity' refers to the extent to which the practice can be easily understood and implemented. The study's validation data collection and analysis methods were reviewed and approved by the University of Manitoba Research Ethics Board.

Table 4: Validation Criteria and Questions for DM Indicators (Communication Practices (CP) Indicator)

Relevance
1. Implementing CP in construction companies is important.
2. All CP's key practices fit to its title and definition.
3. CP specifies DM maturity in construction companies.
4. It is useful to use CP as a DM maturity index in construction companies.
5. CP is a representative of how to evaluate DM maturity in construction companies.
6. Assessing CP's application level fits the purpose of benchmarking DM performance.
7. Assessing CP can help improving DM performance in construction companies.
Practicability
8. Implementing all CP's key practices is easy for every construction company.
9. Implementing all CP's key practices is practical for every construction company.
10. Implementing CP's practices may need training in the company level.
11. Implementing CP in construction companies may have some other prerequisites.

12. Evaluating CP's implementation level can be done for an acceptable sample size of construction companies.
13. If CP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.
Appropriateness
14. The result of CP implementation level will be reliable.
15. The result of CP implementation level will be verifiable
Uniqueness
16. CP does not replicate existing DM Indicators

Table 5: Validation Criteria and Questions for DM Metrics (DM1 Metric)

Relevance
1. Tracking DM1 is important for every construction company.
2. Tracking DM1 can help improving DM performance in every construction company.
3. DM1 has been defined well/in unambiguous terms and is understandable.
4. DM1's definition includes clear explanation of its variables.
5. It is useful to use DM1 as a DM performance measure in construction companies.
6. DM1 is a representative of evaluating DM performance in construction companies.
Practicability
7. Tracking DM1 is easy for every construction company.
8. Tracking DM1 is practical for every construction company.
9. Tracking DM1 by construction companies may need training in the company level.
10. Tracking DM1 by construction companies may have some requirements (other than training).
11. Collecting DM1's values from each construction company will be easy.
12. Collecting DM1's values from each construction company will be practical.
13. Collecting DM1's values from each construction company can be done over a reasonable period.
14. Collecting DM1's values can be done for any size of construction company.
Appropriateness
15. Data collected for DM1 in construction companies is reliable.

Two technical working groups (TWGs) of experienced industry experts conducted the validation of the indicators, practices and metrics. These groups were formed in collaboration with the project's partners: the Construction Safety Association of Manitoba (CSAM) and the Manitoba Heavy Construction association (MHCA). One TWG represented the building sector and include local building experts. The other represented the heavy construction sector and include local heavy

construction experts. These two different TWGs were needed because the building and heavy construction sectors may not have the exact same needs and requirements when it comes to DM and RTW. Therefore, there was a need to develop two versions of the DM maturity model and metrics: one for each sector.

Expert inclusion criteria for the two TWGs included working knowledge of disability management and health and safety in the construction industry, with at least 5 years working experience in the field. Participants must also have worked actively in the construction industry. Due to the level of information required from participants, that is, ranking the importance of DM indicators and how they affect overall performance and validating the indicators and importance and practicality of the developed DM metrics, participants must have the relevant experiences. Potential experts were asked to identify if they meet these criteria. Due diligence was conducted to ensure all potential participants have the required knowledge and experience to validate the practices, indicators, metrics and conduct the AHP. Experts were recruited from around MB for their experience and in-depth knowledge of the construction industry, of health and safety and DM within the construction industry. Each of the project's partners provided names of potential experts who meet this criterion and could become part of these TWGs. In all, building sector TWG was made up of seven experts, and the heavy sector TWG was made up of five experts. Table 6 summarizes the characteristics of the experts making up the two TWGs.

Table 6: Technical Working Group for Building and Heavy Sectors

Expert	Position	Years of Experience
Building Construction Sector TWG		
1	Regional Health and Safety Manager	18
2	Senior Health and Safety Manager	17
3	Health and Safety Manager	13
4	Executive Director	25
5	Health and Safety Training Expert	11
6	Health and Safety Manager	21
7	Health and Safety Manager	20
Heavy Construction Sector TWG		
1	Executive Director	25
2	Senior Health and Safety Manager	18
3	Senior Health and Safety Manager	23
4	Health and Safety Manager	29
5	Health and Safety Training Expert	13

The validation process involved administering the validation surveys (for indicators, practices and metrics) shown in Appendix A individually to each expert in separate meetings. In conducting the validation, each expert assessed each indicator, practice, and metric separately, with the identity of each member kept private from the rest of the group. This is to ensure the confidentiality of the experts and minimize response bias. Data collection was done either online, by email or in person. Each expert was required to review and sign a consent form before filling out the validation surveys. A detailed description of each indicator, practice, metric and validation Likert scale responses were also given to each participant. The entire data collection process took around 2 hours to 3 hours for each expert to complete all validation surveys.

3.2.6 Validation of Indicators: Analytical Hierarchy Process

As part of the validation process, experts in the two TWGs were asked to participate in the AHP to rate the DM indicators based on their level of importance. As part of the implementation and DM performance benchmarking using the CDM3, the indicators inherent in the model must be weighted based on their overall critically and influence on overall DM performance, which is done using AHP (see appendix B). This is a key precept in the develop of performance benchmarking models based on the maturity model theory (Willies and Rankin, 2011). This was previously conducted as part of initial developed model (cf. Quaigrain, 2019, Quaigrain and Issa 2017). With the in-depth refinement of the model indicators from 12 to 11, it is imperative to reassess the weighting of the indicators again.

Briefly, AHP is an analytic decision-making process used to select the best alternative among a number of alternatives, in this case, the DM indicators. The AHP introduced by Saaty (1980) is an effective tool for dealing with multiple criteria and setting priorities. It allows users to determine the relative weights of importance of different variables through their pairwise comparisons (Saaty 1987, Quaigrain and Issa 2017). The AHP has three main methodological functions, which are: structuring complexity, measurement, and synthesis (Forman and Gass 2001). AHP identifies the first function as the different factors that affect the decision in a hierarchical structure (Forman and Gass 2001). The second function, measurement is obtained by comparing those factors in pairs in a process called absolute comparison. The third function, the priorities (i.e., weights) are determined by multiplying the priority of one factor by the priority of the other compared factor. The computations made by the AHP are always guided by decision makers' experience. In construction H&S research, Goggin and Rankin (2009) applied the AHP to rank the six factors

constituting the H&S maturity model they developed to evaluate an organization's H&S maturity. Reyes et al. (2014) used an AHP to rank the set of H&S criteria making up the Integrated Value Model for Sustainability Assessment

In this study, the same experts for both building and heavy sectors who participated in the survey were invited to participate in AHP sessions to rank the indicators based on their level of importance to overall DM performance. They were asked to make pairwise comparisons of the indicators systematically using a nine-point fundamental scale from "equal importance" (1) to "extreme importance" (9). Appendix D includes the AHP instruction sheet to be used by participants to familiarize themselves with AHP process and conduct the pairwise comparison of the indicators. The experts were asked to carry out the comparisons of the 11 indicators by determining their level of importance to each of the indicators, using the nine-point scale. The pairwise comparisons conducted by each participant produced a pairwise comparison matrix.

3.2.7 Data Analysis

Once the data was collected, each of the validation survey's responses was analyzed. For the practice validation survey, experts were allowed to suggest new practices. Each new practice would be included if it was suggested by at least two thirds of the experts in either the building or heavy TWG. An existing practice would be removed if it received an average rating below 3 (i.e., neutral) across the four validation criteria. If a practice had an average rating of 3 and above on average but less than 3 in the clarity criterion, the practice would be retained but revised to make it clearer and more concise. This is in line with other validation studies such as Rajendran and Gambatese (2009), Hwang et al. (2008) and Lucko and Roja (2009). For the indicators and metrics,

a similar approach will be adopted. An indicator or metric will be retained if it received an average rating of 3 and above across the four validation criteria.

Orugun (2020) and Oertel (2001) suggested using a range of values from a category of responses, to evaluate the level of agreement of participating experts. This approach was found to be useful when analyzing the extent of experts' agreement with the ratings of the indicators and metrics.

$$Agreement\ \% = (Total\ number\ of\ H\&S\ experts\ indicating\ agree\ or\ strongly\ agree)/\ (Total\ number\ of\ responding\ experts) * 100$$

The research also involved examining the relationship between AHP evaluation of the indicators and their validation scores. This entailed the use of SPSS Statistics to carry out correlation analysis of the relationship between AHP rankings of the indicators and expert agreement percentage and validation score of the indicators.

3.3 Developing free, accessible web-based versions of these tools that construction workplaces in MB can use to benchmark their DM and RTW performance

The refined and validated indicators, practices and metrics formed the basis for the development of the web-based DM benchmarking tool. The design and development of the web-based tool that construction workplaces can use to evaluate and benchmark their DM and RTW performance was done in collaboration with an interactive local digital media company in Manitoba: Bit Space Development. Bit Space Development were hired to act as the technology coordinator for the

project and to design and develop the final web-based version of the tools based on those requirements.

Two distinct tools were developed, one for the building sector of the construction industry and one for the heavy sector of the construction industry. Each tool was hosted separately by the safety association representing them, that is, for the building sector the construction safety association of Manitoba (CSAM) and Manitoba heavy construction association (MHCA) Worksafely^{TM}. In the CSAM and MHCA, the tools were integrated into the association's websites, under the "Resources tap "to be available to all members. The web-based DM/RTW benchmarking tools enable companies receive to assessment results immediately, providing each with empirical evidence about their actual performance in comparison to past performance and to average industry performance.

This immediate feedback allowed companies to identify their most effective DM and return to work (RTW) practices and ones in need of improvement. The tool also defines DM and RTW best practices that should help improve the maturity of DM and RTW practices. The assessment tool also identify specific actions companies can take to ensure continuous improvement of their DM and RTW performance. Upon logging onto the digital benchmarking tool, the questionnaire making up the CDM3 will be made available to companies, together with the data collection form for the developed and validated DM metrics. The web-based DM benchmarking tool enables the archiving of every company's log in history, their historical responses to the questionnaire or metrics and their assessment results. Only the research team has access to the individual responses

of every company, which are all aggregated and anonymized to ensure company data confidentiality.

3.3.1 Web-based Tool Development

Development of the tool was done in collaboration with a local IT firm made of three developers. The development altogether took 10 months from inception to pilot ready. The head of the development team and head of Bit Space development were part of the project's PAC, which meant they were part of the project from the very inception, ensuring all decisions were feasible for the eventual developed online tool. The research team worked with the Bit Space team to develop each aspect of the tool, from companies creating accounts, to filling out demographics, creating login username and passwords to eventually accessing the tool to take the survey and metrics to assess their companies DM/RTW performance. The research team met regularly with the developers to review the tools as they were being developed to ensure it meet all the requirements. The following subsections discusses each aspect of the digital benchmarking tools in detail.

3.3.1.1 Web-based DM Benchmarking Tool: Hosting Interface

To access the online building and heavy sector DM/RTW benchmarking tools, companies are required to set up an account, either on the "Building Sector DM/RTW Benchmarking Tool" or "Heavy Sector DM/RTW Benchmarking Tool". The "Building Sector DM/RTW Benchmarking Tool" the tool was integrated in CSAM's website and the "Heavy Sector DM/RTW Benchmarking Tool" integrated into MHCA Website. To access the tool, companies go to their respective association websites, and under the "Resources Tap" click on "Return to Work Benchmarking

Tool" to access the page on which the link to the tool is. The links to these pages on CSAM and MHCH websites are listed below. Figures 1 and 2 below shows a screenshot of these pages.

Links to DM benchmarking tools on associations pages:

Building Sector Tool on CSAM website: [RETURN TO WORK BENCHMARKING TOOL (constructionsafety.ca)]

Heavy Sector Tool on MHCA website: [Return to work tool - MHCA WORKSAFELY®]

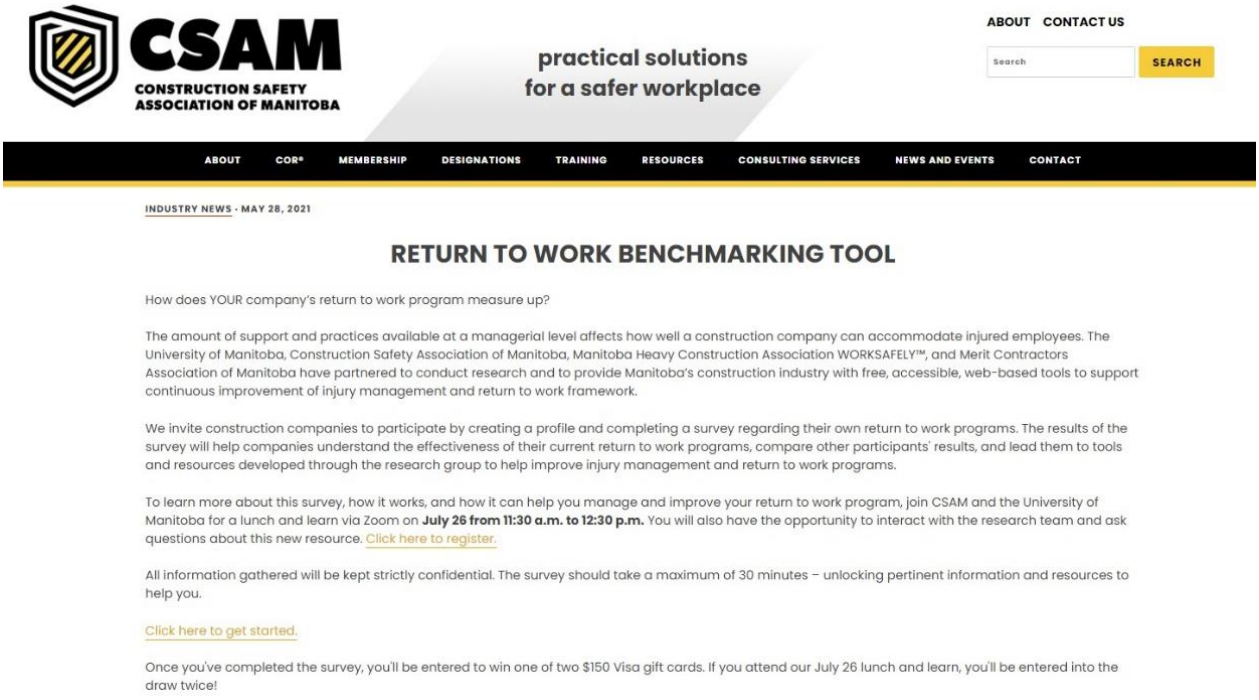


Figure 1: Building Sector Tool on CSAM Website

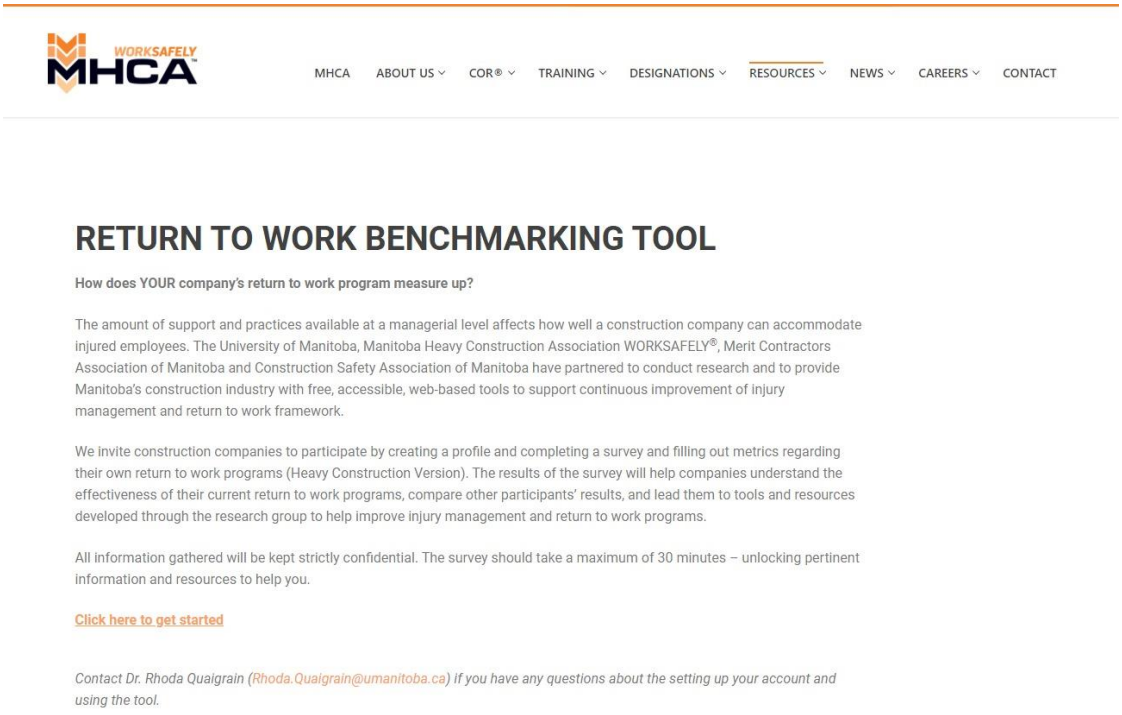


Figure 2: Heavy Sector Tool on MHCA Website

3.3.1.2 Web-based DM Benchmarking Tool: Login, Creating Account and Demographics

To access the DM benchmarking tools, companies must create accounts on the respective tool applicable to them, either on the "Building Sector DM/RTW Benchmarking Tool" or the "Heavy Sector DM/RTW Benchmarking Tool". The accounts ensure companies information, data and performance assessments are all in one place, accessible only with the unique username and password created by that company. Links to the actual tool pages where companies set up accounts are listed below. Figure 3 shows a screenshot of the login page companies see once they click on the links below.

Building Version: https://tools.bitspacedevelopment.com/accept-company-invitation/?dD1jNmZhMzUyOS1hMzM2LTQ4YmUtYWI0MC05ZmI5MDdjODk2NWImYz0z

Heavy Version: https://tools.bitspacedevelopment.com/accept-company-invitation/?dD01ZGYwNDUwYy0zZjE4LTQzNTMtOTlhMC01MDI5ZGUxYjg3MWMmYz00

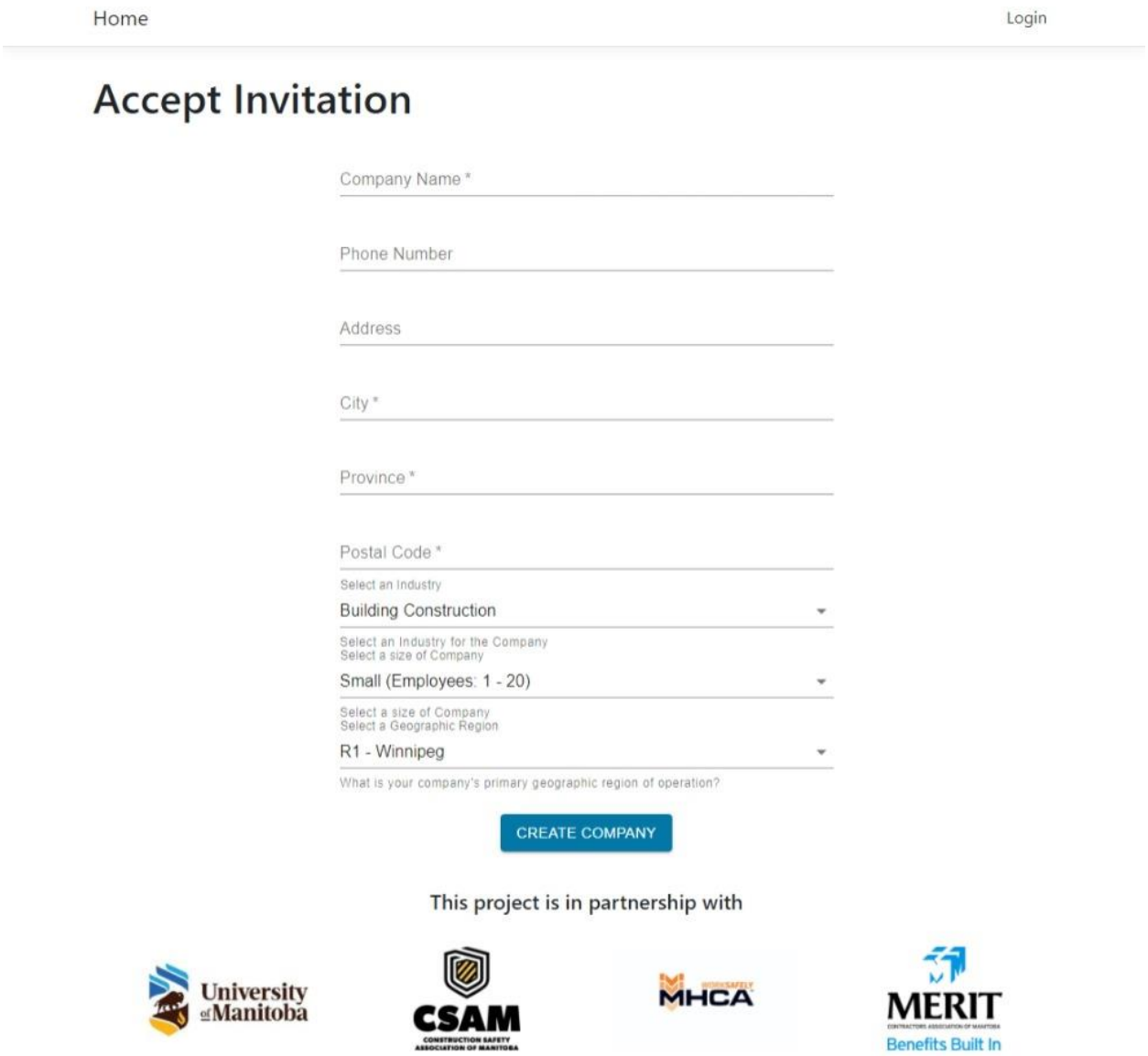


Figure 3: Login and Create Account page for the Building and Heavy DM Tool

To create an account, companies must specify their company name, address, complete the demographics and create a username and password. Once these have been filled, they would receive an email confirmation of their account being created. From there, companies can simply use their username and password to access the tool. For the demographics, companies specify, the

which sector of the industry they identify most with, the size of their company (that is classified by number of employees) and the geographic regions the companies mostly operate in. The industry classification, company size and geographic region options have shown in Table 7 below.

Table 7: Demographics for industry classification, company size and geographic region

Industry Classification	**Company Size**	**Geographic region**
Building construction	Small-(1-20 Employees)	R1-Winnipeg
Floor and tiling	Medium (21-50 Employees)	R2-Brandon & Steinbach
Installing metal products	Large-(51+ Employees)	R3-Portage, Selkirk & Mordern-Winkler
Painting and decorating		
Wrecking and moving buildings		R4-Pas, Flin Flon, Thom & Swan River
Drywall, doors and windows		
Concrete work		R5-Dauphin & Neepawa
Installing case good and fixtures		R6-North Rural
Landscaping		R7-South Rural
Electrical contracting		R8- Out of Province
Plumbing, insulating and mechanical		
Roofing and eaves troughing		
Constructing dams, wharves, bridges, and steel		
Installing elevators		
Installing heavy machinery		
Sewer and water construction		
Pipeline construction		
Excavation, foundations, installing pools and tanks		
Piling and underwater construction		
Trenching and drainage		
Roadwork		
Gravel and stone pits		
Equipment contracting		
Tower and energy construction		
Railway construction		

3.3.1.3 Web-based DM Benchmarking Tool: Home Page

Once companies set up accounts, they can now access the tool using their username and password. Once in the tool, companies are asked to read and sign an informed consent which describes the project and tools details as well handling of data and company information, which are all encrypted back-to-back so only aggregated data is available to the researchers and tool developers. Once completed, they are taken to the "Home page" of the tool shown in figure 4 below.

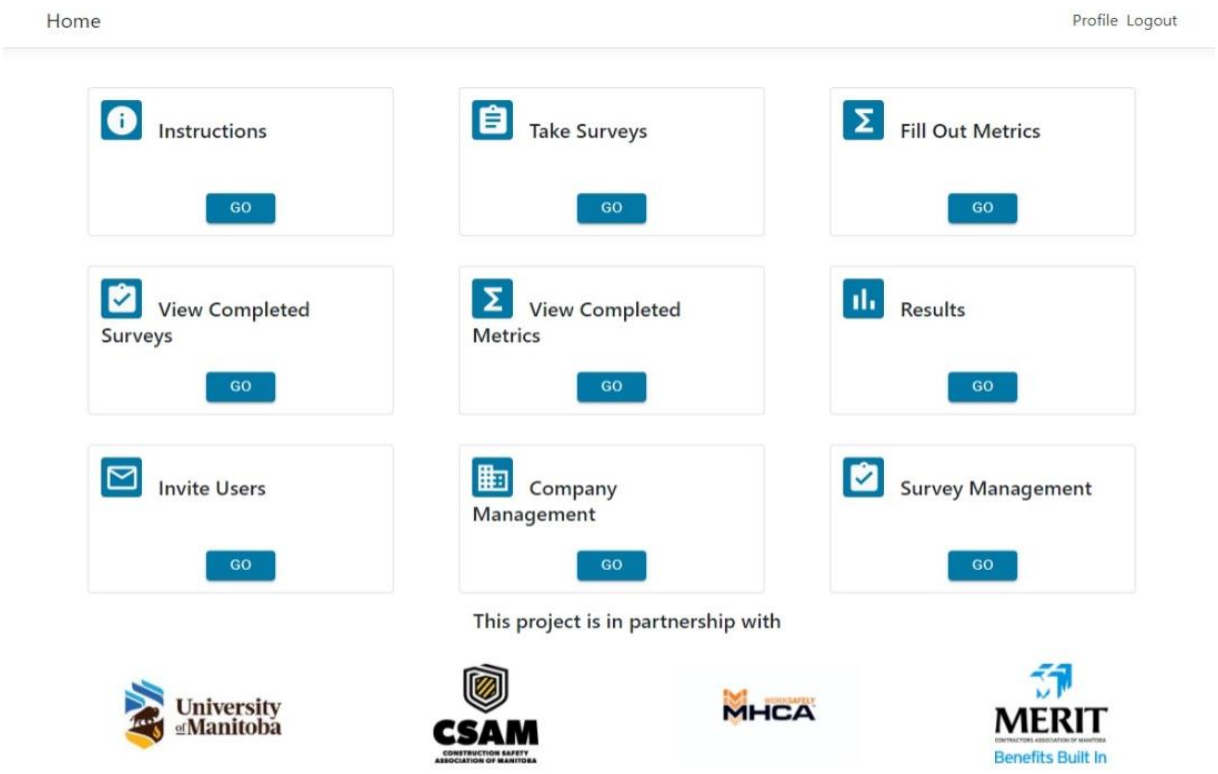


Figure 4: Home Page on DM Benchmarking Tool

From the "Home page" companies can navigate to all sections in the tool, displayed on the "Home page" as taps. Companies can navigate to the "Instruction page", DM performance survey "Take Survey" tap, the DM metrics "Fill out Metrics" tap, and see their results based on their responses

to the survey and data provided in the metrics in “Results” tap. Other function includes “View Completed Surveys”, “View Completed Metrics”, “Invite Users”, “Company Management” and “Survey Management” taps.

3.3.1.4 Web-based DM Benchmarking Tool: Instructions Page

The “Instructions” tap has three sections as seen in figure 5 below, “Project Overview”, “How to use” and “Definitions taps. The “Project Overview” page summarizes the project and details the project aims and objectives as well as the collaborating industry partners, CSAM, MHCA and Merit Contractors. The “How to use” page summarizes the DM/RTW tool, which is made up of two main sections, the CDM3 model, assessing performance based on leading indicators (survey) and DM metrics, assessing performance based on lagging indicators. It also describes the benefits and overall goals of the benchmarking tool to companies. The “How to use” page also explains the instructions for using the survey and fill them out, instructions for the metrics and how to fill each out and how to access your results and navigate the “Results page”. The final page “Definitions”, details explanations and working definitions to key terms used in the tool such as DM, maturity score, indicators as well as explaining all 11 indicators assessed as part of the CDM3 (survey).

Figure 5: Instructions Page on DM Benchmarking Tool

3.3.1.5 Web-based DM Benchmarking Tool: DM Survey

The "Take Survey" tap allows companies assess their performance using leading indicators of DM performance. Once on the page, as illustrated in figure 6 and 7 below, companies can read the instructions to the survey and access the survey under "Do Survey". There are 11 validated DM/RTW indicators, each with a set of practices, 91 validated for the building sector and 75 validated for the heavy sector. Companies are to rate their level of implementation of each practice on a scale of 1 to 5, "Strongly disagree" to "Strongly agree". Companies can choose to complete all the 11 indicators or select specific ones of interest to their company. They are not required to complete the entire survey to access their results. Their results will be based on the indicators they have completed. However, companies can only receive the overall DM performance results once

they have completed all 11 indicators, otherwise they will receive results and recommendations based on the specific indicators they chose to complete.

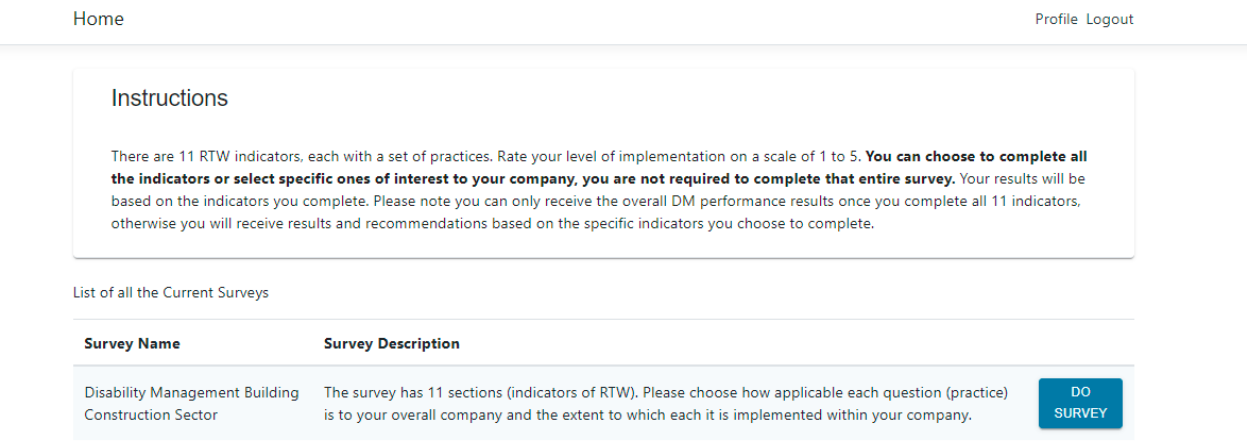


Figure 6: Take Survey Page on Building Sector DM Benchmarking Tool

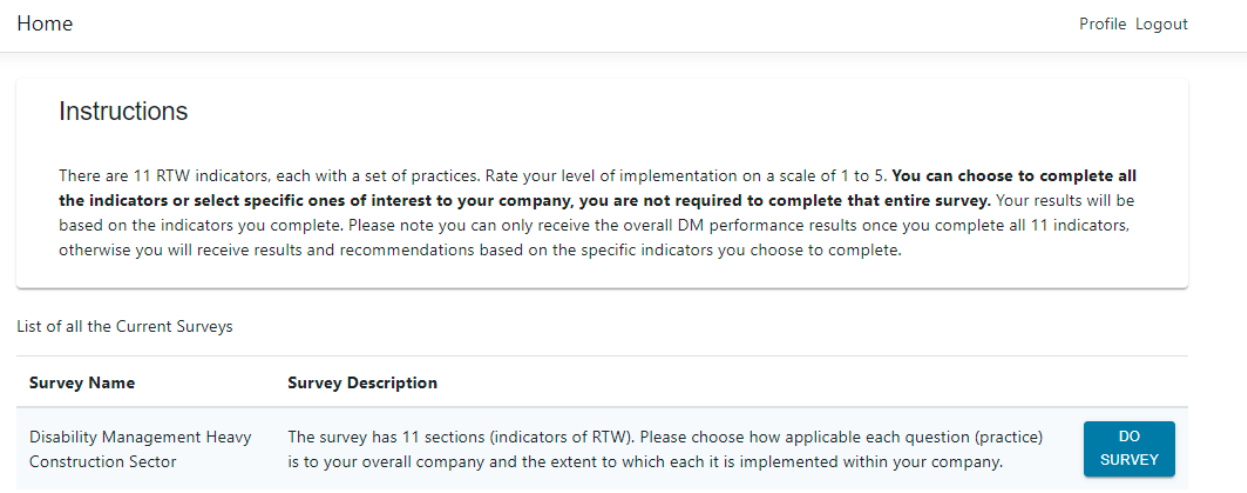


Figure 7: Take Survey Page on Heavy Sector DM Benchmarking Tool

The survey as shown in Figure 8 allows companies to log their responses to the practices inherent within each DM indicator. Companies can choose to skip the indicator altogether if they choose not to assess their performance within that indicator. If companies choose to assess their performance within that indicator, all questions must be answered to proceed. Definitions to the indicators are also listed in the indicator legend on the drop down tap on the page. Once the survey is completed companies can choose to proceed to the DM metrics or view their results to the survey immediately in the “Results” tap on the “Home page”. Companies can likewise view completed surveys in the “View Completed Surveys” tap shown in figure 9 below and delete past completed surveys on “Survey Management” tap on the “Home page”.

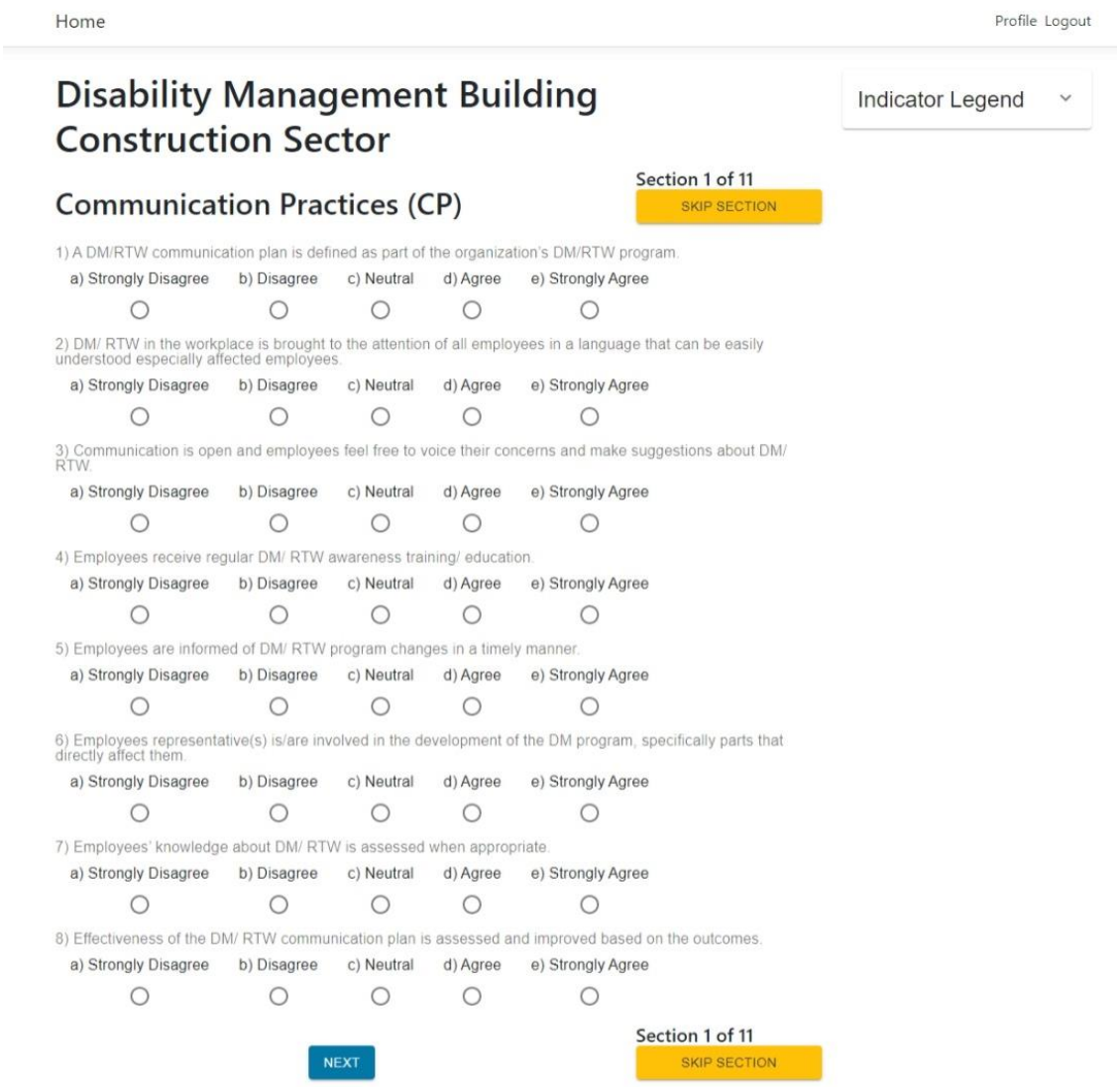


Figure 8: DM Survey page for DM Benchmarking Tool (Building Sector)

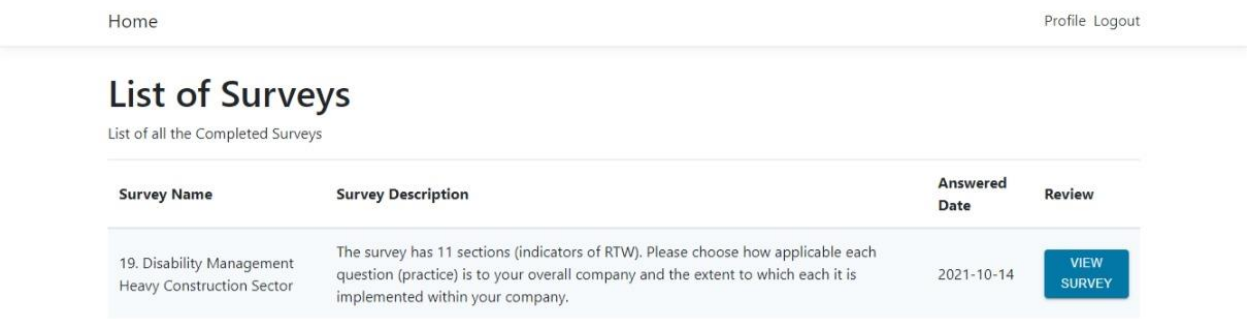


Figure 9: View Completed Survey Page on DM Benchmarking Tool (Heavy sector)

3.3.1.6 Web-based DM Benchmarking Tool: DM Metrics

The “Fill out Metrics” tap allows companies assess their performance using lagging indicators of DM performance. Once on the page, as illustrated in figure 10 and 11 below, companies can read the instructions to the metrics and fill out data to calculate the validated metrics under “Fill out metrics” button There are 25 validated metrics for the building sector and 15 validated metrics for the heavy sector which can be tracked on a monthly, quarterly, semi-annual, or annual basis. Companies again here can choose to complete all the metrics or select specific ones of interest to their company. They are not required to fill out all metrics. If companies track data monthly, input all the 12 months, for quarterly entry, input data for 4 months (e.g., January, April, July and October), for semi-annual entry, input data for 2 months (e.g., January and December) and yearly entry, input data for 1 month (e.g., December). Entries can be done for previous years, as far back as they choose.

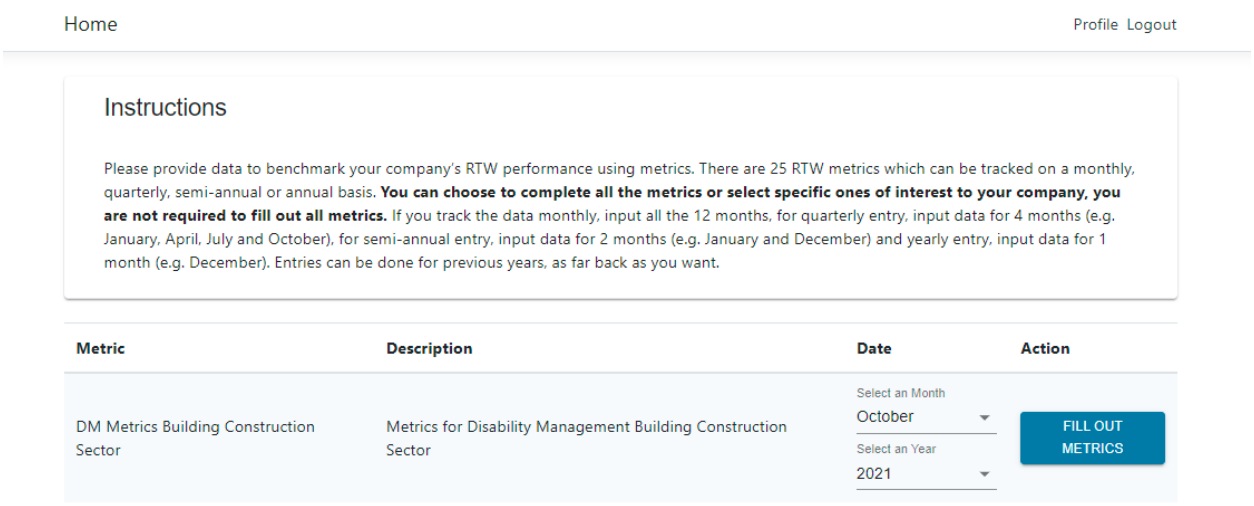


Figure 10: Fill Out Metrics Page on Building Sector DM Benchmarking Tool

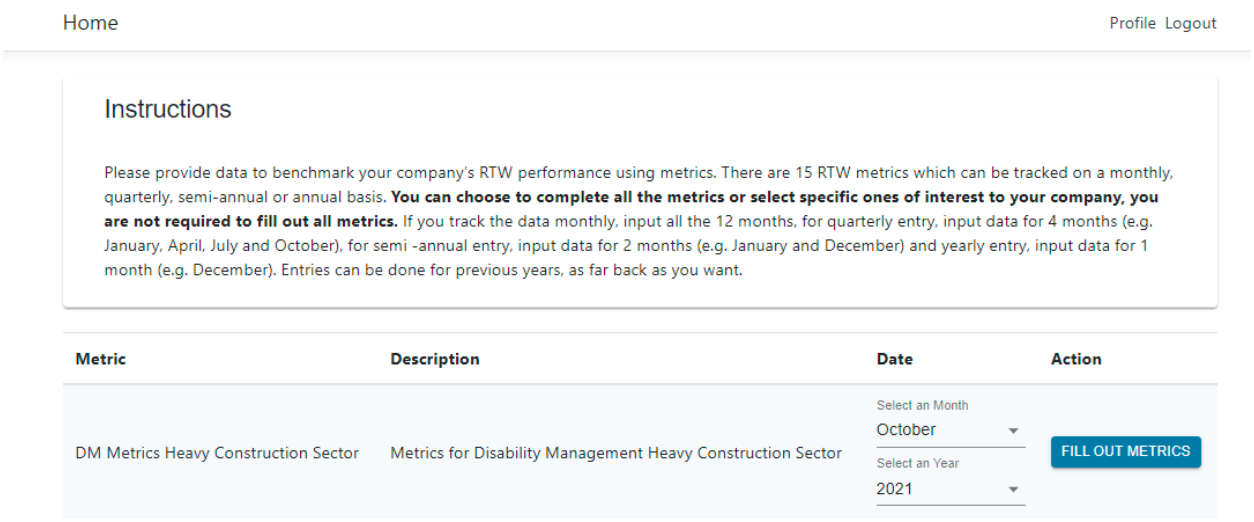


Figure 11: Fill Out Metrics Page on Heavy Sector DM Benchmarking Tool

The fill out metrics page shown in figure 12 below, lists the definition for each DM metrics, the formula to calculate them, and a button "fill out metric" which allows companies to fill out the data needed to calculate that metric as shown in figure 13 below, using DM1 as an example. Companies can choose which metric they want to assess, fill out the data need to calculate them and proceed. Once the metrics are completed companies can choose to view their results to their

assessed metrics immediately in the “Results” tap on the “Home page”. Companies can likewise view completed metrics in the “View Completed Metrics” tap shown in figure 14 below, edit metrics data and delete past completed metrics as well.

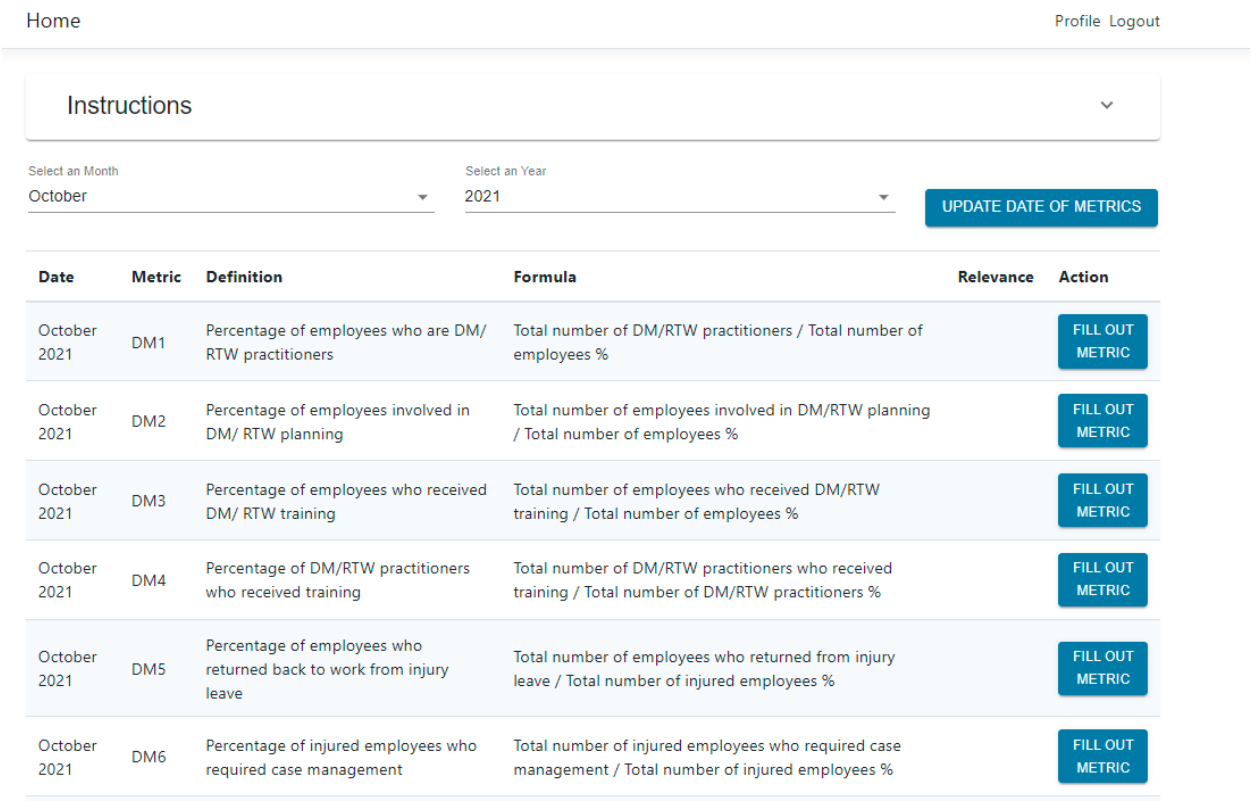


Figure 12: DM Metrics Page on DM Benchmarking Tool (Building Sector)

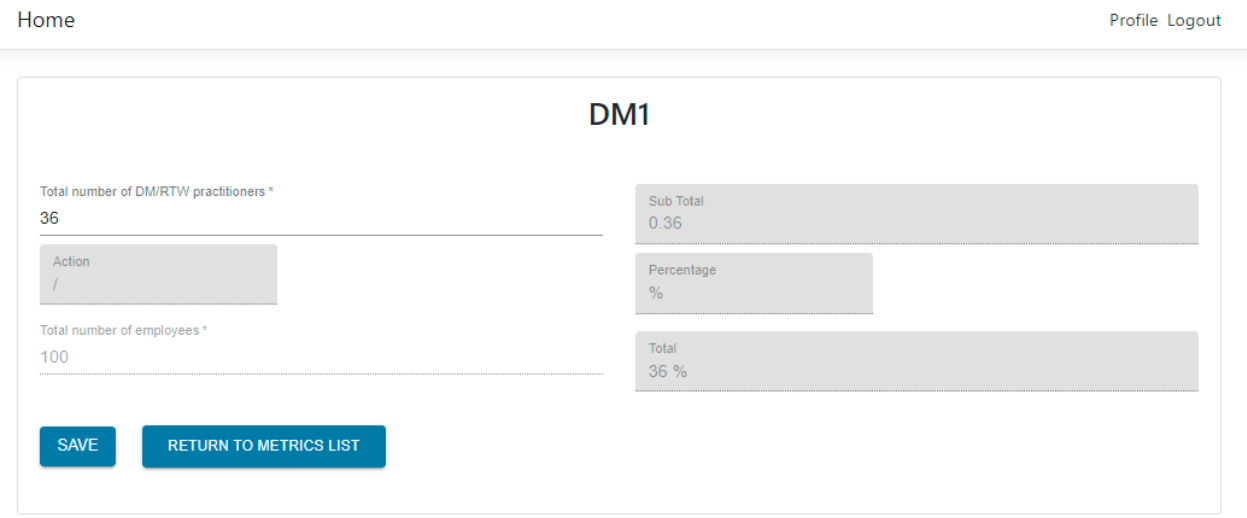


Figure 13: Fill out DM1 Metric on DM Benchmarking Tool (Building Sector)

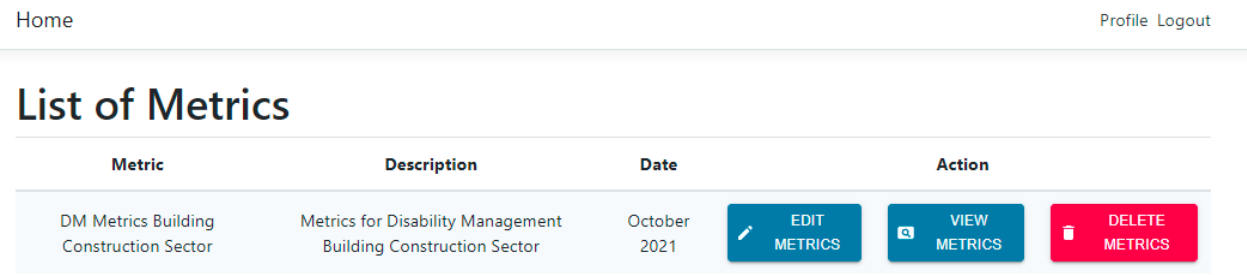


Figure 14: View Completed Metrics Page on DM Benchmarking Tool (Building Sector)

3.3.1.7 Web-based DM Benchmarking Tool: Results

Once companies complete the survey and/or DM metrics, they can navigate to the "Results" tap to view their performance. The survey results were analyzed using the formulas developed as part of maturity modelling performance assessment conceptualised in the previous study by Quaigrain (2019). The DM/RTW benchmarking tool (survey) has 5 levels of maturity (1-5), the higher the number (the maturity score (MS)), the better the performance, and the more mature the RTW/DM program is. The maturity of each practice was rated on a Likert scale from 1 to 5 and referred to

as MS Practice. The maturity scores of the practices (i.e. MS Practice) within every indicator were then summarized to produce the Actual Score Indicator (AS). That score was divided by the optimal score for the indicator (i.e. Optimal Score (OS) Indicator) which assumed a rating of 5 for each practice and was multiplied by the number of practices within that indicator. This value was multiplied by the highest maturity level of 5 to derive the initial maturity score for each indicator (i.e. MS Indicator).

To obtain MS Indicator %, the value was multiplied by 100 instead of the 5. The MS Indicator score aimed to quantify the relative contribution of each indicator to the overall maturity of the company and thus determine the practices that make the greatest contribution to it without considering the weight of importance of every indicator. A comparison of the MS Indicator for different indicators within the same company can also determine the extent to which every indicator is prioritized within the company.

The MS indicator for each indicator was then summed, and divided by the optimal score for all the indicators (i.e. Optimal Score (OS), which is 5 multiplied by the number of indicators) and multiplied by 5 to calculate the overall maturity score for each company without taking into account the AHP weights of importance (i.e. MS Company unweighted). Another maturity score that took the AHP weights of importance into consideration (i.e. MS Company) was calculated for each company by multiplying the MS Indicator for each indicator by its weight of importance (i.e. AHP weight) and summing up the resulting product for all indicators, dividing it by the optimal score (i.e. 69 Optimal Score (OS)) and multiplying it by 5. A comparison of these maturity scores (i.e. MS Indicator, MS Company unweighted and MS Company) across different companies can

help determine the level of influence of key indicators on overall DM performance. The potential maturity growth for each company at the indicator (i.e. PG Indicator) and company (i.e. PG Company) levels were also calculated by finding the difference between the optimal maturity score of 5 and the MS Indicator and MS Company respectively. Similarly, the potential maturity growth percentages for each company at the indicator (i.e. PG Indicator %) and company (i.e. PG Company %) levels were also calculated by dividing the PG Indicator and PG Company values respectively by 5 and multiplying them by 100. The metrics are calculated using the defined formulas.

The “Results” tap as shown in figure 15 has 4 taps, "Results by Survey Indicators", "Overall RTW Results", "Results by Metrics" and "Results Comparing Survey Indicators and Metrics". Instructions to navigate each tap is detailed in the “Instruction” tap on the “Home page”. As previously stated, "Overall RTW Results" can only be assess if companies complete all 11 indicators, otherwise, companies can view the results and tailored recommendations for improvements to specific indicators on the “Results by Survey Indicators” tap. Figure 16 illustrates for example the assessment results for “Communication Practices” as would be shown on the tool.

Also, under “Overall RTW Results” Figure 17 illustrates for example the assessment results as would be shown on the tool. Figure 18 illustrates under “Results by Metrics” tap for example the assessment results for “DM1” as would be shown on the tool. Finally, regarding the “Results Comparing Survey Indicators and Metrics”, Figure 19 illustrates for example the assessment results as would be shown on the tool.

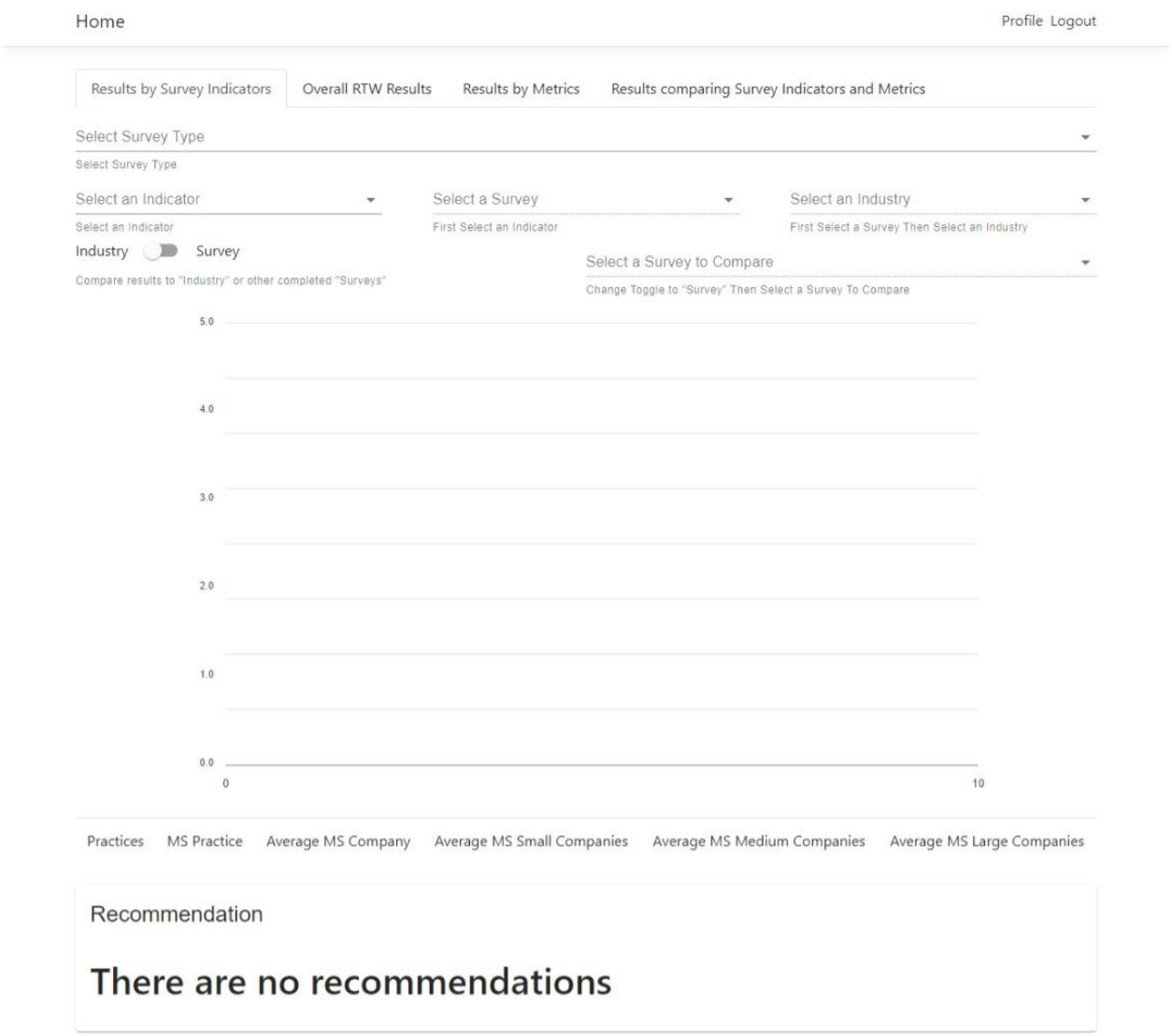


Figure 15: Results Page on DM Benchmarking Tool

Practices	MS Practice	Average MS Company	Average MS Small Companies	Average MS Medium Companies	Average MS Large Companies
Q-1	4	4	3.5	-	4.67
Q-2	4	3.71	3.25	-	4.33
Q-3	4	4	3.75	-	4.33
Q-4	4	3.14	3	-	3.33
Q-5	4	3.86	3.75	-	4
Q-6	4	3.29	3.25	-	3.33
Q-7	4	4	4	-	4
Q-8	4	4.14	4	-	4.33
MS Indicator	4.00	3.77	3.56	-	4.04

Recommendation

- Continuously improve communication routes to ensure all employees receive and understand DM policy changes
- Optimize the organizations' method for policy change communications, whilst ensuring open communication with employees
- Implement early intervention strategies, such as timely contact to injured employees immediately following injuries

Figure 16: Results by Survey Indicator on DM Benchmarking Tool (Communication Practices)

Home Profile Logout

Results by Survey Indicators | Overall RTW Results | Results by Metrics | Results comparing Survey Indicators and Metrics

Select Survey Type: Disability Management Building Construction Sector

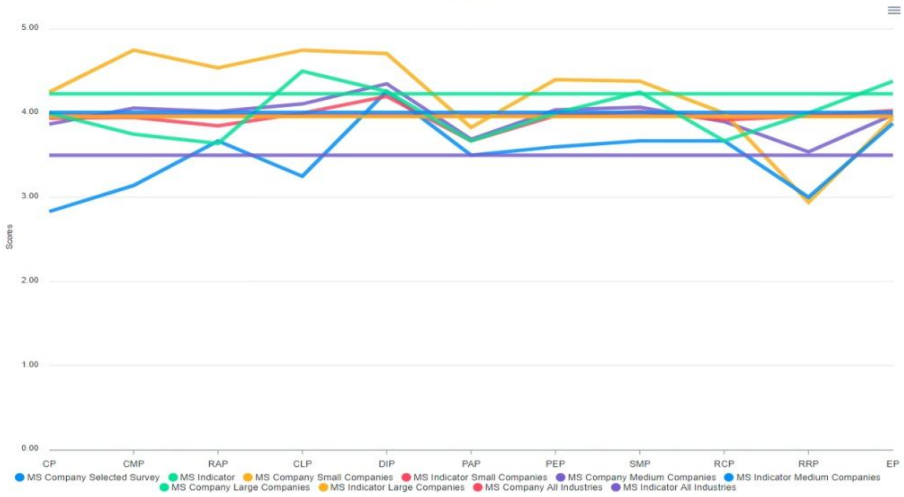
Select a Survey: 22. Disability Management Buildi...

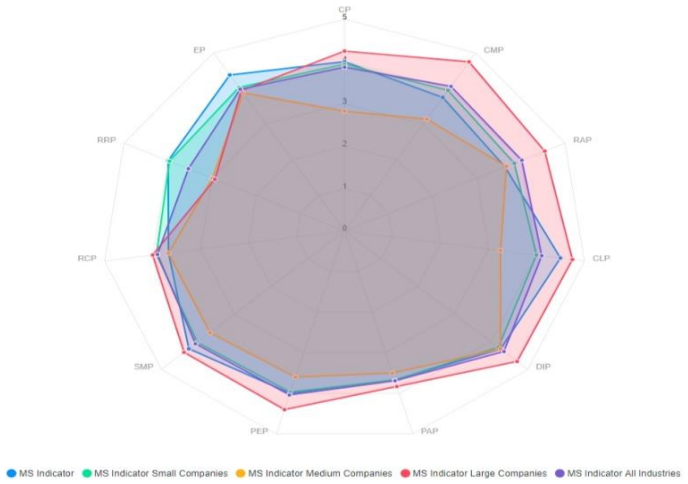
Select an Industry: All Industries

Select Survey Type

Only Surveys With All Sections Completed Will be Shown

First Select a Survey Then Select an Industry

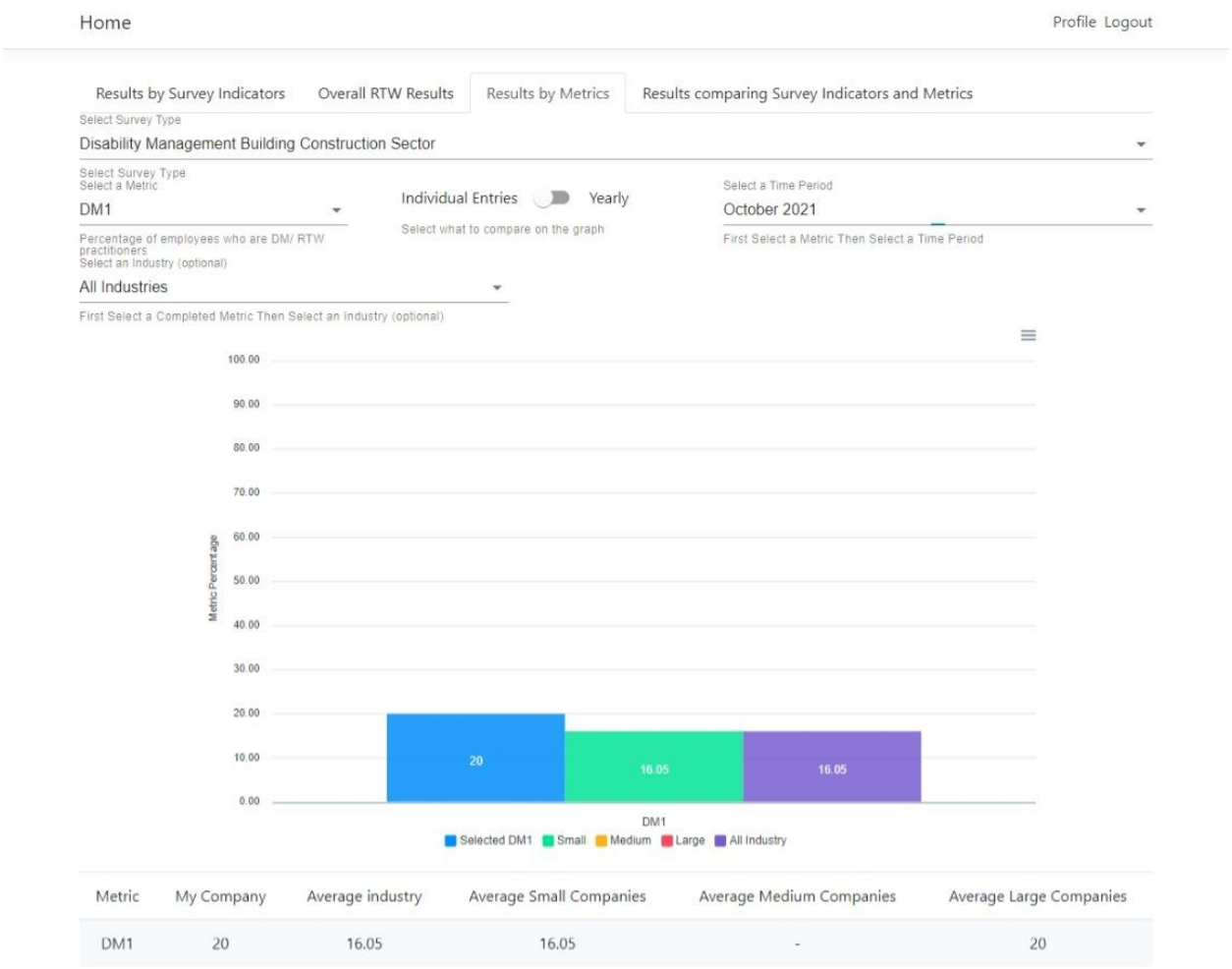




Indicator	Maturity Score	Industry	Small Companies	Medium Companies	Medium to Large Companies
CP	4	3.87	3.94	2.83	4.25
CMP	3.75	4.06	3.95	3.14	4.75
RAP	3.64	4.02	3.85	3.67	4.54
CLP	4.5	4.11	4	3.25	4.75
DIP	4.26	4.35	4.2	4.26	4.71
PAP	3.67	3.69	3.67	3.5	3.83
PEP	4	4.04	3.97	3.6	4.4
SMP	4.25	4.07	4.02	3.67	4.38
RCP	3.67	3.9	3.92	3.67	4
RRP	4	3.54	3.97	3	2.94
EP	4.38	3.98	4.03	3.88	3.94
MS Company	4.01	3.97	3.96	3.50	4.23

Indicator Legend

Figure 17: Overall DM/RTW Results on DM Benchmarking Tool



Metric	My Company	Average industry	Average Small Companies	Average Medium Companies	Average Large Companies
DM1	20	16.05	16.05	-	20

Figure 18: Results by Metrics on DM Benchmarking Tool (DM1)

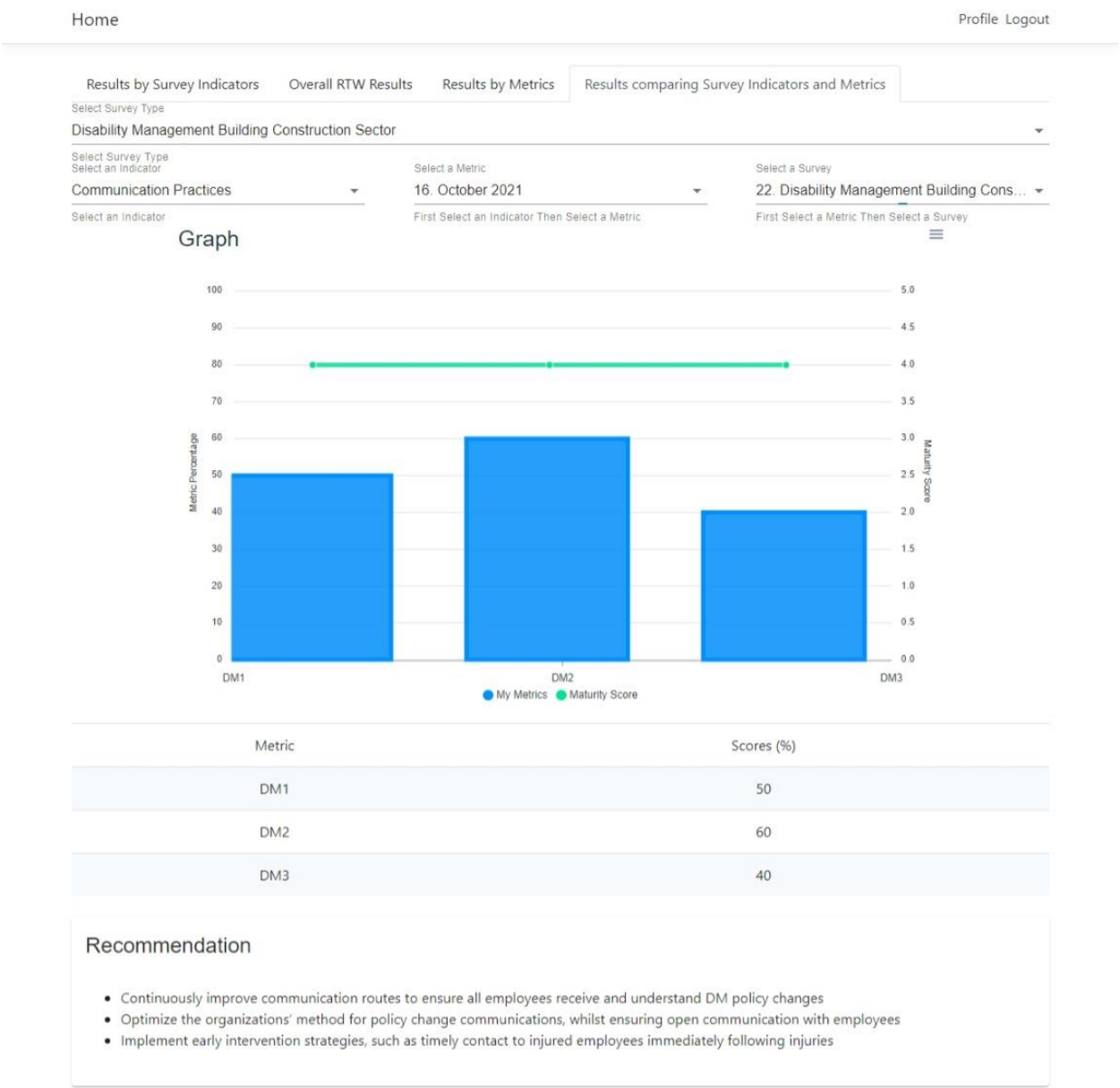


Figure 19: Results Comparing Survey Indicators and Metrics on DM Benchmarking Tool (Communication practices and its associated metrics, DM1, DM2 and DM3)

3.3.1.8 Web-based DM Benchmarking Tool: Other Functions

Other functions on the tool include the ability for companies to edit company demographic information in the "Company Management" Tap as shown in figure 20 below. Companies are also

able to invite other users for example company employees to their specific accounts or invite other companies to access the tool and create their own accounts. Companies can send the tool link to other companies to gain access to the tool by filling out the "Create company & invite user" tab as shown in figure 21. The invitation link sent is exclusively for invited companies to gain access to the system and not for the invited company to gain access to the profile of the company that sent the link. Invited companies will set up their own profile exclusive of the company that sent them the link.

Companies can alternatively invite other companies to use the tool by creating a user for that company with their owner at the same time by filling out the "Create company & create user" tab. Invited companies will use the user profile set up for them which is exclusive of the company that sent them the link. Companies can also invite users to the tool who will have access to the company's profile by filling out the "Invite user" tab. This is exclusively for persons and subsidiaries whom the company wants them to have access to the tool and fill out the surveys and/or metrics under the company's profile.

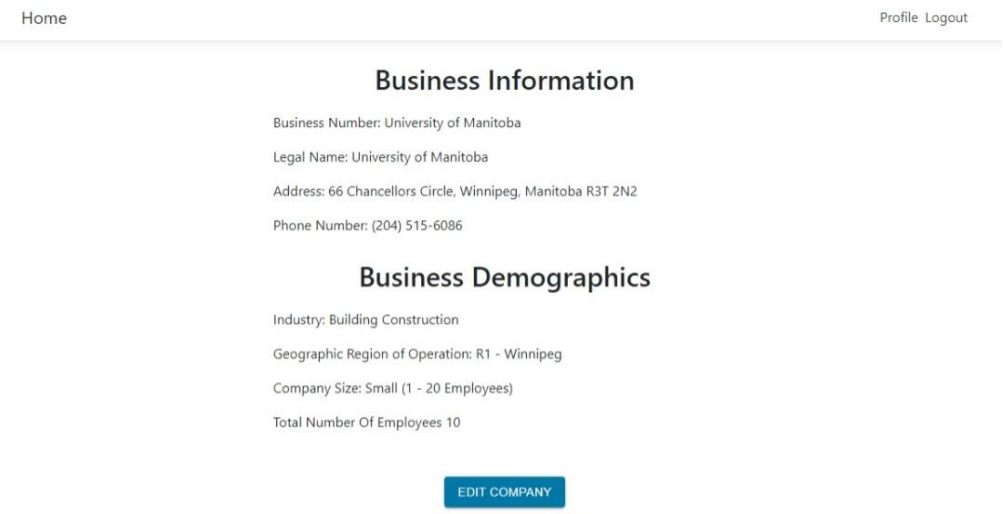


Figure 20: Company Management Page on DM Benchmarking Tool

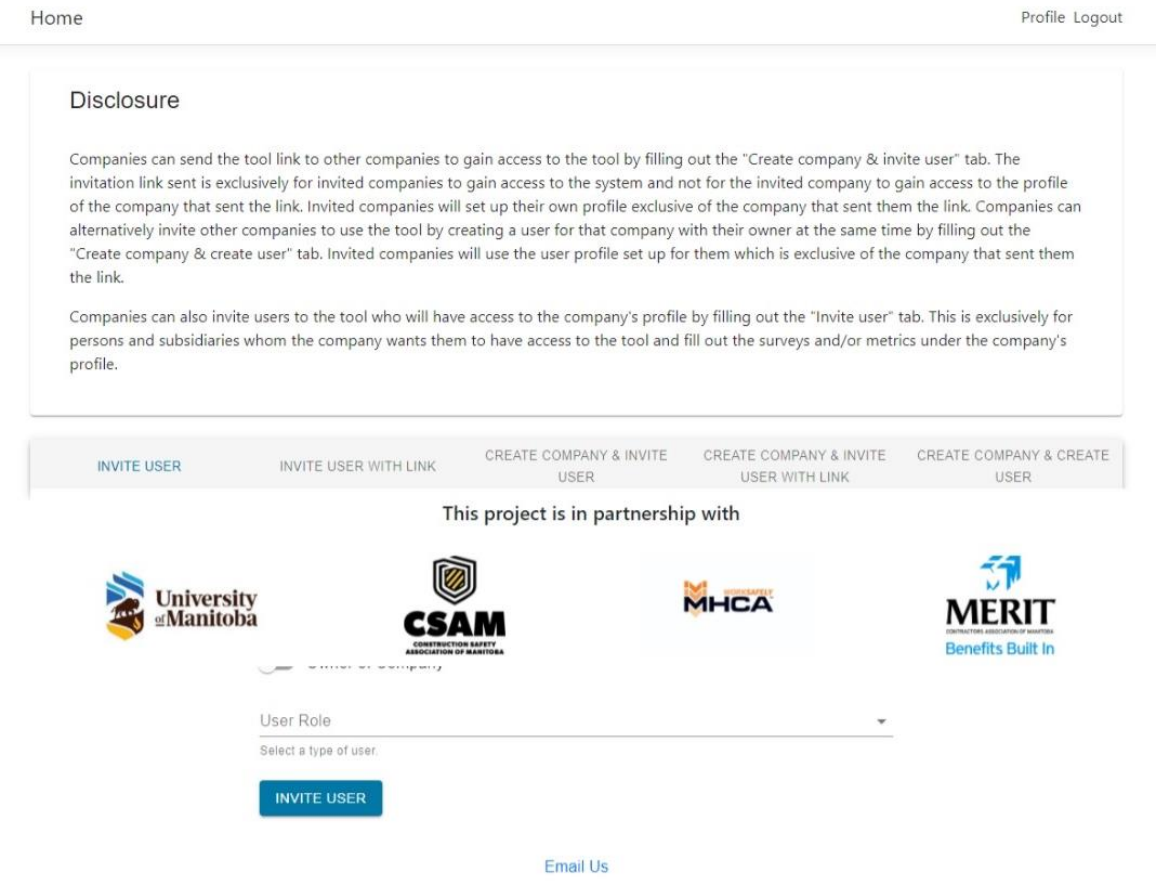


Figure 21: Invite Users Page on DM Benchmarking Tool

3.3.2 Piloting of Web-based tool

Once the online tool was developed, the project piloted the tools prior to their deployment by tasking the building and heavy TWG with testing their sector's version of the tools. The piloting of the online tool sort to assess the usability and navigability of the web-based tool. This consisted of administering a survey questionnaire by email with the link to the developed web-based tool attached. Feedback on the developed tool was collected through a survey questionnaire (see appendix C for survey).

The survey consisted of 8 questions, a combination of closed and open-ended questions. The first question has 15 sub-questions, which the participants rated their opinion of them on a five-point scale from strongly disagree to strongly agree. The remaining 7 questions were single questions, a combination of yes or no answers, a five-point scale answer to choose from and open-ended questions. Participants only reviewed the online tool but not fill it, after which they answered the 8 survey questions. In the administration of the survey, only the principal investigator was in contact with the participants. Participants completed the survey on-line (sent by email) and send back the responses. The estimated duration for the session was 30 minutes. Once the participants agreed to participate, the survey was administered individually, on-line by email. The individual data was then be collected and analyzed. Participants were required to read and sign an inform consent form before proceeding.

Feedback from the pilot study was used to further refine the web-based versions of the tools prior to full deployment. The feedback received on the tool was analyzed and summarized based on their feasibility considering limitation of time and ability to implement. These summarized

suggested improvements were then discussed and approved by the PAC. Suggested changes include:

- Word changes to “Instruction” page for further clarity.
- Change Home page (landing page) with the navigation bottom such as “Instruction”, “Take survey, “View completed survey” ect.
- Add navigation buttons back and forth on the survey, so it enables users to go back if you want
- Add the skip section at the top of the “Survey” page instead of the bottom
- In the “View Completed Surveys” tab, add “Delete Survey” button just like that of “View Completed Metrics” tap
- Change the create company and invite user tap to just invite company, with just a simple email to be provide.
- Minor changes under “Results” tab

3.4 Deploying and promoting the adoption of these tools by construction workplaces

Once the online tools were piloted and refined, they were deployed industry wide. All member companies of the CSAM, MHCA and Merit Contractors were be invited to use their sector’s version of the tools. An intensive marketing campaign was launched with strong support from the CSAM and MHCA to inform members, and thus the entire construction industry about the project and the developed online benchmarking DM/RTW tool by email, on their websites and in their newsletters and newspaper inserts. The project also utilized the associations’ social media accounts that is Facebook, Twitter, and LinkedIn to promote the tools and encourage member companies to

use them. The project also participated in the annual Safety Conference 2020 held by the CSAM and that brings together Manitoba's construction companies to further promote the project, its results to date, benefits, and outcomes. A series of workshops and webinars was also organized in collaboration with CSAM and MHCA about the project, how to use the tool through in-depth reviews and benefits of the benchmarking tool with companies. The workshops and webinars were well attended, and participants had the opportunity to explore the tool and ask all the questions they wanted to further clarity how to fully navigate the tool. In addition to these organized workshops, the tool was heavily promoted in all courses administered by CSAM and the Winnipeg construction association (WCA). The project used all these opportunities to emphasize the benefits of the tools to construction workplaces in MB and to the industry at large. This deployment and promotion lasted 4 months. The tool however remains permanently online so companies can continue to use.

3.4.1 Management of the Tools after Project Conclusion

There is a commitment to sustain the tools by the CSAM and the MHCA following the completion of the project. The tools are expected to permanently remain on their websites so that construction companies can continue to use them after the project has ended. This should lead to the building of an industry-wide web-based DM and RTW database that will aggregate all assessment results and provide real-time industry averages that construction companies can compare themselves against for benchmarking purposes.

3.5 Using these tools to evaluate the actual DM and RTW performance of the construction industry in Manitoba and disseminating results to the industry

The web-based tool is designed to archive every company's response and to provide each with an immediate online assessment of these responses every time they use them. The assessment benchmarks company's actual performance against past performance and against average industry performance. It will also identify specific actions they can take to ensure continuous improvement of their DM and RTW performance. The web-based tools enable construction workplaces to depict assessment results in a tabular or chart format and to customize them based on a number of different criteria such as year, industry sector, company size, and practice area. The web-based online accessibility of the tools will encourage construction workplaces to use them regularly, promoting thus their adoption across all of Manitoba.

Detailed statistical analysis of web-based responses received by all companies that used the tools during the four-month deployment and promotion phase was conducted. This is to evaluate the DM and RTW performance of these workplaces and of the construction industry at large. For the CDM3, the analysis involved determining the most mature DM and RTW practice areas and individual practices implemented in MB versus the least mature ones in need of improvement, at the industry level and sector level (i.e. building and heavy). It also involved assessing the relationship between the weights of importance of these practice areas and their relative maturity, as well as the relationship between the maturity of different practice areas. In all, although 26 companies created accounts on the "Building Sector DM Benchmarking Tool" only 15 fully completed the DM survey and thus included in the analysis of the industry DM performance. In the "Heavy Sector DM Benchmarking Tool", although 8 companies set up accounts, only 6 fully completed the DM survey and thus included in the analysis of the industry DM performance. These

15 and 6 companies included in the analysis in this report demographic data are detailed in table 8 below. The limited deployment period within the project attributed to the small number of companies who created accounts and eventually used the tool. In the long term, after the project conclusion, it is expected more companies will use the tool to assess DM performance giving a more representative overview of DM performance.

Table 8: Company Demographics

Company	**Industry classification**	**Company Size**	**Geographic region**
Building Construction Sector Companies			
Company 1	Building Construction	Small	R1 - Winnipeg
Company 2	Building Construction	Large	R1 - Winnipeg
Company 3	Building Construction	Large	R1 - Winnipeg
Company 4	Building Construction	Large	R1 - Winnipeg
Company 5	Building Construction	Small	R1 - Winnipeg
Company 6	Building Construction	Medium	R3 - Portage & Selkirk & Mordern-Winkler
Company 7	Building Construction	Medium	R1 - Winnipeg
Company 8	Drywall and Stucco Contracting	Large	R1 - Winnipeg
Company 9	Roofing and Eavestroughing	Large	R1 - Winnipeg
Company 10	Painting and Decorating	Small	R1 - Winnipeg
Company 11	Building Construction	Large	R4 – Pas, Flin Flon, Thom & Swan River
Company 12	Building Construction	Large	R1 - Winnipeg
Company 13	Building Construction	Medium	R1 - Winnipeg

Company 14	Building Construction	Large	R7 - South Rural
Company 15	Building Construction	Small	R1 - Winnipeg
Heavy Construction Sector Companies			
Company 1	Roadwork	Small	R1 - Winnipeg
Company 2	Roadwork	Large	R1 - Winnipeg
Company 3	Pipeline Construction	Large	R1 - Winnipeg
Company 4	Pipeline Construction	Large	R4 – Pas, Flin Flon, Thom & Swan River
Company 5	Roadwork	Small	R1 - Winnipeg
Company 6	Roadwork	Large	R1 - Winnipeg

For the metrics, although the intention was to investigate the best versus worst performing metrics as well as the relationship between individual metrics, assess the relationship between the CDM3 and metric data, in particular between individual metrics and the maturity of specific CDM3 practice areas, insufficient data collected made this impossible. As of this report, no company either on the building or heavy DM tool successfully used the metrics to assess their DM performance. This could be potentially attributed to; the limited time widow for companies to access, familiarize and use the tool adequately. The tool is expected to remain permanently on the associations website and companies will be continuously encouraged to use the tool. Another reason is that these DM metrics are newly proposed so it is expected that most companies would not have tracked the data necessary to calculate the metrics. Companies' awareness of these metrics is critical in that it will prompt companies to track such essential DM data and subsequently use the DM benchmarking tool to assess their DM performance using these metrics. The model and metric data will also be analyzed over time, beyond this project as it remains as a permanent benchmarking tool and as a function of different criteria such as industry sector, company size, and practice area whenever possible. Direct comparisons between the building and heavy

construction sectors' performance can also be made to benchmark every sector's DM and RTW performance. The project involved making specific recommendations to address DM and RTW issues in construction based on this thorough data analysis and summarizing lessons learned.

The dissemination of the project's results to the industry is an integral part of the project and one of its four main objectives. Another intensive marketing campaign similar to the one launched after deploying the tools will thus be run with strong support from the CSAM and the MHCA to achieve this objective. This second marketing campaign will use the same tools (e.g. email, website, social media, newsletters, newspaper inserts) used on the first one to accomplish this objective.

3.5.1 Data Analysis

A Shapiro-Wilk test assessed the normality of the dataset obtained from the maturity model implementation. This test was used because it is ideal for small sample sizes (3-30) (Laerd 2018). Non-parametric Mann-Whitney U test or parametric independent t-tests was used depending on the normality of the data to evaluate the statistical difference in maturity between building and heavy DM maturity. Parametric independent t-test was used to assess the difference in maturity between building and heavy companies if the dataset was normal, whereas a non-parametric Mann-Whiney test was used where the dataset was non-normal. The Mann-Whitney U test is a rank-based nonparametric 115 test that can be used to determine if there are differences between two groups on a continuous or ordinal dependent variable (Laerd 2018). The Independent t-test is a parametric test (i.e. for normal data distribution) and used to compare the means of two independent groups in order to determine whether there is statistical evidence that the associated

population means are significantly different (Laerd 2018). A Spearman's or Pearson's correlation test was used, depending on the normality of the dataset to assess: 1) the relationship between industry maturity level and building and heavy maturity, 2) relationship between industry maturity level and sector classification, and 3) the relationship between the AHP ranking of the indicators and their level of implementation on in the building and heavy sectors. Spearman's correlation was used where the dataset was non-normally distributed as confirmed by a Shapiro Wilk test. A Spearman's correlation test also assessed the relationship between project maturity level and project size and type. Spearman's correlation is a non-parametric test used to determine the relationship between non-normally distributed variables (Laerd 2018). Pearson's correlation was used where the dataset was normally distributed as confirmed by a Shapiro Wilk test. Pearson's correlation is a parametric test that measures the strength of a linear a relationship.

CHAPTER 4: RESULTS & DISCUSSION

This chapter presents the results of the research and provides a discussion of them in the context of the existing literature. The results are divided per research objective, with every section presenting the results related to a particular objective. The first subsection presents the results of the validation and AHP evaluation of the 11 indicators making up the CDM3 for the building and heavy sectors, and a discussion of the results in the context of the wider literature. It reports on the highest and least validated indicators and practices and the most important and least important indicators for both the building and heavy sectors. The section also discusses the relationship between the indicator's relative importance and their level of validity as defined by their validation score and expert agreement percentage. The second subsections discuss the validation of the 26 DM metrics within the building and heavy sectors. The third subsection describes the results of online DM benchmarking tool to evaluate the maturity and performance of construction companies in Manitoba, at industry and sector levels, as well as per company size, industry classification and geographic region. The section also discusses the analysis of the maturity of DM indicators and their relationship to their critically ranking using AHP.

4.1 DM Indicators and Practices Validation and AHP evaluation

The overall AHP consistency ratio was 0.079 which was less than 0.1, thus indicating a good consistency in the responses of the AHP experts. Specifically, the AHP consistency ratio for the building sector was 0.076 and 0.061 for the heavy sector. Table 9 shows the relative AHP ranking and mean validation scores for the indicators for the building and heavy sectors. Table 10 shows the validated practices under each validated indicator for the building and heavy sectors. The results in the table show that expert agreement was higher for indicators that had a higher mean

validation score. This was consistent across both sectors of the construction industry. For example, indicators with a mean validation score of 4 and above, had expert agreement percentages of 80% and above.

Table 9: Validation score and AHP weightings for DM Indicators for Building and Heavy Construction Sectors

		Building Construction sector				**Heavy Construction sector**			
		Validation		AHP Evaluation		Validation		AHP Evaluation	
	Indicator	Mean score	Percentage of response higher than 3	Eigenvalues	Ranking	Mean score	Percentage of response higher than 3	Eigenvalues	Ranking
1	Communication Practices	4.10	85.7%	0.052	7	3.61	80%	0.078	5
2	Case Management Practices	4.22	85.7%	0.117	4	3.65	80%	0.061	6
3	Return to work Practices	4.53	100%	0.124	3	4.18	100%	0.221	1
4	Claims management Practices	4.08	100%	0.045	9	3.28	60%	0.060	7
5	Disability injury prevention Practices	4.92	100%	0.219	1	4.66	100%	0.217	2
6	Physical accessibility Practices	3.88	71.14%	0.019	11	3.25	60%	0.018	10
7	Program evaluation Practices	4.6	100%	0.046	8	4.25	100%	0.036	8
8	Senior management support Practices	4.79	100%	0.114	5	4.36	100%	0.162	3
9	Regulatory and compliance Practices	4.25	100%	0.084	6	3.15	80%	0.024	9

10	Recruitment and retention	3.98	85.7%	0.044	10	4.07	80%	0.116	4
11	Ergonomics Practices	4.97	100%	0.137	2	4.02	80%	0.008	11
	∑weight			1.00			1.00	1.00	

A key observation by the experts within both building and heavy sectors was about the comprehensiveness of the previously developed (Quaigrain and Issa, 2017) and now refined 11 indicators in capturing DM implementation within the construction industry and ability to use them to evaluate overall DM performance. For the Relevance and Practicality validation criteria, all indicators validated within both sectors had a mean value of above 3.5 and an expert agreement percentage of above 75%, suggesting that the indicators defined provided a reliable and practical basis for evaluating DM and RTW maturity. The average validation score for the 11 indicators was 4.39 for the building sector and 3.87 for the heavy sector. This implies the building sectors rated the indicators 13.4% more valid compared to the heavy sector. Additionally, 9 of the 11 indicators were rated "highly valid" (i.e., mean score of/greater than 4 but less/equal than 5) for the building sector whilst only 6 fell into that category for the heavy construction sector. This may be a reflection on how systematically DM is prioritized within the building sectors as opposed to the heavy sectors. This would be reflected on the extent DM is implemented within both sectors, that is, performance levels. To date no study has thoroughly assessed both sectors separately to assess the extent DM is implemented in both, and if indeed there is a point of departure in terms of performance, perception, and prioritization.

A Spearman's correlation analysis confirmed that there was a statistically significant ($p=0.008$) and strong positive correlation ($R=0.746$) between the indicator's expert agreement percentage and validation scores for the indicators, as shown in Table 9 for the building sector. For the heavy

sector, the analysis similarly found a statistically significant (p=0.0007) and strong positive correlation (R=0.858) between the indicator's expert agreement percentage and validation scores for the indicators. This implies that for both sectors, as the validation mean scores increased for the indicators, experts consistently agreed that the indicators were indeed relevant within their respective industries. Similarly, a statistically significant (p=0.03) and strong positive correlation (R=0.636) was found between building and heavy sectors validation scores for the indicators. Meaning that, both sectors consistently agreed on which indicators of DM maturity were most relevance within the construction industry and which indicators are relatively least relevant. This is an important finding as it further establishes that for the most part, the industry perceives DM more comparably and previously hypothesize, and any difference is relatively minimal.

Table 10: Validated DM Practices for the Building and Heavy Sectors

		Building Construction sector		**Heavy Construction sector**	
Practice code	**DM Practices**	**Mean score**	**Percentage of response higher than 3**	**Mean Score**	**Percentage of response higher than 3**
Communication Practices (CP)					
CP1	A DM/RTW communication plan is defined as part of the organization's DM/RTW program.	4.4	100%	4	100%
CP2	DM/ RTW in the workplace is brought to the attention of all employees in a language that can be easily understood especially affected employees.	4.75	100%	4	100%
CP3	Communication is open and employees feel free to voice their concerns and make suggestions about DM/ RTW.	4.36	100%		
CP4	Employees receive regular DM/ RTW awareness training/ education.	4.63	100%	3.5	100%
CP5	Employees are informed of DM/ RTW program changes in a timely manner.	3.99	85.71%	3.75	80%
CP6	Employee's representative(s) is/are involved in the development of the DM	3.99	85.71%		

	program, specifically parts that directly affect them.				
CP7	Employees' knowledge about DM/ RTW is assessed when appropriate.	3.74	85.71%	3.5	80%
CP8	Effectiveness of the DM/ RTW communication plan is assessed and improved based on the outcomes.	4.06	100%	3.5	100%
Case Management Practices (CMP)					
CMP1	Injured employees are contacted shortly following an injury and offered DM/ RTW services and support.	4.71	100%	5	100%
CMP2	Regular communication is maintained with injured employees' physicians to facilitate their RTW.	3.99	100%	5	100%
CMP3	When off work, injured employees are contacted on a regular basis to assess their ability to RTW.	4.55	100%	4.5	100%
CMP4	There's a process in place for finalizing rehabilitations decisions when there are disagreements about them.	3.54	85.71%	4.5	100%
CMP5	An employee within the organization (HR personnel or DM/RTW officer) is appointed for severe injured employee cases.	3.63	85.71%		
CMP6	For active injured employee cases, the personnel responsible for DM/ RTW maintains regular communication with all relevant stakeholders (e.g. DM/ RTW committee, work supervisors).	4.12	100%	3.25	80%
CMP7	Case management processes for injured employees are evaluated and improved on a regular basis.	4.35	100%	3.5	100%
CMP8	Case management processes for injured employees comply with all relevant legislation.	4.29	100%	4	100%
Return to Work Practices (RAP)					
RAP1	The organization has a written RTW program that is clear and simple to understand.	4.78	100%	4.5	100%
RAP2	The organization involves employees' representative(s) in formulating its RTW program.	4.1	100%	4.5	100%
RAP3	The organization has a person responsible for DM/RTW or hires third parties' entities (EAP)	3.56	100%	3.25	80%
RAP4	The person in the DM/ RTW role receives DM/ RTW training/ education.	3.56	85.71%	4	100%
RAP5	DM/RTW role candidates/ or third parties' entities (EAP) are assessed prior to hiring	3.34	71.43%		

	to ensure they have the required knowledge and skills.				
RAP6	The job description for the DM/ RTW role emphasizes DM/ RTW importance and duties.	3.24	71.43%		
RAP7	Functional abilities assessment is conducted for injured employees to develop a tailored rehabilitation and/ or RTW plan.	4.64	100%	5	100%
RAP8	A collaborative approach is used to develop a tailored rehabilitation and/ or RTW plan for injured employees.	4.45	100%	4.5	100%
RAP9	A general job assessment/physical demands assessment is completed for each job in the workplace to facilitate the development of RTW plans for injured employees.	4.2	100%	4.5	100%
RAP10	Job modifications/alternative job placements are identified in line with injured employees' functional abilities assessment results.	3.75	100%	4.25	100%
RAP11	The organization provides productive and meaningful modified work to injured employees in a timely manner.	5	100%	4.5	100%
RAP12	Modified work provided to injured employees aims to eventually move them to their regular positions.	5	100%	5	100%
RAP13	A vocational assessment is conducted for injured employees who are unable to return to their regular positions to identify alternative job placements for them.	4.5	100%	4.25	100%
RAP14	The organization actively monitors injured, ill or at-risk employees to determine if they should be referred to the DM/ RTW program.	3.89	100%	4.25	100%
Claims Management Practices (CMP)					
CLP1	Claims management practices are clearly defined in the workplace DM program.	4.45	100%	3.75	100%
CLP2	Claims management is well coordinated from initial injury to claim resolution.	4.03	85.71%	4	100%
CLP3	Long duration claims are evaluated to determine whether more intensive services are required.	3.75	100%	3.5	100%
CLP4	The current claims management program is designed to support early intervention and RTW.	4.29	100%	4.5	100%
Disability and Injury Prevention Practices (DIP)					
DIP1	DM prevention goals and strategies are clearly defined in the organizations' health and safety/DM program.	5	100%	4.5	100%

DIP2	The DM program includes interventions aimed at reducing workplace injuries and accidents.	4.85	100%	5	100%
DIP3	The organization provides first-aid services to employees and ensures the availability of first-aid kits	4.7	100%	5	100%
DIP4	The organization has qualified first-aid attendants available during regular working hours.	4.7	100%	4.5	100%
DIP5	The organization has a program promoting employee health and wellness/ stress management.	4.35	100%	3.75	100%
DIP6	The employee health and wellness/stress management program provide incentives to encourage participation in them.	4.15	100%	3.25	80%
DIP7	The organization has an injury prevention program.	4.65	100%	4.5	100%
DIP8	The organization allocates a budget for its injury prevention program.	4.45	100%	3.25	80%
DIP9	Employees participate in training programs designed to enhance workplace safety.	4.7	100%	4	100%
DIP10	The organization's health and safety policy comply with governing legislation.	4.6	100%	4.5	100%
DIP11	The organization has a formal reporting system that encourages employees to report their safety concerns.	4.45	100%	3.75	100%
DIP12	The organization frequently reviews employee's knowledge and understanding of health and safety procedures.	4.65	100%	3.75	100%
DIP13	The organization responds to health and safety issues promptly and initiates required changes.	4.5	100%	3.75	100%
DIP14	Equipment, Materials and Resources (EMR) health and safety requirements are considered during health and safety planning.	4.5	100%	4	100%
DIP15	Defective EMR is replaced/repaired immediately upon detection of defects, with the cause investigated.	4.65	100%	4.5	100%
DIP16	The organization implements and monitors a hazard prevention program.	4.6	100%		100%
DIP17	Safety hazards are investigated in order to reduce/eliminate them.	4.8	100%	4.5	100%
DIP18	Hazard management procedures are communicated to employees in a timely manner.	4.75	100%	4.5	100%
DIP19	Hazard statistics and incident data are tracked and reviewed regularly.	4.5	100%	3.75	100%
Physical Accessibility Management Practices (PAP)					

PAP1	The organization has well trained staff to safely evacuate the workplace in an emergency.	3.3	85.71%		
PAP2	Staff training programs include evacuation techniques and assistance for disabled and elderly employees.	3.2	71.43%		
PAP3	The organization investigates additional physical support that will help accommodate a new employee.	3.2	85.71%		
PAP4	The organization modifies workstations in advance of a new disabled employees' starting date.	3.4	85.71%		
PAP5	The organization modifies the workstations of injured/disabled employees to enable RTW.	3.63	100%	3.75	80%
PAP6	The organization's office premises incorporate physical accessibility features such as lifts, ramps and rails.	4.6	100%	3.75	80%
Program Evaluation Practices (PEP)					
PEP1	The organization maintains injury and illness data.	4.4	100%	4.75	100%
PEP2	The organization uses the injury and illness data to identify problem areas and address them accordingly.	4.75	100%	4.5	100%
PEP3	The organization evaluates the outcomes of their employee health and wellness/ stress management program.	4.03	100%	3.75	100%
PEP4	Periodic meetings are held for managers whereby injury and illness data patterns are reviewed.	4.95	100%	4.5	100%
PEP5	The organization tracks costs associated with its DM/RTW program.	4.9	100%	4.25	100%
PEP6	The organization uses its injury and illness data and tracked costs to improve its DM/RTW program.	4.7	100%	4.25	100%
PEP7	The organization monitors and evaluates injured employees who RTW.	4.45	100%	3.5	100%
PEP8	Employees have access to their RTW evaluations.	4.1	100%	3.25	100%
PEP9	The organization evaluates the effectiveness of their DM/RTW program at regular intervals and make improvements where required.	4.9	100%	4	100%
PEP10	The organization ensures the confidentiality of injured employees' data when evaluating its DM/RTW program.	4.55	100%	4.5	100%
Senior Management Support Practices (SMP)					
SMP1	Senior management is actively involved in the DM/RTW program.	4.9	100%	4.5	100%

SMP2	The DM manager receives support from senior management.	5	100%		
SMP3	Senior management spends time and money on improving DM/RTW performance.	4.8	100%	4.25	100%
SMP4	Senior management considers DM/RTW as much as other project goals in the execution of projects.	4.7	100%	3.5	80%
Regulatory and Compliance Polices (RCP)					
RCP1	The organization considers DM/RTW an integral part of its human resource development strategy.	4.85	100%	4.5	100%
RCP2	The DM/RTW program is formulated in accordance with governing legislation.	4.8	100%	4.75	100%
RCP3	The DM/RTW program accommodates employees who are already disabled.	4.7	100%	3.25	80%
Recruitment and Retention Polices (RRP)					
RRP1	The organization hires people with disabilities.	4.65	100%		
RRP2	The organization ensures that all possible accommodations are in place, when hiring employees with disabilities.	4.45	100%		
RRP3	Alternative ways to assess skill/trainability of candidate are available to enable equal/fair opportunities.	4.6	100%		
RRP4	Recruitment staff are trained to handle issues involving equal opportunity, diversity and disability.	4.7	100%		
RRP5	During interviews, applicants with disabilities are invited to identify any specific accommodations they might require at work.	4.7	100%		
RRP6	The same recruitment assessment process is used for disabled and non-disabled candidates.	4.8	100%		
RRP7	Recruitment process is assessed as to whether people with disabilities are overrepresented in rejection decisions for positions.	4.1	100%		
RRP8	The organization ensures confidentiality when dealing with employees' disabilities.	4.85	100%	5	100%
Ergonomic Practices (EP)					
EP1	Ergonomic interventions are used to improve workstations/ work areas.	4.75	100%	4.25	100%
EP2	Jobs are designed to reduce heavy lifting.	4.65	100%	3.75	100%
EP3	Jobs are designed to limit repetitive movement.	4.5	100%	3.75	100%

EP4	Work rotations or changes in job responsibilities are used to minimize exposure to ergonomic risks.	4.65	100%	3.25	80%
EP5	Ergonomic factors are considered when purchasing new tools, equipment, or furniture.	4.85	100%	4.25	100%
EP6	Ergonomic factors are considered when providing modified work to injured employees.	4.85	100%	4.25	100%
EP7	The organization incorporates ergonomic principles in its health and safety training to minimize the risk of injury.	4.75	100%	3.75	100%
EP8	The organization evaluates ergonomic interventions to determine if they were successful.	4.85	100%	3.25	80%

4.1.1 Most Validated DM indicators and Practices: Building vs Heavy Sectors

The validity of the indicators reflected their ability to benchmark and evaluate disability management (DM) and RTW within the construction industry. The highest rated and most significant indicator within the building sector was “Ergonomics practices”, as compared to “Injury Prevent practices” for the heavy sector. The indicators had a “highly valid” score of 4.97 and an expert agreement percentage of 100% and 4.66 and an expert agreement percentage of 100% respectively. This is significant in that it shows that when it comes to DM, the building sector prioritizes the design of the work environment in order to optimize worker well-being, ensure workers are stay safe, comfortable, and productive, whilst working to ensure overall system performance (Antwi-Afari et al, 2020; Quaigrain and Issa 2015, Ratri and Pradip Kumar, 2012). Nath et al. (2017) postulated that ergonomics interventions and designs can reduce significantly reduce the risk of strains and sprains and other related musculoskeletal injuries (MSIs) which as been noted as the most common work-related injury within the construction industry (Lingard and Wakefield, 2019; Inyang et al. 2012). This consistent with the overall goal of safety management

as captured by “Injury prevention practices” rated highly by the heavy construction sector as a key priority when implementing DM within their specific sector. ‘Ergonomics” and “injury prevention” practices overlap significantly as their overall goal is essentially the same, ensuring a safe and productive. work environment. This has been theorized by several studies such as Lingard and Wakefield (2019) and Fang et al. (2015) which emphasize that a systematic and effective safety management system considerably reduces the number of injuries in the workplace through the prevention and control of hazards, minimizes the risk of major accidents and risks and improves worker morale and productivity. In terms of their validated practices, of the 8 refined practices under “Ergonomics”, the building industry highly validated that all to be assessed, with an average mean score of 4.73 and expert agreement percentage of 100%. Also, for the heavy sector, of the 19 refined practices under “Injury prevention practices”, all practices were highly valid, with an average mean score of 4.15 and expert agreement percentage of 98%.

The second most valid indicator for the building sector was “injury prevention practices” with a highly valid mean score of 4.92, and an expert agreement percentage of 100%. This is a confirmation of the importance of safety management as a key component of DM implementation as put forward by Quaigrain and Issa (2017): (2021b), Linguard and Saunders 2004 and Chen et al. (2017). This finding is in line with earlier rating by the heavy sector, rating it as the most valid and a bedrock of overall DM within construction. In contrast, for the heavy sector the second most valid indicator was “senior management support practices” with a mean score of 4.36, and an expert agreement percentage of 100%. Ofori and Toor (2012) considered “senior management support” to be key ingredient in the promotion of DM, without which any program no matter how well intentioned and designed will inevitably fail. The indicator’s high relevance is also due to its

ability to influence budgetary allocation and overall prioritization within the organization (Habeck and Kirchner, 1999), which as essential if the program will succeed. In terms of their validated practices, for the buildings sector's "injury prevention practices", similar to that of the heavy sector, all 19 refined practices were also rated highly valid with an average mean score of 4.61 and perfect expert agreement percentage of 100% across board, which is only 2% higher than that of the heavy sector. This is evidence that when it comes injury prevention and safety management, both sectors are in high agreement and therefore, its implementation is consistent across the entire industry. For the heavy sectors "senior management support practices (SMP)' of the 4 refined practices, only 3 were validated to be reflective of how the industry approached that indicator, with an average mean score of 4.08 and expert agreement percentage of 93%. SMP2 "The DM manager receives support from senior management" was not validated as the experts deemed it to be reflected in SMP1 "Senior management is actively involved in the DM/RTW program". This is in direct contrast to that of the building sector which deemed both practices to be separate and distinction, and therefore essential to spell them out separately without ambiguity. Hence, SMP1 and SMP2 emphasize that senior management had to be actively involved in DM as well as make provisions to adequately support the DM manager to drive the program forward and continuously improve.

The third most valid indicator in respect to the building sector was found to be "senior management support practices" with a highly valid score of 4.79, and a perfect expert agreement percentage of 100%. Although rated as the third most valid indicator and the second most valid indicator for the heavy sector, it had a mean score of 9.86% higher within the building sector. Ultimately the high ranking and highly validation across both sectors pinpoints to the relevance

and role of senior management in driving the prioritization of injury management, DM and disability issues within the industry. This is in line with the arguments made by Baril et al. (2003) and Williams-Whitt et al. (2016) that organizational readiness and the beliefs and values of senior managers are critical factors in facilitating and driving to DM practices within the workplace. Moreover, Baril et al. (2003) in their qualitative research project across three Canadian provinces exploring the perceptions of many different actors involved in return-to-work (RTW) and DM programs for injured workers, found a strong correlation between RTW program success and labor–management relations and senior management commitment to Health and Safety.

Distinctively, for the heavy sector the third most valid indicator was "return to work practices" with a mean score of 4.25, and an expert agreement percentage of 100%. The indicator was rated the fourth most valid indicator within the building sector with a highly valid score of 4.6 and an expert agreement percentage of 100%, which is 13% higher than in the heavy sector. It widely acknowledged that interventions that promote return to work (RTW) following injury is critical to DM, rehabilitation and the reduction long-term disability and absenteeism (Gray et al. 2019, Newman et al. (2014), Pransky et al. (2005). A number of studies have demonstrated a link between the level and type of support offered by the employer to the injured worker and overall RTW realization. The majority of these have noted that greater employer support is associated with better RTW outcomes and overall DM outcome (Williams-Whitt et al. (2016), Gray et al. (2019), Quaigrain and Issa, (2019), Quaigrain and Issa (2021a), Jetha et al. (2018), Van-Valzen et al. (2011), Feuerstein et al. (2001), Labriola et al. (2006), Lane et al. 2017)). Regarding the validated practices, for the buildings sectors' "senior management support practices", as stated earlier, all 4 practices were highly validated, with an average mean score of 4.1 and expert

agreement percentage of 100%. Also, for the heavy sectors "return to work practices" (RAP) of the 15 practices conceptualized and refined, only 12 were validated in comparison to 14 practices validated for the building sector. The practice "An individual job assessment is conducted for injured employees as part of their RTW plan to determine the specific physical and mental demands of jobs" was not validated by either sectors as its was deem incorporated in other practices such as RAP9 "A general job assessment/physical demands assessment is completed for each job in the workplace to facilitate the development of RTW plans for injured employees" and RAP11 "The organization provides productive and meaningful modified work to injured employees in a timely manner". RAP5 "DM/RTW role candidates/ or third parties' entities (EAP) are assessed prior to hiring to ensure they have the required knowledge and skills." and RAP6 "The job description for the DM/ RTW role emphasizes DM/ RTW importance and duties" were not validated by the heavy sector. This is a key point of departure when it comes to how DM and RTW are approached in each sector of the construction industry. Whilst the role of the DM manager is highly seen as key to DM implementation within the building industry, the heavy industry disagrees and focuses on laid down systems and procedures to drive the program.

For the heavy sector, the fourth most valid indicator was deemed "program evaluation practices" with a mean score of 4.18 and an expert agreement percentage of 100%. Similarly, the indicator was rated at the fifth most valid indicator with a mean score of 4.53 and an expert agreement percentage of 100%, an 8.37% increase from the heavy rating. As indicated by both sectors of the industry, a DM program cannot exist and thrive if it is not assessed and evaluated on a regular basis. This agrees with best practices postulated by Lane et al. (2017) and Jetha et al. (2018) that DM program evaluation helps ensure an organizations' DM program is comprehensive, helps identify gap within the program, and plays a critical role in ensuring a smooth-running program

and ultimately, a smooth transition back to work for injured workers. Studies (cf. Quaigrain and Issa (2021a), Labriola et al. (2006), Williams-Whitt et al. (2016)) have shown that if a RTW fails, the chances of it failing a second time is 80%. Therefore, designing a strong DM strategy including "program evaluation practices" can greatly prevent relapse and reduce safety risks. It can also reduce employer costs overall (Feuerstein et al. 2001). Regarding the validated practices for "program evaluation practices" all 10 refined practices were highly validated by both sectors, with an average mean score of 4.57 and expert agreement percentage of 100% for the building sector and 4.13 and expert agreement percentage of 100% for the heavy sector.

"Recruitment and retention" was found to be the fifth most relevant indicator for the heavy sector with a highly valid score of 4.07 and an expert agreement percentage of 80%. The high validity of the indicator is not surprising as workforce shortages are a significant impediment within the industry, with companies scrabbling to secure, attract and retain skilled workforce to drive projects and growth (Ganesh and Tyagi 2021, Lui-Farrer et al. 2021). Ormerod and Newton (2013) asserted that an area construction companies can significantly use to attract young people into the industry is by demonstrating high worker retention rates, job security and a comprehensive, detailed and worker-oriented safety management system and injury management and RTW program. Regarding the validated practices for "Recruitment and retention" only 1 practice RRP 8 "The organization ensures confidentiality when dealing with employees' disabilities" was validated out of the 9 practices in contrast to 8 being validated for the building sector. Only "A disabled employee or DM expert is part of the recruitment panel" practice wasn't validated for the building sector. The significant difference in validated practices between the two sectors can speculatively to attributed to traditional views and perceptions held by the heavy construction sector that

disabled/injured workers have no place in the construction industry. This ideology was purported by Lingard and Saunders (2004) and supported by Newton and Ormerod (2005), Tshobotlwane (2005), Clarke et al. (2009) and Winter et al. (2015). In their studies investigating the construction industries in Australia, United Kingdom, South Africa, Netherlands and Canada, they conclusively argued that the nature of the industry is such that many construction employees do not have a long-term relationship with their employers, compounding the unwillingness of employers to accommodate them should they get injured (*ibid*). Furthermore, their studies pinpointed that although the industry upheld high safety standards and recognized that health and safety issues that affected both disabled and non-disabled employees, construction organizations did not for the most part recognize the importance of employing disabled persons even in the face of persistent labor shortages. Therefore, base on the findings in this study, the building sector seems to be moving away from this and actively embracing change, adopting necessary polices to attract and retain workers irrespective of disability, something the heavy sector is actively shying away from.

The sixth most relevant indicator for the building sector was "regulatory and compliance practices" which was validated with a highly valid mean score of 4.25, and an expert agreement percentage of 100%. Similarly, the sixth most validated indicator for the heavy sector was "ergonomics practices" with a highly valid mean score of 4.02, and an expert agreement percentage of 80%. "Regulatory and compliance practices" rating is as expected as a company cannot run successfully without showing evidence that all laid out policies and regulations are adhered to. Newton and Ormerod (2005) in their survey of the top 100 construction companies in the UK found that most companies only had minimal policies regarding DM, only as required by regulation and legislation to be compliant, with only a quarter going beyond that to provided policies on how to effectively support its disabled workers.

This is evidence that for DM to be prioritized by most companies, there must be the necessary legislation to drive if further forward, as its now mostly market driven. It is interesting that although "ergonomic practices" was the highest validated indicated within the building sector, it only ranked sixth in the heavy sector. However, it was still in the top validated indicators suggesting its importance and relevance to overall DM within both sectors. In terms of their respective validated practices, all 3 defined practices under the building sectors' "regulatory and compliance practices" were validated, with an average mean score of 4.78 and an expert agreement percentage of 100%. All 8 practices under the heavy sectors' "ergonomic practices" were validated with an average mean score of 3.81 and an expert agreement percentage of 95%.

4.1.2 Least Validated DM indicators and Practices: Building vs Heavy Sectors

The least relevant indicator for the building sector was "physical accessibility practices" with a valid score of 3.88 and an expert agreement percentage of 71.4%. Its perceived low relevance may be due to the fact that the physical accessibility of the project site or office has the most upfront cost, and arguably has minimal effects on H&S performance. However, construction companies may lose out significantly on potential clients and needed skilled workers if the office or project is inaccessible. Additionally, accessibility in the workplace is not the only issue, accessibility of the workstation is also pivotal if RTW plans and, modified work provided to injured workers will be successful as some workers on modified duties may require it (Williams-Whitt et al. 2016). Similarly, for the heavy sector, the least validated indicator was surprisingly "regulatory and compliance practices" with a valid mean score of 3.24 and an expert agreement percentage of 80%. It can be argued that it low rating within the heavy sector is due to that fact that irrespective of

existing company priorities, companies have no choice but comply with laid down regulations and therefore shouldn't have a significant effect on DM. This is in direct contrast to its rating within the building sector, which perceived the indicator as vital to a successful DM program, rating it as one of the most relevant indicators. In regard to their validated practices, of the 6 defined "physical accessibility practices", even with the low rating the building sector validated all 6, with an average mean score of 3.56 and an expert agreement percentage of 88%. Also, regarding "regulatory and compliance practices" similar to that of the building sector, all 3 practices were validated for the heavy sector, with an average mean score of 4.17 and an expert agreement percentage of 93%.

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In line with the building sector, second least relevant indicator for the heavy sector was "physical accessibility practices" with a valid mean score of 3.25 and an expert agreement percentage of 60%. Both sectors perceive that, notwithstanding its significance to managing disability in general (Newton et al. 2007), compared to other factors its not as relevant or widely embraced by the industry. This is in agreement with Winter et al. (2015), who found that of the 88 construction companies in Canada surveyed, only 6 to 33% provided physical accommodations. Additionally, in direct contrast to the heavy sector, "recruitment and retention" was the second least validated indicator for the building sector with a valid mean score of 3.98 and an expert agreement percentage of 85.7%. In spite of its rating, its mean score is comparable to that of the heavy sector's mean score of 4.07, indicating that the difference between the two sectors in regard to how relevant this indicator is, is minimal. By implication both sectors agree that a robust DM should have policies promoting the inclusion of injured and disabled worker and should work to retain and attract such workers. However, as discussed previously, the building sector validated 8 of the 9 defined practices under "recruitment and retention" in comparison to only 1 for the heavy sector.

Also, regarding “physical accessibility practices”, the heavy sector only validated 2 of the 6 defined practices, with an average mean score of 3.75 and an expert agreement percentage of 80%.

“Claims management practices” was rated as the third least valid indicator for both the building and heavy sectors, with valid mean score of 4.08 and an expert agreement percentage of 100% and with valid mean score of 3.28 and an expert agreement percentage of 60% respectfully. The low relevance of the indicator as agreed upon by both sectors is surprising since studies have proven that managing claims is as important as managing any other aspect of DM (Lane et al. 2017). The benefits of effective claims management include faster recovery time for injured workers, reduced operational downtime, reduced claims costs, and less negative impact on an organization's experience modification index, which is a determinant of premiums set by insurance bodies. Nevertheless, the indicators’ low relevance may be because companies are more likely to have a robust claims management system in place as compared to other areas because it directly affects their bottom-line. All 4 “claims management practices” were validated by both sectors, with the building sector averaging a mean score of score of 4.13 and an expert agreement percentage of 96% and heavy sector averaging mean score of 3.94 and an expert agreement percentage of 100%.

Again, “communication practices” was the fourth least relevant indicator for both the building and heavy sectors, with a highly valid score of 4.10 and an expert agreement percentage of 85.7% and mean score of 3.61 and an expert agreement percentage of 80% respectively. Despite its overall rating, its high mean score implies its still regarded as relevant and essential when developing and building a DM program. This is because communicating accommodations and existing DM policies as well updating workers on any subsequent changes helps keeps workers informed about

available accommodations, which significantly increases their ability to access these accommodations. This finding is in line with Jetha et al. (2018) who defined communication as one of the most important factors influencing overall RTW success. Effective communication between the DM manager and workers (injured worker) helps ensure early intervention, which has been proven to ensure that injured workers return to work in the earlier time possible. Of the 9 defined "communication practices", 8 were validated by the building sector with an average mean score 4.24 and an expert agreement percentage of 95%. The practice "Employees affected by the DM/ RTW program are provided with appropriate information in a timely manner" was deem unnecessary and encompassed in the validated 8 practices such as CP1, CP2, CP3 and CP4. For the heavy sector, only 6 were validated, with a mean score of 3.71 and an expert agreement percentage of 93%. In addition to the practice not also validated building sector, CP3 "Communication is open, and employees feel free to voice their concerns and make suggestions about DM/ RTW" and CP6 "Employee's representative(s) is/are involved in the development of the DM program, specifically parts that directly affect them" were not validated. This is evidence of how differently communication practices is perceived and practiced in the building sector as compared to the heavy sector.

4.1.3 Highest Ranked and Most Critical DM Indicators: Building vs Heavy Sectors

The analysis of the AHP results revealed that "Injury prevention practices" and "return to work practices" was the most critical indicators to overall DM performance for the building and heavy sectors respectfully. This is in cognisance with earlier work by Quaigrain and Issa (2021a) who found theses indicators to be the most matured and widely implemented within the construction industry. This was also in line with earlier findings by Quaigrain and Issa (2017) who found "return

to work practices" most important critical factor when implementing DM followed by "injury prevention practices, when they initially proposed and developed the DM indicators. The earlier study assessed these indicators with eight experts across the construction industry, making no distinction between the two sectors, building and heavy. The earlier study also failed to formally validate and refine the 12 proposed DM indictors, not ascertaining how well suited and reflective they were of DM practice within the construction industry. Interestingly, Quaigrain and Issa (2017) found "Injury prevention practices" as the second most critical indicator to overall DM performance, which is a departure from how the building sector rated, which rated it as the most critical, with "return to work practices" being a close second. The critically ranking in Quaigrain and Issa's (2017) earlier study is more in line with that of the heavy sector, which rated Injury prevention practices" as the most critical, with "return to work practices" rated as the second most critical and "senior management support practices" rated as the third most critical. In all, both sectors criticality ranking is in agreement, with the highest ranked indicators being the almost same, which a confirmation of the earlier study (ibid) and which indicators are most critical and thus more practice and standardized within the construction industry. A DM program cannot exist without a robust safety management system, and ultimately within the construction industry the DM program most likely falls under the safety management. Therefore, how strong and matured a safety program is can directly impact how matured the overall DM is. This was the premise of the earlier study by Quaigrain and Issa (2021b), who found that companies with more matured and high performing DM programs also had lower recordable injury rates (RIR), severity rates (SR) and lost time case rates (LTCR), that is, it corresponded with a matured and high performing health and safety program and vice versa. The findings also confirm how important safety is taken across the industry, with studies like Mohammadi et al. (2018), Guo et al. (2015) and Rajendran and

Gambatese (2009) arguing that since safety is a key determinant of overall project success and ability to secure future projects, construction companies consider it crucial to business success and longevity, and thus, allocate the necessary resources to ensure a strong running program. “Return to work practices” similarly is seen as the bedrock of a DM program, and a predominant determinant of how well a DM operates and succeeds (Lane et al. 2017, Lingard and Saunders 2004, Newton and Ormerod 2005). A robust RTW ensures companies retain experienced workers, with studies (Lingard and Saunders 2004, Newton and Ormerod 2005) asserting, that injured workers who remain at home beyond six months only have a 20% chance of returning to work, hence, early intervention and provision of graduated modified and alternative work is critical. Also, a comprehensive RTW promotes reduced worker turnover, better worker relations, better productivity and most importantly lower claims cost and thus lower workers’ compensation costs. “Senior management support” as rated by both sectors and Quaigrain and Issa (2017) is critical to overall DM performance in that, inadequate upper management involvement and backing of overall DM program will ultimately ensure programs does not receive the necessary resources to succeed, despite a well laid out program. Jetha et al. (2019) noted that defining detailed roles and responsibilities is arguably the most important step in defining an DM/injury management (IM) program and in ensuring success. Without clearly set roles and responsibilities especially as it ascertains to senior management responsibilities, the processes and programs established will not be realised. Integrating disability management throughout the company, with all levels of staff involved in understanding the process and their roles in it, together with the backing of appropriate policies and procedures indicates management's commitment to best practice. Integrated work disability planning and management improves morale and the bottom line (Dyck 2017, Gray et al. 2019).

Regarding the building sector, “ergonomic practices” was ranked as the second most critical indicator to overall DM performance, which is in cognisance with its ranking as the most valid indicator. Just as with the validation scores, the heavy sector in direct contrast rated the indicator as the least critical to DM, which is more in line with Quaigrain and Issa (2017) earlier findings, who rated the indicators as the eighth most critical, falling in the lower ranking as the least critical. The drastic difference in the perception of this indicator between the two sectors shows how critical is it to study DM distinctly between building and heavy sectors, as one overall ranking is not representative of how DM is seen, and which aspects are more prioritized. Whilst the design of work process and integration of ergonomic principles is seen as a critical to success indicator in overall DM management within the building sector, this isn’t that case within the heavy sector. The argument made by experts within the heavy sector is that ergonomic principles are by default integrated and therefore has less of an effect on how successful a DM program is.

“Case management practices” was ranked as the fourth most critical to success indicator to DM within the building sector and whilst “recruitment and retention practices” was rated as the fourth most critical within the heavy sector. The ranking of “case management practices” within the building sector contrasts with Quaigrain and Issa (2017), who rate it as the third least critical to DM performance. This shift in perception of “case management practices” are in line with the argument made by Creen (2018) that workplace case management programs can reduce health care costs and sickness absence, as well as hastening the worker's rehabilitation, which hastens a workers RTW. Also, the ranking of “recruitment and retention practices” within the heavy sector is surprising as although rated as one of the most valid indicators, only one practice was validated

within that indicator. The ranking however is not a total departure from earlier study by Quaigrain and Issa (2017), where it was rated as the seventh most critical to DM performance. Managing for employee retention involves strategic actions to keep employees motivated and focused so they elect to remain employed and fully productive for the benefit of the company (Dyck 2017). A comprehensive employee retention program can play a vital role in both attracting and retaining key employees, as well as in reducing turnover and its related costs, which is something clearly recognized and valued within the heavy sector.

In line with the heavy sector, “senior management support practices” was ranked as the fifth most critical to success indicator to DM/IM, which is a recognition of the importance of a well-defined role of senior management in a DM program and its influence on program success. Alternatively, “communication practices” was ranked as the fifth most critical to DM within the heavy sector. This is a major improvement as it was ranked as the ninth most critical by Quaigrain and Issa (2017). “Communication practices” is arguably the most important factor in DM as posited by Jetha (2021), WCB (2020), Williams-Whitt (2016) and Dol et al. (2021) despite its ranking. Ineffective communication causes problems within all aspects of DM. Managing a return to work requires the input of many participants, and it's hard to achieve a good outcome unless everyone involved is communicating effectively (Dol et al. 2021, Jetha et al. 2021). Communication and collaboration are inherently more difficult in return-to-work because each stakeholder has a different perspective and context (Jetha et al. 2021), however, managing DM is a cooperative process that needs the input of all the stakeholders, and it's hard to achieve good results unless everyone is communicating.

The sixth most critical to success indicator for the building was “regulatory and compliance practices”, whilst that for the heavy sector was “case management practices”. “Regulatory and compliance practices” ranking within the building sector is in cognisance with Quaigrain and Issa (2017) who ranked it as the fifth most critical, implying its importance to overall DM. As previously discussed, case management practices as ranked fourth by the building sector, a clear departure from the findings in Quaigrain and Issa (2017) is seen by both sectors as an important component of DM, which involves early intervention by the case manager at the time of injury and does not end until the worker returns to work successfully (Angeloni 2013). Implementation of a case management program requires the commitment of the company, and everyone must take responsibility for their own role in the program (Jetha et al. 2021).

4.1.4 Least Ranked and Critical DM Indicators: Building vs Heavy Sectors

“Physical accessibility practices” was found to be the least critical to success indicator affecting DM within the building sector and the second least critical within the heavy sector. This is probably because despite its importance physical accessibility features and practices are not always in place or practiced by several construction companies especially at project sites, because provincial regulation does not require it (WCB, 2020) and it’s seen as more invasive and costly. This was affirmed by Winter et al. (2015), who surveyed 88 construction companies in Canada and found that only 33% provided physical accommodations such as accessible workstations, technical aids and devices, accessible elevators, accessible workstations and accessible transportation within their workplaces. “Ergonomic practices” not surprising was ranked as the least critical to success indicator within the heavy sector as previously discussed, in direct contrast to the building sector who rated it as the second most critical component within a DM program, reaffirming the sectors

commitment to integrating safety within all aspect of project planning and delivery. On the other hand, “recruitment and retention” was ranked as the second least critical to success indicator, which consistent with its ranking as the second least valid indicator by the sector but in contrast with Quaigrain and Issa (2017) ranking as the 7th most critical. The lower ranking within this study could be attributed to other indicators being seen as more critical to success comparatively.

“Claims management Practices” was ranked as the third least critical indicator within the building sector and the fifth least critical within the heavy sector, which is somewhat in line with Quaigrain and Issa (2017) who rated the indicator as the second least critical. The low relative importance of the indicator may be because most organizations outsource the management of claims to third party companies and/or effectively expect workers to coordinate injury claims with the workers compensation board (Bakhary et al. 2009). The later strategy is rarely effective as workers aren’t provided with timely information to file claims in time or adequately, which in turn has adverse effects on RTW plans.

The only indicator consistently ranked by both sectors was “program evaluation practices” as the 4th least critical (or 8th most critical) to DM. Despites its relative lower ranking by both sectors, its importance cannot be overstated. DM/IM program effectiveness must be measured with critical resources, therefore, understanding the need for measurement and benchmarks at all stages of program development (leading indicators) and post-implementation (lagging indicators) is essential. Data can assist in the evolution of a DM program to ensure gaols are met, as well as the improving worker experience (Jetha, 2021). Measuring the ability to return employees back to

work assists RTW coordinators to support and document their assumptions, theories, and progress (Quaigrain 2019, Quaigrain and Issa 2021a, Dol et al, 2021).

Surprisingly, "communication practices" was ranked by the building sector as the fifth (7^{th} overall) least critical indicator to DM performance. Its ranking is an improvement, as it graduated from 4^{th} least critical in the study by Quaigrain and Issa (2017). However, its ranking is significantly below that of the heavy sector, which ranked it as the fifth most critical. Its ranking midway between the indicators still shows that the building sector understands its role within DM and expects companies to have clearly established communication lines and for communication to be in a language easy understood by all stakeholders within the DM program, from workers, DM manager, supervisors, to physicians and senior management.

4.1.5 Relationship between Criticality Ranking and Validation Scores of the DM Maturity Indicators

The resonance of the AHP rankings and expert agreement percentages and that between AHP rankings and validation scores is shown in Table 11 for both building and heavy sectors. The Spearman's correlation confirmed that the AHP criticality rankings of the indicators and their validation mean scores had a statistically significant and strong inverse correlation for both building and heavy sectors, with a value of (R= -0.882) and (R= -0.70) respectively. Again, the analysis also found a statistically significant and moderated inverse relationship between the AHP critically rankings of the indicators and expert agreement percentage for both building and heavy sectors, with a (R= -0.533) and (R= -0.613) respectively. Thus, reaffirming the existence of a strong relationship between criticality or importance of the indicators and their validity within the

construction industry. This shows that as the relative criticality ranking of the indicators decreased, their validation scores and expert agreement percentage also decreased but in an unsteady trend, hence the inverse correlation. This affirms the existence of a relationship between the relevance of the indicators (as represented by its validity score) and its importance (as represented by its AHP ranking) to overall DM performance, which is logical and expected. For instance, within the building sector "Injury prevention practices" was the most critical indicator with a highly valid score of 4.92 and a 100% expert agreement. Also, "Ergonomic practices" was the second most critical indicator and had a highly valid score of 4.97 and expert percentage agreement of 100%. Similarly, "Return to work practices" was the third most critical indicator with a highly valid score of 4.6 and expert agreement percentage of 100%. "Case management" was the fourth most critical indictor with a high valid score of 4.22 and expert agreement percentage of 85.7%. This trend similarly applied within the heavy sector. For example, "Return to work practices" was the most critical indicator with a highly valid score of 4.25 and a 100% expert agreement. Also, "Injury prevention practices" was the second most critical indicator and had a highly valid score of 4.66 and expert percentage agreement of 100%. Additionally, "Senior management support practices" was the third most critical indicator with a highly valid score of 4.36 and expert agreement percentage of 100%. Finally, "Recruitment and retention" was the fourth most critical indictor with a high valid score of 4.07 and expert agreement percentage of 80%.

Table 11: Correlation between Criticality Ranking of Indicator and their Validation Scores

Correlation	**R**	**P**
Building and Heavy validation mean scores	0.63636	0.035
Building AHP ranking and validation mean scores	-0.882	0.00033
Heavy AHP ranking and validation mean scores	-0.70	0.0165
Building AHP ranking and expert agreement percentage (insignificant)	-0.533	0.0913
Heavy AHP ranking and expert agreement percentage	-0.613	0.044

There were a few indicators with low relative importance, but high relevance. For instance, within the building sector "Program evaluation practices" was the 4th least important indicator, with a highly valid score of 4.53 but a high expert agreement percentage of 100%. This is probably because program evaluation enables companies to define a strategy for tracking the program's progress towards achieving its goals, indicating what, how, when, and from whom data will be gathered, thus its moderately high relevance. Dol (2021) had found RTW programs that don't put in the necessary mechanisms to track its performance will inevitably fail.

Similarly, Quaigrain and Issa (2021b) found a strong positive correlation between the level of maturity in DM program and the overall safety performance. Thus, systematically assessed matured DM programs positively influenced the overall safety performance. Nevertheless, the tracking DM programs is not usually priority for construction companies as there previously did not exist the tools to assess the maturity of DM programs, which may explain its low importance to experts. However, this paradigm has and will continue to shift with the development of the CDM3 (Quaigrain and Issa 2021a), which assesses DM programs maturity, and the conceptualization of DM metrics (Quaigrain and Issa, 2021b) which assess performance using lagging indicators. Also, within the heavy sector "Ergonomic practices" was found to be the least critical indicator but had a highly valid score of 4.02 and an expert agreement percentage of 80%.

Despite the indicator's low relative criticality, its high relevance indicates its impact DM performance is significant. This is because ergonomic principles help ensure the design and layout of the workplace and project sites are the saftest and minimizes accidents and injuries (Gray et al. 2019).

4.2 DM Performance Metrics Evaluation and Validation

This section presents the results of the validation of the proposed DM performance metrics and a discussion of the results in the context of the wider literature. The first subsection highlights the validation results based on the validating experts' ratings of the extent to which the performance metrics satisfied the criteria of relevance, practicality, appropriateness (analytical soundness) and uniqueness. The second subsection discusses the metrics which satisfied the validating criteria with respect to their relationship with the validated DM maturity indicators.

4.2.1 Validated DM Performance Metrics for Building and Heavy Construction Sectors

Table 12 and 13 shows the validation scores for each performance metric based on the criteria of relevance (R), practicality (P), appropriateness (A), and uniqueness (U) for the building and heavy sectors. The 26 conceptualized DM metrics were respectively validated by experts for the building and heavy sectors to ascertain which metrics were most applicable and appropriates for their respective sectors of the construction industry. Of the 26 proposed metrics, 25 were validated for the building industry whilst only 15 were validated for the heavy industry. This disparity in the number of validated metrics can be attributed partly to how differently DM is approached within each sector, which practices are standard and therefore should be implemented and thus, based on

these, which metrics are most applicable. The disparity can also be attributed to the differences between the two sectors, from project types, budgets, project timelines, project complexity, worker turnovers and project organizational structures (Pheny and Hou, 2019). It should be noted that all 12 DM metrics previously proposed by Quaigrain and Issa (2021b) in their earlier study were validated by both sectors.

For the full set of the 25 validated DM performance metrics for the building sector, the average scores for relevance, practicality, appropriateness and uniqueness were 4.33, 4.11, 4.28 and 4.37 (out of 5) respectively, with an average mean score of 4.27. Overall, of the 25 validated metrics, 23 performance metrics were rated highly valid (i.e., mean validation score equal to/more than 4 or equal to 5), with the remaining 2 being rated as valid (i.e., mean validation score equal to/more than 3.0 or equal to 3.99). Breaking it down further, with respect to relevance, 19 performance metrics were rated highly valid (i.e., mean validation score equal to/more than 4 or equal to 5), while the remaining 6 were rated valid (i.e., mean validation score equal to/more than 3.0 or equal to 3.99). For practicability, 16 of the performance metrics were rated highly valid and 9 were rated valid. For appropriateness (analytical soundness), 22 performance metrics were rated highly valid and 3 valid. Finally for uniqueness, 24 performance metrics were rated highly valid and only 1 was rated as valid.

In respect to that of the heavy sector, of the 15 validated DM performance metrics, the average scores for relevance, practicality, appropriateness and uniqueness were 4.26, 3.85, 3.84 and 3.88 respectively, with an average mean score of 3.96, significantly below that of the building sector. Overall, of the 15 validated metrics, 5 performance metrics were rated highly valid (i.e., mean

validation score equal to/more than 4 or equal to 5), with the remaining 10 being rated as valid (i.e., mean validation score equal to/more than 3.0 or equal to 3.99). Breaking it down further, with respect to relevance, 13 performance metrics were rated highly valid (i.e., mean validation score equal to/more than 4 or equal to 5), while the remaining 2 were rated valid (i.e., mean validation score equal to/more than 3.0 or equal to 3.99). For practicability, 3 of the performance metrics were rated highly valid and 12 were rated as valid. For appropriateness (analytical soundness), 2 performance metrics were rated highly valid, whilst 13 were rated as valid. Finally for uniqueness, only 4 performance metrics were rated highly valid and the remaining 11 rated as valid.

Table 12: Building Sector Validation Scores for DM Metrics

Metric	Definition	Validation Criteria				
		R	**P**	**A**	**U**	**Mean score**
DM1	Percentage of employees who are DM/ RTW practitioners	3.89	3.75	4.4	4.6	4.16
DM2	Percentage of employees involved in DM/ RTW planning	4.20	3.90	4.3	4.6	4.25
DM3	Percentage of employees who received DM/ RTW training	4.46	4.13	4.3	4.7	4.40
DM4	Percentage of DM/RTW practitioners who received training	4.7	4.03	4.5	4.4	4.41
DM5	Percentage of employees who returned back to work from injury leave	4.87	4.34	4.6	4.73	4.64
DM6	Percentage of injured employees who required case management	4.73	4.45	4.5	4.4	4.52
DM7	Percentage of injured employees who are away on injury leave	4.43	4.3	4.6	4.4	4.43

DM8	Percentage of injured employees who actively participated in the development of their individual RTW plans	4.48	4.2	4.5	4.2	4.35
DM9	Percentage of injured employees who were placed on modified work	4.67	4.23	4.5	4.4	4.45
DM10	Percentage of employees who transitioned from temporary work to their original work	4.63	4.23	4.6	4.4	4.47
DM11	Percentage of injured employees whose job were modified	3.97	3.95	4.1	4.2	4.06
DM12	Frequency of how quickly injured employees were contacted following the onset of injury	4.23	3.6	3.1	4.2	3.78
DM13	Percentage of injured employees whose functional abilities form was filled out	4.73	4.23	4.4	4.2	4.39
DM14	Percentage of employees who received any type of physical accommodation	4.13	3.93	4.3	4.2	4.14
DM15	Percentage of injured employees whose workstations were physically modified	3.93	4.15	4.1	4.4	4.15
DM16	Percentage of employees who received health and wellness/stress management training	4.47	4.28	4.4	4.4	4.39
DM17	Frequency of overall DM program evaluations	4.5	4.38	4.5	4.4	4.45
DM18	Ratio of cost of DM/ RTW claims against number of claims	4.4	4.23	4.0	4.4	4.26
DM19	Percentage of disabled employees in the organization	3.93	4.13	4.0	4.6	4.17
DM20 (DM21)	Percentage of hiring staff trained in Equity	3.8	3.88	3.7	4.2	3.90

	Diversity and Inclusion (EDI Training)					
DM21 (DM22)	Percentage of injured workers retained following the onset of injury	3.8	4.63	3.9	3.8	4.03
DM22 (DM 23)	Percentage of employees doing physical work who are trained on ergonomic practices	4.47	4.10	4.5	4.4	4.37
DM23 (D24	Percentage of employees who received ergonomic accommodations	4.23	3.98	4.4	4.4	4.25
DM24 (DM25)	Percentage of jobs designed to reduce heavy lifting and repetitive movement	4.27	3.8	4.4	4.4	4.22
DM25 (DM26)	Percentage of new tools, equipment, or furniture that incorporate ergonomic principles	4.33	3.83	4.3	4.2	4.17

Table 13: Heavy Sector Validation Scores for DM Metrics

Metric	**Definition**	**Validation Criteria**				
		R	**P**	**A**	**U**	**Mean score**
DM2	Percentage of employees involved in DM/ RTW planning	3.96	3.7	3.8	3.8	3.82
DM3	Percentage of employees who received DM/ RTW training	4.1	3.75	3.95	3.7	3.88
DM5	Percentage of employees who returned back to work from injury leave	4.27	3.8	3.56	3.8	3.86
DM7	Percentage of injured employees who are away on injury leave	4.6	3.97	4.1	4.1	4.19
DM8	Percentage of injured employees who actively participated in the development of their individual RTW plans	4.12	3.67	3.53	3.7	3.76

DM9	Percentage of injured employees who were placed on modified work	4.75	4.10	3.75	3.7	4.08
DM10	Percentage of employees who transitioned from temporary work to their original work	4.0	3.6	3.7	3.8	3.78
DM11	Percentage of injured employees whose job were modified	4.10	3.78	3.9	3.75	3.88
DM12	Frequency of how quickly injured employees were contacted following the onset of injury	4.10	3.8	3.75	3.9	3.89
DM18	Ratio of cost of DM/ RTW claims against number of claims	3.67	3.87	3.75	4.0	3.82
DM21 (DM22)	Percentage of injured workers retained following the onset of injury	4.10	3.77	3.97	4.10	3.99
DM22 (DM23)	Percentage of employees doing physical work who are trained on ergonomic practices	4.13	3.98	3.9	3.8	3.95
DM23 (DM24)	Percentage of employees who received ergonomic accommodations	4.70	4.0	3.9	4.10	4.18
DM24 (DM25)	Percentage of jobs designed to reduce heavy lifting and repetitive movement	4.65	4.05	3.85	3.90	4.11
DM25 (DM26)	Percentage of new tools, equipment, or furniture that incorporate ergonomic principles	4.7	3.98	4.20	4.10	4.25

Experts from both sectors noted that the conceptualized metrics where comprehensive and cover each area within DM. It was also noted by experts that these metrics formulation were comparati8vely more straightforward to measure and interpret as it was expressed in percentages, as opposed to existing safety metrics such as RIR, SR and LTCR widely adopted within the industry. This is in line with the assertations by Lingard and Wakefield (2019) and Reiman and Pietkäinen (2012) who questioned the usefulness and validity of so these established safety lag indicators (i.e. metrics), arguing their formulations are hard to understand and interpret. Lingard

and Wakefield (2019) and Dekker and Pitzer (2016) suggested the use of composite measures of performance that combine traditional lag indicators with positive indicators of management activity (leading indicators). They postulated that for metrics to have positive impact on overall organisational performance, they must be based on predictive performance model (lead indicators), which the validated DM metrics were.

For the building sector only 1 (3.855) of the 26-performance metrics were found to be invalid and thus dropped for that sector. The metric "percentage of hiring committees that include a DM/RTW practitioner" (see table 5) was not validated as it was deemed impractical to expect construction companies to all have a DM expert on it, and rather favored the training of all committee members on equity diversity and inclusion (EDI) as expressed in DM20 "percentage of hiring staff trained in equity diversity and inclusion (EDI training". For the heavy sector 11 (42.3%) of the 26-performance metrics were found to be invalid and thus dropped for that sector. In addition to the metric dropped by the building sector, validated building sector metrics such as DM1, DM4, DM6, DM13, DM14, DM15, DM16, DM17, DM19 and DM20 (see table 11) were found to be impractical for the heavy sector, which is consistent with the validated DM practices under the validated DM indicators for the heavy sector. For example, of the 8 proposed practices under "recruitment and retention" indicator, only 1 was validated for the heavy sector. Thus, it makes sense based on these proposed practices, of the 4 metrics conceptualised under that indicator, only 1 DM21 was validated by heavy sector.

4.2.2 Validated DM Performance Metrics Relationship with DM Maturity Indicators

For the 25 and 15 validated performance metrics shown in Table 14 and 15 respectively for the building and heavy sectors, there have been categorized under their applicable DM maturity indicator (leading indicators) as they were conceptualized based on the indicators inherent in the CDM3. This way of metrics development has been acclaimed by Lingard and Wakefield (2019) and Dekker and Pitzer (2016) and Orugun (2020) as the best methodology for metrics conceptualization.

Table 14: Building Sector Validated DM Metrics per Indicator

Metric	Definition	Indicator
DM1	Percentage of employees who are DM/ RTW practitioners	Communication Practices
DM2	Percentage of employees involved in DM/ RTW planning	Communication Practices
DM3	Percentage of employees who received DM/ RTW training	Communication Practices
DM4	Percentage of DM/RTW practitioners who received training	Return to Work and Accommodation Practices
DM5	Percentage of employees who returned back to work from injury leave	Return to work and accommodation Practices
DM6	Percentage of injured employees who required case management	Case management, Program evaluation
DM7	Percentage of injured employees who are away on injury leave	Return to work and accommodation, Program evaluation
DM8	Percentage of injured employees who actively participated in the development of their individual RTW plans	Return to Work and Accommodation Practices
DM9	Percentage of injured employees who were placed on modified work	Return to work and accommodation, Program evaluation
DM10	Percentage of employees who transitioned from temporary work to their original work	Return to work and accommodation, Program evaluation
DM11	Percentage of injured employees whose job were	Return to Work and

	modified	Accommodation Practices
DM12	Frequency of how quickly injured employees were contacted following the onset of injury	Case Management Practices
DM13	Percentage of injured employees whose functional abilities form was filled out	Case Management Practices
DM14	Percentage of employees who received any type of physical accommodation	Physical Accessibility Management Practices
DM15	Percentage of injured employees whose workstations were physically modified	Physical Accessibility Management Practices
DM16	Percentage of employees who received health and wellness/stress management training	Disability and Injury Prevention Practices
DM17	Frequency of overall DM program evaluations	Program Evaluation Management
DM18	Ratio of cost of DM/ RTW claims against number of claims	Claims management Practices
DM19	Percentage of disabled employees in the organization	Recruitment and Retention Polices
DM20 (DM21)	Percentage of hiring staff trained in Equity Diversity and Inclusion (EDI Training)	Recruitment and Retention Polices
DM21 (DM22)	Percentage of injured workers retained following the onset of injury	Recruitment and Retention Polices
DM22 (DM 23)	Percentage of employees doing physical work who are trained on ergonomic practices	Ergonomic Practices
DM23 (D24	Percentage of employees who received ergonomic accommodations	Ergonomic Practices
DM24 (DM25)	Percentage of jobs designed to reduce heavy lifting and repetitive movement	Ergonomic Practices
DM25 (DM26)	Percentage of new tools, equipment, or furniture that incorporate ergonomic principles	Ergonomic Practices

Table 15: Heavy Sector Validated DM Metrics per Indicator

Metric	**Definition**	**Indicator**
DM2	Percentage of employees involved in DM/ RTW planning	Communication Practices
DM3	Percentage of employees who received DM/ RTW training	Communication Practices
DM5	Percentage of employees who returned back to work from injury leave	Return to work and accommodation Practices
DM7	Percentage of injured employees who are away on injury	Return to work and

	leave	accommodation Practices
DM8	Percentage of injured employees who actively participated in the development of their individual RTW plans	Return to Work and Accommodation Practices
DM9	Percentage of injured employees who were placed on modified work	Return to work and accommodation, Program evaluation
DM10	Percentage of employees who transitioned from temporary work to their original work	Return to work and accommodation, Program evaluation
DM11	Percentage of injured employees whose job were modified	Return to Work and Accommodation Practices
DM12	Frequency of how quickly injured employees were contacted following the onset of injury	Case Management Practices
DM18	Ratio of cost of DM/ RTW claims against number of claims	Claims management Practices
DM21 (DM22)	Percentage of injured workers retained following the onset of injury	Recruitment and Retention Polices
DM22 (DM23)	Percentage of employees doing physical work who are trained on ergonomic practices	Ergonomic Practices
DM23 (DM24)	Percentage of employees who received ergonomic accommodations	Ergonomic Practices
DM24 (DM25)	Percentage of jobs designed to reduce heavy lifting and repetitive movement	Ergonomic Practices
DM25 (DM26)	Percentage of new tools, equipment, or furniture that incorporate ergonomic principles	Ergonomic Practices

Regarding the validated metrics under “communication practices”, of the 3 metrics proposed, all were validated by the building sector whist only 2 were validated for heavy sector. DM1 “percentage of employees who are DM/ RTW practitioners” was found to be impractical for the heavy sector. Again, for “return to work practices”, of the 7 proposed performance metrics, all were validated by the building sector and 6 were validated by the heavy sector. These “communication practices” and ‘return to work” metrics tend assess the involvement of employees in the RTW process, the training received by employees and managers on RTW policies and

procedures, the number of employees on modified duties, those who successfully returned to work, employee's participation in the development of their RTW plan etc. Under "case management practices" of the 3 metrics proposed, again, all 3 were validated by the building sector, whilst only 1 was validated for the heavy sector, which is in cognisance with the practices validated under that indicator for the heavy sector. Only 1 metrics was proposed under "claims management" 1 all of which was validated by both sectors. "Case management" and "claims management metrics measure how early a company contacts injured worker as this has been seen a key predictive of early RTW (Angeloni, 2013, Gray et al. 2019), number of employees on case management, completion of functional abilities form in a timely manner and cost of claims as against the number of claims. No metric was proposed under "injury prevention practices" as this has been extensively captured within the literature, with a vast number of health and safety performance metrics proposed by a wide range of studies, coverall all aspects of safety management (cf. Orugun and Issa 2021, Mohammadi et al. 2018, Swuste et al. 2012, Lingard and Wakefield 2019, Guo et al. 2015).

Furthermore, under "physical accessibility practices" all 2 proposed metrics were validated by the building sector, with none being validated for the heavy sector. This is not surprising as only 2 of the 6 practices were validated by the heavy sector, none of which cover what is measured in the 2 proposed metrics. The 2 metrics measure physical accommodations received by employees and modifications to workstations as may be required by incoming employees or returning injured employees. Arguably, all validated metrics fall under "program evaluation practices" as this leading indicator measures an organizations overall assessment of their DM program by collecting necessary data, reviewing for trends, identifying areas of success, assessing for problem areas, and

documenting results, savings, and return on investment (ROI) for the organization. Aligning the measurements of these metrics to show the effect on important key company values will allow the DM manager to place a more precise value on the DM program's services and contributions to the organization's success as well (Lane et al. 2019, Dol et al. 2021).

No metrics were proposed under “senior management support” and “regulatory and compliance practices” as these areas are not easily quantifiable and are more qualitative in nature. However, under “recruitment and retention” of the 4 metrics proposed, as earlier discussed 3 were validated by the building sector whilst only 1 was validated by the heavy sector. Metrics under this indicator measures the number of disabled employees in an organization, training of hiring staff in EDI and how many employees are retained and successfully integrated back to work following injury. Finally, for “ergonomic practices”, all 4 metrics were validated by the building and heavy sectors. Validated metrics under this indicator measures the training of employees in ergonomic principles as applicable to their work, ergonomic accommodations, jobs designed to reduce heavy lifting and repetitive movement and the procurement of tools, equipment, or furniture that consider ergonomic principles.

4.3 Overall Maturity of DM/RTW: Building vs Heavy sectors

This section presents the results of the implementation of the web-based DM/RTW benchmarking tool. It reports on the industry and company’s overall maturity and the indicator’s level of implementation within the industry as a whole. It also discusses the relationship between the relative importance of the indicators and their level of implementation within the industry. These results were also discussed within the wider context of the literature. The Cronbach’s alpha (α)

value for the assessment worksheet was 0.986, which was above the acceptable internal consistency and reliability threshold of 0.70. This suggested the CDM3 survey results were reliable and produces consistent results.

4.3.1 Overall Maturity of DM/RTW: Building vs Heavy sectors

At the industrial level, the 21 companies had an overall mean MS of 3.97, thus performing at the standardized maturity level (i.e. MS greater than 3 and below 4), as shown in Table 16. Breaking it down further, 10 companies operated at the quantitatively managed maturity level (i.e. with MS Company greater than or equal to 4 and below 5), with the remaining 11 companies operating at the standardized maturity level. This performance is comparatively lower than in the earlier study by Quaigrain and Issa (2021a), who assessed only 10 companies, with the assessment worksheet (i.e. survey) of the CDM3 within that study not validated by the industry. In their study, companies mean MS was 4.06, thus operating at the quantitatively managed maturity level as opposed to the construction industry found to be at the standardized maturity level within this study. The difference however is marginal with only 0.09 difference. This difference could be attributed to the relatively larger number of participating companies, therefore being more representative of the industry DM performance benchmark, and more diverse companies participating in the study, with companies from both sectors within the industry. This finding reinforces the need to strengthen DM and injury management programs within all sectors of the industry, as the industry is not progressing as it should be. More companies should be made aware of the importance of not only having a DM/RTW and injury management program, but the need to continually assessed them to ensure they met industry best practices, as demonstrated in this study, and meet program goals. Lingard et al. (2018) and Liu-Farrer et al. (2021) stressed the need for construction companies

strengthen strategies to retain and motivate workers through robust work health and safety programs, which includes DM/RTW and injury management programs. When workers are seen as valued within their organization, they are more motivated, productive, and committed to the organization which leverages the organization chances of attracting more skilled workers to them and the industry at large (Newton and Ormerod, 2005).

Table 16: DM Maturity Scores by Industry, Sector, Company size, Industry classification and Geographic region

	Maturity Score (MS)	**Potential growth (PG)**
MS Industry	3.97	1.03
Industry Type		
MS Building Sector	4.04	0.96
MS Heavy Sector	3.80	1.20
Company Size		
MS Small Companies	4.0	1.0
MS Medium Companies	3.89	1.11
MS Large Companies	3.98	1.02
Building Sector Company Size		
MS Small Companies	4.16	0.84
MS Medium Companies	3.89	1.11
MS Large Companies	4.05	0.95
Heavy Sector Company Size		
MS Small Companies	3.69	1.31
MS Large Companies	3.86	1.14
Industry Classification		
Building Construction	4.05	0.95
Drywall and Stucco Contracting	3.86	1.14
Roofing and eavestroughing	4.21	0.79
Painting and decorating	3.97	1.03
Roadwork	3.75	1.25
Pipeline Construction	3.90	1.10
Geographic Region		
R1 - Winnipeg	3.95	1.05
R3 - Portage & Selkirk & Mordern-Winkler	3.94	1.06
R4 – Pas, Flin Flon, Thom & Swan River	4.05	0.95
R7-South rural	4.27	0.72

At the sector levels, the building and heavy sectors had an overall average MS of 4.04 and 3.80, thus performing at the quantitatively managed and standardized maturity level respectively. The sectors thus have an overall potential growth of 0.96 (19.2%) for the building sector and 1.20 (24%) for the heavy sector. An independent t-test showed no statistically significant difference ($p > 0.05$) between the average MS for the building and heavy sectors. Spearman's' correlation analysis also found no statistically significant correlation between the MS for the building sector and the heavy sector. The finding implies that, within the building sector, DM/RTW is more matured and robust, and thus companies within the sector perceive DM as an integral part of managing projects as compared to the heavy sector. The building sector also performed above average when benchmarked against the industry MS of 3.97, which is significant in that the heavy sector averagely performed below that benchmark. The marginally higher MS of the building sector could be attributed to all but one DM indicator performing better within the building sector comparatively. Only "Recruitment and retention" was found to be more matured with an MS of 4.0 within the heavy sector than the building sector with an MS of 3.43. This significant difference can be attributed to the vast difference in the number of validated practices within that indicator, with the building sector validating 8 out of 9 defined practices, and the heavy sector validating only 1. These maturity levels were all again below the threshold of 4.06, which was the average MS of companies in the study by Quaigrain and Issa (2021a). Within the building sector, 9 companies had MS from 4.01-4.46 thus operating at the quantitatively managed maturity level, and the remaining 6 companies had MS from 3.47-3.97, thus operating at the standardized maturity level. Interesting, the highest performing company, with an MS of 4.46 was a small sized company (i.e. Company 1), whilst the least matured company with an MS of 3.47 was a large sized company (i.e. Company 4), with more disposable resources. However, within the heavy sector, only 1

company had an MS above 4, that is, 4.01, thus operating at the standardized maturity level, which happens to be a large sized company (i.e. Company 4). This challenges the narrative purported by Quaigrain and Issa (2021a) that large sized companies tend to have less matured DM programs compared to small sized companies, who had relatively more matured DM/RTW programs. The remaining 5 companies had MS from 3.5-3.88, thus operating at the standardized maturity level, with the least matured company with an MS of 3.5 being a small sized company (i.e. Company 1).

Spearman's correlation analysis found a statistically significant ($p<0.000$) very strong positive relationship between the average MS at the industry level and that of building sector ($R=0.951$). Also, the analysis similarly found a statistically significant ($p<0.05$) positive relationship between the average MS at the industry level and that of heavy sector ($R=0.525$). This implies that as the industry level of maturity increases, the performance at the building and heavy sectors also significantly improves. This is important in that strategies aimed at promoting DM should be implemented industry wide if there would be significant improvements. Strategies also must be sector specific as based on these findings more work is required to promote the culture of DM within the heavy sector than the building sector. While the building sector more positively perceives the importance of retaining and integrating injured workers back to work and employing disabled workers, the heavy sector actively resists and agree with the arguments made by Lingard and Saunders (2004) Eppenberger and Haupt (2003), Clarke et al. (2009) and Tshobotlwane (2005). They argue that the structure of the construction industry does not foster employment of disabled workers and such workers have no place within the industry. This is made very clear in the validated practices under "Recruitment and retention" as the practices relating to the employment of disabled workers, fair and accessible recruitment polices, and training in EDI were

all not validated by the heavy sector but was resoundingly validated by experts within the building sector. Future research is recommended to investigate this vast difference in perception between both sectors and draw out a strategic framework to address this so there is cognisance within the entire industry.

4.3.2 Overall Maturity of DM: Comparison of Performance per Size, Location and Industry Classification

Table 16 also shows the mean DM MS values of industry by company size, industry classification and geographic region. The Kruskal-Wallis test showed that none of these differences were statistically significant ($p > 0.05$). At the industry level per company size, small sized companies performed marginally better with a mean MS of 4.0 than medium and large sized companies, which had mean MS of 3.89 and 3.98 respectively. This finding was echoed in Quaigrain and Issa (2021a) who found small-sized companies to have more matured DM/RTW programs than medium and large-sized companies. This finding, with a larger more representative sample affirms that despite the findings in Winter et al. (2015), small-sized companies tend to have standardized strategies in place to reintegrate injured workers and hire more disabled workers than medium and large-sized companies. Winter et al. (2015) in contrast asserted that small-sized companies found it more difficult to provide DM accommodations than medium to larger ones, and that large companies also developed more customized RTW plans. Their study was however a simple survey based on perception of having a DM program, unlike the actual assessment of DM programs conducted within this study, thereby making the findings within this study more representative of what is happening within the industry. Kenny (1999) and Lingard and Saunders (2004) reiterated similar sentiment that large sized companies should ideally have more matured DM programs as they have

more resources in their disposal to integrated injured workers. Spearman's correlation analysis found a statistically significant ($p<0.05$) strong positive correlations between the mean MS at the industry level to that of small, medium, and large-sized companies with R-values of 0.791, 0.841 and 0.97 respectively. This implies that as company DM maturity improves (i.e. either small, medium or large-sized), it has a direct influence at the industry level.

Breaking it down by sector, similar patterns were found within the building sector, with small sized companies outperforming medium and large-sized companies with a mean MS of 4.16, in comparison with the mean MS of 3.89 and 4.05 by medium and large-sized companies respectively. In direct contrast, within the heavy sector, large-sized companies were found to be more matured with a mean MS of 3.86 than small-sized companies with a mean MS of 3.69, a departure from the findings at the industry and building sector levels. Their findings affirm the assertation made by Winter et al. (2015) and Lingard and Saunders (2004). Future research is recommended to investigate why larger companies in heavy sector have more matured DM programs than in the building sector.

Analysing DM performance per industry classification, companies that fell under "Roofing and eavestroughing" were found to have the most matured DM programs with a mean MS of 4.21. It is noted that only 1 company identified within this category. This followed by companies that fell under "Building Construction", with a mean MS of 4.05. The majority of companies (i.e. 12) identified within this category, which is important in that, it can be implied that companies within "Building construction" value not only having a DM program but also ensuring lower worker turnover, with companies doing all they can to retain them. Companies that fell within "Painting

and decorating" had the third most matured DM programs with a mean MS of 3.97. This was closely followed by companies within "Pipeline construction" with a mean MS of 3.90. The least matured industry classification were companies under "Roadwork", with a mean MS of 3.75. This isn't surprising in that these fell under the heavy sector, which performed below the industry benchmark of 3.97. These findings are eye opening as it further contextualizes DM within the industry and more importantly which sectors, industry classification and regions require more targeted resources and training to ramp-up and improve their DM/RTW and injury management programs.

Furthermore, analyzing DM performance per geographic region reveals that, companies operating in rural regions of the province (i.e. R3 - Portage & Selkirk & Mordern-Winkler, R4 – Pas, Flin Flon, Thom & Swan River and R7-South rural) which were 4 in number had more matured DM programs with mean MS of 4.09 comparatively. Interesting 3 out of these 4 companies were large sized companies, with the 1 being a medium sized company. Therefore, it can be concluded that although collectively at the industry level medium to large-sized companies DM/RTW are less matured than small-sized companies, rural based medium and large-sized companies are the exception in that, hey tend to have more matured DM program. This could be attributed to value placed on skilled workers in the rural areas where there is historical high demand for such workers but very small supply (Ganesh and Tyagi 2021). Surprisingly however, companies based mostly within urban areas (i.e. R1 – Winnipeg), which was the majority (i.e. 17 companies), collectively had the least matured DM programs, with a mean MS of 3.95. Companies within urban areas should ideally have more matured programs owing to the number of resources accessible within these areas such as such training programs offered by industry associations and the Workers'

Compensation Board of Manitoba. Because of the small sample of companies investigated per category (i.e. size, industry classification and geographic region, those findings do not entirely reflect the industry in Manitoba, Canada and cannot therefore be generalized. Nevertheless, the findings give some useful insights on the DM maturity within the industry in MB and represent therefore a concrete foundation upon which future studies involving larger sample size could be undertaken. The online DM benchmarking tool data should therefore be analyzed yearly to ascertain the performance of the industry as it remains a permanent digital tool companies are encouraged to continually use to benchmark their DM programs.

4.3.3 Maturity of DM Indicators

Table 17 and figures 22 and 23 shows the maturity of the indicators at the industry level, sector level and per company size. As illustrated, none of the indicators achieved full maturity either at the industry level, sector level or per company size. It should be noted that consistently in the building sector, all but one indicator performed better compared to the heavy sector, with only "Recruitment and retention practices" being more matured in the heavy sector compared to the building sector. As illustrated in figures 24 and 25, "Disability injury prevention" (i.e. safety management) was found to be the most matured and highest performing indicator in at the industry level and at the building and heavy sectors with MS of 4.42, 4.50 and 4.23 respectively. Again, this indicator was found to be the highest implemented and performing indicator irrespective of company size, with MS of 4.41, 4.44 and 4.42 on small, medium, and large-sized companies respectively. This high performance across the industry is a testament of how regulated safety is within the industry, thus companies take is very seriously to ensure they have a robust safety management system in place irrespective of the sector they belong to, company size or location.

Antwi-Afari et al. (2020) asserted that safety is considered as a major concern for all sectors and organizations within construction. This can be the source of many direct and indirect costs. A good safety management system that fosters a safety culture ultimately ensures improvements in quality and production, increased employee morale, gains in employee recruiting and retention and better result (Vignoli et al. 2021, Lingard et al. 2017).

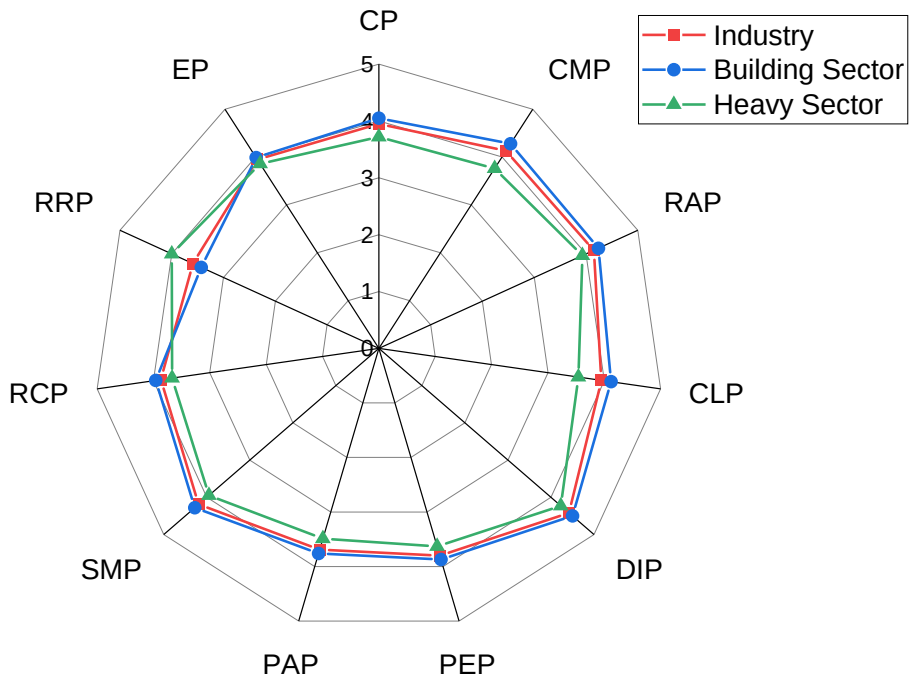

Figure 22: Maturity of DM Indicators at the Industry and Sector levels

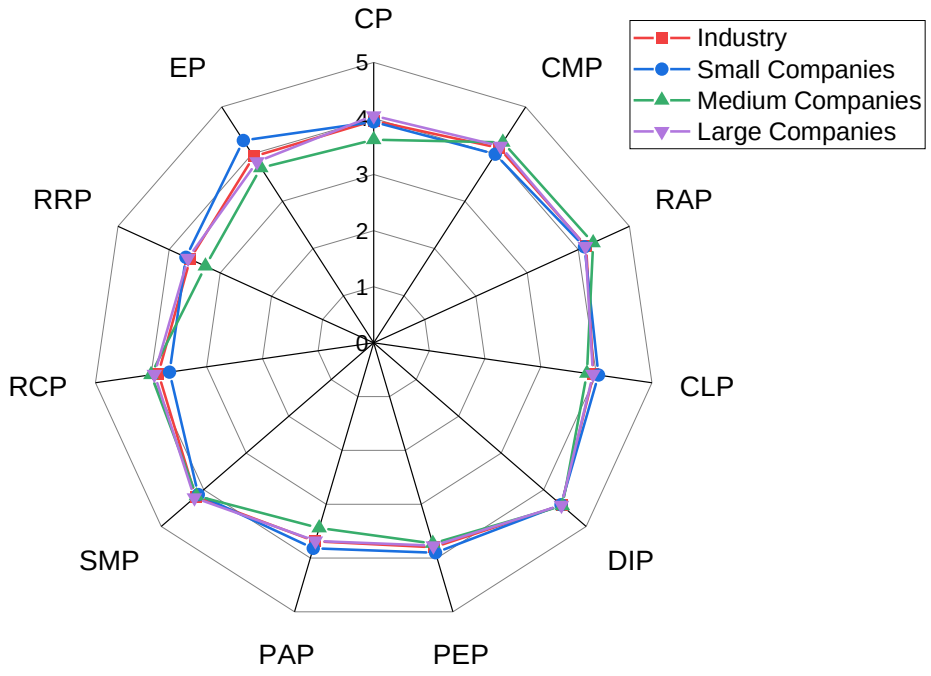

Figure 23: Maturity of DM Indicators per Company Size

Table 17: Maturity of DM Indicators breakdown for the Industry, Building sector, Heavy sector and per Company size

Indicator	**MS Industry**	**MS Building**	**MS Heavy**	**MS Small**	**MS Medium**	**MS Large**
Communication Practices	3.96	4.05	3.72	3.94	3.62	4.05
Case Management Practices	4.13	4.28	3.76	4.00	4.25	4.17
Return to work Practices	4.15	4.24	3.93	4.12	4.29	4.14
Claims management Practices	3.95	4.12	3.54	4.04	3.83	3.94
Disability injury prevention Practices	4.42	4.50	4.23	4.41	4.44	4.42
Program evaluation Practices	3.80	3.87	3.63	3.90	3.73	3.77
Physical accessibility Practices	3.69	3.76	3.49	3.82	3.44	3.68

Senior management support Practices	4.19	4.28	3.95	4.13	4.17	4.22
Regulatory and compliance Practices	3.87	3.96	3.67	3.67	4.00	3.94
Recruitment and retention	3.59	3.43	4.00	3.67	3.29	3.63
Ergonomics Practices	3.95	3.99	3.86	4.29	3.71	3.84

The second most matured and highest performing indicator differed quite a bit across the industry. At the industry level and in the building sector, “Senior management support” was found to be the most matured, with MS of 4.19 and 4.28 respectively. These findings were reflected in Quaigrain and Issa (2021a) who reversely found “Senior management support” to be most matured indicator with an MS of 4.60, with “Disability injury prevention” being the second most matured with an MS of 4.44 across the 10 companies assessed. Also, at the building sector, “Case management” was jointly found to the second most matured indicator with an MS of 4.28, which was observed to the fourth most matured indicator with an MS of 4.16 in the earlier study by Quaigrain and Issa (2021a). In the heavy sector however, surprisingly, “Recruitment and retention” was found to be the second most matured with an MS of 4.0. This is surprising considering the sector only validated 1 of 9 defined practices, with the validated practice covering confidentiality when dealing with employees with disabilities and injuries. However, is finding is in line with Quaigrain and Issa (2021a) who found this indicator to be the third most matured, with an MS of 4.18. Nevertheless, the earlier study assessed all 9 defined and unvalidated practices, unlike that of the heavy sector in this study. Prior to assessment, the model CDM3 with its indicators and practices where formally validated within the building and heavy sectors. “Senior management support” was however found to be the third most matured and highest performing indicator in the heavy sector, with an MS of 3.95. The importance of “Senior management support” cannot be overstated, as they dictate to

some extent the level of success of DM program, as they decide the amount of resources allocated and its relevance at the organizational level (Lane et al. 2017). It is therefore extremely encouraging to see the majority of companies within the industry taking it so seriously to ensure management is in full support of their DM program, and senior management recognizing the value of having a comprehensive DM/RTW program. “Senior management support” was also found to be third most matured indicator in small-sized companies with MS of 4.13, with “Ergonomic practices” being the second highest performing indicator with MS of 4.29. In medium-size companies, “Senior management support” was the fourth most matured indicator with MS of 4.17, with “Return to work” and “Case management being the second and third highest performing indicators with MS of 4.29 and 4.25. Only in large sized companies did “Senior management support” emerge as the second most matured indicator, with MS of 4.22.

The third most matured and highest performing indicator at the industry level and building sector and fourth most matured in the heavy sector was “Return to work practices” with MS of 4.15, 4.24 and 3.93 respectively. This represents a huge improvement from the earlier study by Quaigrain and Issa (2021), who found the indicator to be one of the least matured, with MS of 3.86. This improvement indicates a paradigm shift and high level of awareness by the industry of the important of Return-to-work practices. RTW is arguably the bedrock of DM program as these practices embody the goal of DM, the safe reintegration of injured and disabled workers back into the workplace and in the construction industry as a whole. The recognition which has been translated into performance improvement is a positive indication that the industry is willing to adapt and allocate the necessary resources to develop and continually improve their DM programs. “Return to work practices” was also found to the fourth most matured in small and large-sized

companies with MS of 4.12 and 4.17 respectively, and the second most matured in medium-sized companies as earlier stated. “Case management” was found to be the fourth most matured indicator at the industry level and in the heavy sector with MS of 4.13 and 3.76. The indicator performed marginally better in the building sector, being the second most matured with “Senior management support” in the building sector with MS of 4.28.

“Recruitment and retention” and “Physical accessibility practices” were found consistently to be the least matured and lowest performing indicators at the industry and building sector level and across all companies irrespective of company size. “Recruitment and retention” MS at the industry, building sector and across small, medium, and large-sized companies were of 3.56, 3.43, 3.67, 3.29 and 3.63 respectively. This is in agreement with Quaigrain and Issa (2021a) who also found the indicator to be the least matured with MS of 3.59. The only exception was in the heavy sector, where the indicator performed better and was found to the second most matured indicator with MS of 4.0. Also, with “Physical accessibility practices” MS at the industry, building and heavy sectors and across small, medium, and large-sized companies were 3.69, 3.76, 3.49, 3.82, 3.44 and 3.68 respectively. This suggest that companies perceive “Recruitment and retention” and “Physical accessibility practices” the least important and thus do not have the necessary polices and strategies in place to adequately address these practices in their workplaces. Therefore, is it recommended that since this finding is consistent throughout the industry that the industry collectively put in the necessary measures in the form of training programs, workshops, incentive programs etc., to encourage companies to strengthen their inclusively polices, injury management polices, EDI policies and increase accessibility in offices and project sites.

4.3.4 Relationship between Indicator's AHP criticality rankings and their Level of Implementation (CDM3) Rankings

Spearman's' correlation showed that there were statistically significant ($p<0.05$) strong correlations ($R= 0.873$ and $R=0.609$) between the AHP critically rankings of the indicators in the building and heavy sectors and industry maturity score rankings of the indicators respectively. Additionally, the analysis found statistically significant ($p<0.05$) strong correlations ($R=0.733$) between the AHP critically rankings of the indicators in the building sector and sector maturity score rankings. Similarly, in the heavy sector, statistically significant ($p<0.05$) strong correlations ($R=0.70$) were found between the AHP critically rankings of the indicators and sector maturity score rankings. This implies that consistently across the industry, indicators that were deemed most critical to DM performance (AHP weightings), in practice performed better and had high maturity, and indicators that were deemed least critical to DM performance, in practice were the lowest performing and least matured. This finding is in cognisance with Quaigrain and Issa (2021a) who found that the highest rated indicators by experts (AHP) also performed better and vice versa. The statistically significant correlation of the relationship may be attributed to a similar sense priority as perceived by the experts in the building and heavy sector and assessed companies. This similar perception shows which indicators of DM are considered essential and therefore widely implement and which ones are seen as less important and therefore less widely implemented. The shared perception of priority is shown in "Disability injury prevention" and "Return to work" indicators which were ranked the two most critical indicators in the AHP evaluation by both sector and were found to the most matured indicators at the industry and sector levels. Again, the least critical indicator for both the building and heavy sectors which was "Physical accessibility practices", was also found to be the least implemented and least matured indicator at the industry and sector levels.

CHAPTER 5: CONCLUSION

This chapter summarizes the research findings for each outlined research objective. This is followed by a discussion of the overall implications of the study, research limitations, recommendations for future research and concluding remarks

5.1 Summary of Research Findings

The project evaluated DM within the construction industry using a theoretically developed and empirically validated maturity model called the Construction Disability Management Maturity Model (CDM3) and 26 newly developed and validated DM performance metrics in the building and heavy sectors. The previously developed CDM3 inherent indicators and practices were refined using the concept of constant comparative analysis based on grounded theory. By using this approach, the project was able to do develop more condensed practices inductively by categorizing, coding, delineating categories and connecting them. As a result of the process, the project went from 134 previously developed DM practices categorized under 12 DM indicators (Quaigrain 2019) to 98 refined practices categorized under 11 DM indicators. The previously developed 12 metrics (Quaigrain 2019) were revised and simplified, with new metrics conceptualized developed and added to them, resulting in a total of 26 DM metrics. The refined indicators and practices, as well as the 26 DM metrics were validated by expert judgment using defined criteria of 'relevance', 'practicality', 'appropriateness', and 'uniqueness' for the indicators and metrics validation and 'relevance', 'conciseness' or 'clarity', 'appropriateness' and 'uniqueness' for the practices validation. Two technical working groups (TWGs) of industry experts made of 7 and 5 members respectively conducted the validation of the indicators, practices and metrics for the building sector and the heavy sector. These two different TWGs are needed

because the building and heavy construction sectors may not have the exact same needs and requirements when it comes to DM/RTW. In all, for the building sector all 11 DM indicators were validated and 91 of the 98 practices were validated to be included in the benchmarking of DM using CDM3. In the heavy sector, again all 11 indicators were validated and 75 of the 98 practices were validated to be included in the benchmarking of DM in the heavy sector. In regard to the DM metrics, a total of 25 of the 26 metrics satisfied the validation criteria for the building sector and 15 of the 26 for the heavy sector and will thus were included in benchmarking DM using lagging indicators at the respective sectors. The validated performance metrics improve on the already existing DM performance measures in the literature, as they allow DM performance to be conceptualized based on the DM maturity model that evaluates the maturity of DM practices. The 25 and 15 validated DM performance metrics in this research can help facilitate proactive DM. This is important as the industry shift the DM paradigm from reactive to proactive DM/RTW. These metrics also provide the construction industry with a tool to measure DM outcomes more effectively and identify DM lapses within existing programs. Therefore, any construction company that truly embraces the inclusivity philosophy within their organization should consider the use of these validated indicators, practices, and metrics. These indicators, practices and metrics can also be used as a tool to help construction companies evaluate and benchmark their DM activities on within their organization because these measures can target specific areas of their DM programs.

The potentially lower DM performance within the industry reinforces the need for tools that would improve their performance and improve the maturity of the DM practices implemented on them These validated indicators, practices, and metric provided the basis to develop an online DM benchmarking tool which provide the construction industry with web-based digital versions DM

benchmarking tools that enables construction workplaces to benchmark their DM/RTW performance in order to support continuous improvement. Two versions of the digital tool were developed, one for the building sector called "Building Sector DM/RTW Benchmarking Tool" and one for the heavy sector called "Heavy Sector DM/RTW Benchmarking Tool" based on their respective validated indicators, practices, and metrics. The digital web-based tools enable construction workplaces to receive DM assessment results immediately, providing each with empirical evidence about their actual performance in comparison to past performance and to average industry performance. This immediate feedback allows companies to identify their most effective DM/RTW practices and ones in need of improvement. Once developed, the tools were piloted by the 2 TWGs for the building and heavy sectors to assess its usability and navigability.

A survey was designed to collect the feedback from the experts in the 2 TWGs. The survey consisted of 8 questions, a combination of closed and open-ended questions. The results were analyzed and categorized to assess the feedback received, assessing the feasibility of the changes suggested and narrowing down to the most critical and feasible changes to be implemented on the tools. Once these final changes were made to the tool based on the piloting, the two tools were widely deployed industry wide. The "Building Sector DM/RTW Benchmarking Tool" is permanently host on the Construction Safety Associate of Manitoba's (CSAM) website and the "Heavy Sector DM/RTW Benchmarking Tool" is host on the Manitoba Heavy Construction Association (MHCA) Worksafely's website.

The tools were widely promoted within the industry using several strategies such as email notifications, on association's websites of CSAM, MHCA and Merit Contractors and widely

promoted in their newsletters and newspaper inserts. The project also utilized the associations' social media accounts such as Facebook, Twitter, and LinkedIn. A series of workshops and webinars was also organised in collaboration with CSAM and MHCA about the project, how to use the tool through in-depth reviews and benefits of the benchmarking tool to companies. In all, although 26 companies created accounts on the "Building Sector DM Benchmarking Tool" only 15 fully completed the DM survey and thus included in the analysis of the industry DM performance. In the "Heavy Sector DM Benchmarking Tool", although 8 companies set up accounts, only 6 fully completed the DM survey and thus included in the analysis of the industry DM performance. No company assessed their performance using the validated DM metrics mostly due to limited time window for the project. The tool is expected to remain permanently on the association websites and widely continue to be promoted within the industry after the project conclusion. The data collected via the online tools were analyzed.

On average, at the industry level, companies analyzed operated at the standardized maturity level, although building sector averagely had a slightly higher level of DM maturity operating at the quantitatively managed maturity level, than the heavy sector. However, the difference was statistically insignificant. Spearman' correlation analysis found a statistically significant very strong positive relationship between the average maturity score at the industry level and that of building sector and heavy sector, implying that the higher DM maturity at the sector levels positively influences the construction industry's overall DM maturity. The analysis also showed that small-sized companies implemented more mature DM practices, followed by large-sized companies then medium-sized companies, with only small-sized companies operating at the

quantitatively managed level. These finding were echoed in the building sector with small companies outperforming both large and medium-sized companies.

However, in the heavy sector, large-sized companies had more matured DM practices, outperforming small-sized companies. Also, companies classified under “Roofing and **e**avestroughing” had the most matured DM practices, followed by companies under “Building construction”. However, companies under “Roadwork” and “Pipeline construction” all under the heavy sector, had the least matured DM program and thus lowest performance. Additional, collectively, companies operating mostly in the rural regions (i.e. R3 - Portage & Selkirk & Mordern-Winkler, R4 – Pas, Flin Flon, Thom & Swan River and R7-South rural) had more matured DM programs than companies located in urban areas (i.e. R1 – Winnipeg). Further analysis using Kruskal-Wallis test showed statistically insignificant effects of company size, industry classification and geographic region on overall DM maturity.

The low level of implementation of some indicators within both building and heavy sectors reinforced the need to improve these DM indicators maturity in order to improve the maturity of DM programs. The findings also showed that at the industry level and at the building and heavy sector levels, “Disability Injury prevention” and “Senior management support”, and “Return to work” were the most mature indicators while “Physical accessibility”, and “Recruitment and retention” were the least mature. Also, consistently in the building sector, all but one indicator performed better compared to the heavy sector, with only “Recruitment and retention” being more matured in the heavy sector compared to the building sector. The research also found statistically

significant strong correlations between the AHP critically rankings of the indicators in the building and heavy sectors and industry maturity score rankings of the indicators respectively.

Additionally, the analysis found statistically significant strong correlations between the AHP critically rankings of the indicators in the building sector and sector maturity score rankings as well as the AHP critically rankings of the indicators in the heavy sector and sector maturity score rankings. This implies that consistently across the industry, indicators that were deemed most critical to DM performance (AHP weightings), in practice performed better and had high maturity and vice versa. These findings provide insight into how companies within both building and heavy construction sectors in Manitoba prioritize DM practices within their organizations.

The findings of this research assist companies identify the most critical DM practices to focus on in order to improve their DM performance. They can also use the online benchmarking tools (CDM3 and the DM metrics) to evaluate their organizations DM maturity and identify areas needing improvement. The research was limited by the relatively small sample size of 21 companies. Although significant efforts were made to widely promote the tools within the industry, the small window for the project meant companies that are waiting to use the tool later could not be included in the analysis. Future research projects should therefore investigate using the larger number of companies who would have then used the tools adequately.

5.2 Contributions to the body of knowledge and implications of this research

The project and its findings enabled the practical application of existing knowledge in new ways that foster the rehabilitation and return to work (RTW) of injured construction workers. It builds

on the tools developed in the previous research project (Issa and Quaigrain, 2018) to provide creative technological solutions that construction workplaces can use to evaluate and benchmark their disability management (DM) and RTW performance. While these solutions are based on these existing tools, these tools underwent a complete process of validation, adaptation, refinement and piloting before their eventual deployment and adoption. The project therefore applied the new knowledge gained through that process in developing new practical creative web-based solutions that improve occupational health and safety (OHS) practices and behaviour and foster the rehabilitation and RTW of injured workers.

This research is innovative and does not in any way duplicate any existing DM and RTW research or workplace initiative. It is the first of its kind in Canada to provide practical, creative web-based tools that construction workplaces in Manitoba (MB) can use to evaluate and benchmark their DM and RTW performance. These tools include the validated and refined Construction Disability Management Maturity Model and metrics. The validated and refined CDM3 enables companies to evaluate and benchmark the maturity of their DM and RTW practices. The model defines relevant key best practices that companies should implement and will allow these companies to assess their existing practices against these best practices. This is to determine their most mature DM and RTW practices and practices with the greatest potential for bottom-line impact. The validated and refined metrics enables them to quantitatively evaluate and benchmark their DM and RTW performance over time through the setting of target values for these metrics. This should strongly impact and improve the health and safety environment of construction workplaces in the short and long-term.

The web-based tools benchmarking tools for both building and heavy sectors are designed to provide immediate feedback to participating companies about their actual performance in comparison to past performance and to average industry performance. The tools also provide companies with immediate feedback on actions they can take to ensure continuous improvement of their DM and RTW performance. The web-based online accessibility of the tools will encourage construction workplaces to use them regularly, promoting thus their adoption across all of Manitoba.

The Construction Safety Association of Manitoba (CSAM) and the Manitoba Heavy Construction Association (MHCA) Worksafely are committed to permanently keep and promote the tools following the completion of the project. The tools are expected to permanently remain on their websites so that member companies can continue to use them after the project has ended. This should lead to the building of an industry-wide web-based DM and RTW database that will aggregate all assessment results and provide real-time industry averages that construction companies can compare themselves against for benchmarking purposes.

The project helps instill a culture of continuous improvement and learning in the construction industry in MB and lead to the development of robust organizational DM and RTW programs that would protect people with disabilities and ensure their safe RTW. It should also help break cultural and attitudinal barriers in the industry by encouraging construction workplaces to employ new workers with disabilities. The sharing of the project's results and the wider adoption of the tools to benchmark DM and RTW should enable stakeholders such as the WCB, the CSAM, the MHCA to develop new relevant guidance (e.g. guidelines, regulations, best practices) to support the

Manitoban construction industry. It should also provide opportunities for improving existing guidance such as the Workplace Safety and Health Act and the Certificate of Recognition Program designed to accredit companies that adopt a comprehensive health and safety program.

The program could mandate specific DM and RTW requirements and incorporate relevant elements and questions as part of its audit. This new and existing guidance should help address long-term standing issues in DM and RTW in the industry, encourage the adoption of relevant DM and RTW programs and foster the rehabilitation and RTW of injured and disabled construction workers. It should strongly improve the health and safety environment of construction workplaces and translate in the long-term to a reduction in on-site injuries, fatalities and related costs. These costs can take the form of premiums paid by contractors, compensation costs borne by the WCB, or public health costs spent on injured workers.

This work also positions the province of MB as a champion of DM and RTW performance assessment across Canada given its stakeholders' continuous efforts to develop, provide and promote relevant benchmarking tools for the construction industry. The project addresses issues that are very relevant and extremely important to the WCB. With support from other workers compensation boards, future studies can be replicated in other provinces so that the DM and RTW performance of the construction industry can be benchmarked across the country. The body of knowledge generated through the previous research and this project can also be used to develop a training course that complements the current one offered by the WCB and that addresses DM and RTW in Manitoba's construction industry. Given the drive to improve DM and RTW performance in many other industries across Canada, the project's tools can be adapted to fit these industries in

MB and beyond, thereby ensuring that the benefits of this work extend beyond the construction industry.

5.3 Limitations and recommendations

There were several setbacks experienced to the project. Although the researchers were diligent in adhering to the set timelines, there were a few activities that took longer than anticipated due to a number of unforeseen events. First, the "validation of the maturity model and metrics" which was expected to take three months took nine months complete. The data collection for the validation took a lot longer than expected. This was due in part to the required changes made to the data collection methods for the validation of the model and metrics, as stated in the previous progress report.

The change from focus group, which the timeline was based on, to individual data collection methods, meant an extended period to individually meet with each expert and collect the data. Additionally, recruiting the experts for the technical working groups was a lot more difficult than expected. Some of those who initially agreed to participate eventually declined because of the extensive nature of the validation surveys, which included surveys for the refined practices, each of the indicators and each of the 26 developed metrics and as well as completing the analytical hierarchy process matrix, thus, the average time required was from two to five hours. This combined with having to meet each expert separately to complete the surveys meant multiple meetings with just one expert, as well as long drawn-out meetings. This took more time to complete and thus the project was delayed.

Secondly, the "designing and developing of the web-based versions of the model and metrics" also took longer than expected as its completion was based on the results of the validated model and metrics. Although the structural framework for the web-based tool commenced as scheduled, the delay in the validation of the tools, delayed its completion, with it taking seven months to complete instead of the three months originally scheduled. This also consequently pushed back other dependent activities such as the 'piloting of the tool', and 'promotion and deployment of the tool. Additionally, although the tool was tested by the researchers and developers before piloting, unexpected issues with the tool invitation emails to the experts caused further delays. All subsequent troubleshooting efforts did not resolve the issue, as the experts still could not receive the invitation email to access and review the tool. Overall, it took a further month for the team at Bit Space to investigate the problem further and come out with a workable solution.

Thirdly, the initial principal investigator on the project unexpectedly fell sick and had to take an extended leave of absence from work to fully focus on his health, and this caused a minor setback. He eventually stepped down and the project had to find a replacement for him. The research associate working on the project day to day continued to work on the project despite these unforeseen changes. Finally, the Coronavirus (COVID-19) contributed to some of the setbacks in the project. The most affected activity was the 'promotion and deployment of the tool' to construction workplaces. The outlined delays meant a shorter deployment window for the developed online benchmarking tools, which inevitably lead to slower uptake of the tool as companies were prioritizing only essential business and were not immediately in a rush to access and use the tool right away. Therefore, companies that anticipated to use the tool later could not be included in the analysis within the report. Future research is therefore recommended to re-

analyze the data on the DM/RTW online benchmarking tool after a long period of time, where a lot of companies would have had the opportunity to use not only the survey part of the tool, but also the DM metrics to assess performance.

5.4 Concluding remarks

Employers (both the supervisors and the organization) are central to organizational work disability management, and their instrumental support can enable a more positive perception and awareness of the construction industry to disability, injury and the intentional integration of disabled and injured workers into the industry as a whole. Employers are often the first to be notified of an injury or illness and can be responsible for the development and implementation of RTW plans. Employers can also influence the hiring of disabled worker by championing inclusive hiring policies, actively removing barriers, providing the necessary accommodations, and acknowledging and confronting their inherent bias.

Though most construction companies are well versed in traditional methods to eliminate safety hazards and reduce injury risks in the workplace, there has been a growing interest in reducing the impact of injuries and illnesses by tracking work absences, facilitating early RTW, and communicating more proactively with. affected workers and their health-care provider. An effective DM/RTW has to evaluated, tracked and measures to ascertain if the outcomes meet set DM goals. In measuring organizational DM, solely focusing on using a discrete set of metrics to measure DM as a stand-alone facet of organizational performance is unhelpful because the resulting analysis does not provide an understanding of the emergence of DM in the broader organizational, technological, and social contexts of construction projects. To properly understand

an organization's DM performance, a broader set of indicators, consisting of both leading and lagging is required because DM does not occur in isolation.

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Appendix A

VALIDATION SURVEYS FOR DM PRACTICES, METRICS AND INDICATORS

REFINEMENT OF MODEL PRACTICES

The practices have been categorized under the 12 indictors. Respondents are to choose their level of agreement based on your expertise, whether each of the developed DM practices reflect industry standards and practice in regard to Disability Management (DM) and Return to Work (RTW).

Please state your level of agreement with the Construction Disability Management Maturity Model (CDM3) practices in regards to their **Relevance, Conciseness, Clarity and Uniqueness** using the numerical ranking below:

1=Strongly Disagree 2=Somewhat Disagree 3= Neutral 4=Agree 5= strongly agree

Definition of Criteria

1. Relevance: Extent to which you agree the practices measures and reflects DM in construction (insert: building construction or heavy construction). The degree to which the practice is related and useful in implementing and managing DM/RTW within the industry. Extent to which the practice is compatible with practical DM and RTW management within the construction (building construction or heavy construction) industry.

2. Conciseness: Extent to which the practice is simplified

3. Clarity: Extent to which the practice can easily be understood

4. Uniqueness: Extent to which the practice does not replicate other practices. The variation in measurements obtained when one person takes multiple measurements using the same instrument and techniques on the same parts or items

Demographic Information

1. Name:…….
2. How many years have you been in the field?

☐ Less than 10 years ☐ 10 – 20 years ☐ 20 or over years

3. What is your field of specialty?.....

Code	DM Practices	Refinement Criteria			
		Relevance	**Conciseness**	**Clarity**	**Uniqueness**
Communication Practices (CP)					
CP1	The current DM/ RTW program communication system maximizes internal and external program support.				
CP2	DM/ RTW in the workplace is brought to the attention of all employees in a language that can be easily understood.				
CP3	Communication is open and employees feel free to voice their concerns and make suggestions about DM/ RTW.				
CP4	Employees affected by the DM/ RTW program are provided with appropriate information in a timely manner.				
CP5	Employees receive regular DM/ RTW training/ education.				
CP6	Employees are informed of DM/ RTW policy changes in a timely manner.				
CP7	Employees are involved in the development of the DM program, specifically parts that directly affect them.				
CP8	Employees' knowledge about DM/ RTW is assessed on a regular basis				
	What other Communication practices can you suggest that are not covered?				
Case Management Practices (CMP)					
CMP1	Injured employee is contacted shortly following an injury and offered DM/ RTW services and support.				
CMP2	Regular communication is maintained with the injured employee's physician to facilitate his or her RTW.				
CMP3	The injured employee's physician is followed-up with to ensure he or she fills out the functional abilities form in a timely manner.				
CMP4	An initial assessment of the functional abilities of the injured employee is conducted following an injury in a timely manner.				

CMP5	A job assessment for the injured employee is conducted following an injury in a timely manner				
CMP6	When off work, the injured employee is followed-up with on a regular basis to assess his or her ability to RTW				
CMP7	There's a process in place for finalizing rehabilitations decisions when there are disagreements about them.				
CMP8	A case manager is appointed for severe injured employee cases				
CMP9	The DM/ RTW practitioner provides the injured employee with case management services in a timely manner.				
CMP10	For active injured employee cases, the DM/ RTW practitioner maintains regular communication with all relevant stakeholders (e.g. DM/ RTW committee, work supervisors).				
CMP11	Injured employee case management processes are evaluated and improved on a regular basis.				
CMP12	Injured employee case management processes are conducted in compliance with existing guidance.				
	What other Case management practices can you suggest that are not covered?				
Return to Work and Accommodation Practices (RAP)					
RAP1	Injured employee capacity evaluations are conducted to develop a tailored rehabilitation and/ or RTW plan.				
RAP2	A collaborative approach is used to develop a tailored rehabilitation and/ or RTW plan for injured employees.				
RAP3	Job analyses are conducted as part of injured employees' RTW plan to determine the specific physical and mental demands of jobs.				
RAP4	A functional assessment is conducted as part of injured employees' RTW plan.				
RAP5	Formal job analyses are completed for each job in the workplace to				

	facilitate the development of RTW plans for injured employees.				
RAP6	Job modifications are done in which tasks and responsibilities are modified to be consistent with the injured employee's functional assessment results.				
RAP7	Vocational assessment and alternative job placements are done for injured employees who are unable to return to their regular positions.				
RAP8	The DM/ RTW practitioner receives regular DM/ RTW training/ education				
RAP9	DM/RTW practitioner candidates are assessed prior to hiring to ensure they have the required knowledge and skills.				
RAP10	The job description of the DM/ RTW practitioner position emphasizes DM/ RTW duties.				
	What other Return to work and accommodation practices can you suggest that are not covered?				
Claims Management Practices (CLP)					
CLP1	Claims Management practices are clearly defined in the workplace DM policies.				
CLP2	Claims management is well coordinated from initial injury to claim resolution.				
CLP3	Long duration claims are evaluated to determine whether more intensive services are required.				
CLP4	The current claims/benefit program is designed to support early intervention and RTW.				
	What other Claims management practices can you suggest that are not covered?				
Disability and Injury Prevention Practices (DIP)					
DIP1	DM prevention goals and strategies have been clearly defined in the organizations' health and safety and DM policies.				

DIP2	DM program includes interventions aimed at reducing workplace injuries and accidents.				
DIP3	The organization provides first-aid services to employees and ensures availability of first-aid kits				
DIP4	The organization makes qualified first-aid attendants available to employees during regular working hours.				
DIP5	The organization has a program promoting employee health and wellness and stress management				
DIP6	Employee health and wellness programs provide incentives to encourage participation.				
DIP7	The organization allocates a budget for injury prevention strategies.				
DIP8	The organization has an accident prevention and safety program.				
DIP9	Employees participate in safety training programs designed to enhance workplace safety.				
DIP10	The organization's health and safety policy comply with the governing legislation.				
DIP11	The organization has a formal safety reporting system and encourage employees to report their concerns about site safety.				
DIP12	The organization frequently reviews employee's knowledge and understanding of health and safety procedures.				
DIP13	The organization responds to an identified problem as soon as it is identified and initiates required changes.				
DIP14	Equipment, Materials and Resources (EMR) health and safety requirements are considered during planning.				
DIP15	Defective EMR is replaced/repaired immediately upon detection of defects and the cause for the defect is investigated.				
DIP16	The organization implements and monitors a hazard prevention program.				
DIP17	Safety hazards possibility of reoccurrence is investigated resulting in: reduction of its probability or elimination of the hazard.				

DIP18	Hazard management procedures are made available to all employees through communication and training activities.				
DIP19	Hazard statistics and incident data are tracked and reviewed regularly.				
	What other Disability and injury prevention practices can you suggest that are not covered?				
Transitional Program Management Practices (TPM)					
TPM1	The organization utilizes technological tools such as computerized clinical protocol (called "Work-Ability" programs) to manage the DM/RTW.				
TPM2	The organization actively monitors injured, ill or at risk employees to determine if they should be referred to the DM program.				
TPM3	The organization provides formalized education for individuals responsible for DM/RTW coordination.				
TPM4	The organization has a DM/RTW practitioner.				
TPM5	The organization ensures consistent management of occupational and non-occupational injuries/illnesses.				
TPM6	The organization has a documented comprehensive DM/RTW program.				
TPM7	The organization provides productive and meaningful transitional work to injured employees in a timely manner.				
TPM8	Transitional work that is provided progresses injured employee towards returning to their regular position.				
	What other Transitional program management practices can you suggest that are not covered?				
Physical Accessibility Management Practices (PAP)					
PAP1	The organization has well trained staff to safely evacuate the workplace in an emergency situation.				
PAP2	Staff training programs include evacuation techniques and assistance for disabled and elderly occupants.				
PAP3	The organization seeks knowledge of any additional support that will help accommodate a new recruit.				

PAP4	Requirements are met in advance of the candidate's starting date (follow up to PAP3).				
PAP5	The organization modifies the workstations of injured employees to enable RTW.				
PAP6	The organization's office premises incorporate physical accessibility features such as lifts, ramps, rails etc.				
	What other Physical accessibility management practices can you suggest that are not covered?				
Program Evaluation Practices (PEP)					
PEP1	The organization maintains injury records.				
PEP2	Data gathering techniques and statistical analyses are used to evaluate the impact of the DM/RTW interventions.				
PEP3	The organization uses the injury and illness data to identify problem areas and address them accordingly.				
PEP4	The organization evaluates the outcomes of their employee health and wellness and stress management programs.				
PEP5	Periodic meetings are held for managers or departmental representatives whereby injury, illness and disability patterns are reviewed.				
PEP6	The organization tracks costs associated with DM/RTW program.				
PEP7	Data on direct and indirect costs are used to predict both the direct and indirect costs of DM/RTW program in the future.				
PEP8	The organization monitors and evaluates injured employees who are on the RTW program.				
PEP9	The organization evaluates the effectiveness of their DM/RTW program at regular intervals and make improvements where required.				
PEP10	Employee representatives have access to the evaluation and are able participate.				
PEP11	Information regarding the DM/RTW program is made anonymous and confidential, before being distributed.				

	What other Program evaluation practices can you suggest that are not covered?				
Senior Management Support Practices (SMP)					
SMP1	Top management is actively involved in the DM/RTW program.				
SMP2	The safety manager and DM practitioner receives support from top management.				
SMP3	The organization spends time and money on improving DM/RTW performance.				
SMP4	The organization considers DM/RTW equally as important as other project practices in the execution of projects.				
	What other Senior management support practices can you suggest that are not covered?				
Regulatory and Compliance Polices (RCP)					
RCP1	The organization considers DM/RTW a priority and regards it as an integral part of its human resource development strategy.				
RCP2	The DM/RTW program is formulated in accordance with national legislation and existing policies.				
RCP3	In formulating the DM/RTW program, the organization collaborates with employee representatives.				
RCP4	The DM/RTW program considers provision for employees who support a disabled members.				
	What other Regulatory and compliance practices can you suggest that are not covered?				
Recruitment and Retention Polices (RRP)					
RRP1	In developing measures to encourage the employment of employees with disabilities, the organization consults with DM experts and employee representatives, where necessary.				
RRP2	The organization ensures that all possible accommodations are considered and in place, in hiring employees.				

RRP3	The organization receives incentives in order to maximize opportunities for employees with disabilities or injuries.				
RRP4	Alternative ways of testing skills are available for some jobs rather than relying on standard paper qualifications, to enable equal/fair opportunities.				
RRP5	Recruitment staff and selection panel members are trained to handle issues involving equal opportunity, diversity and disability.				
RRP6	A disabled employee or disability expert is part of the recruitment panel.				
RRP7	During interview, applicants with disabilities are invited to identify any particular arrangements they might require on a jobsite.				
RRP8	The same scoring/assessment system is used for disabled and non-disabled candidates.				
RRP9	The organization ensures confidentiality in dealing with employee's disabilities.				
RRP10	Job descriptions are clearly defined and forms part of the orientation process.				
RRP11	Monitoring checks are implemented to assess whether people with disabilities are overrepresented in rejection decisions for positions.				
	What other Recruitment and retention practices can you suggest that are not covered?				
Ergonomic Practices (EP)					
EP1	Ergonomic interventions are undertaken as needed.				
EP2	Ergonomic interventions are evaluated to determine if they were successful.				
EP3	Jobs are designed to reduce heavy lifting.				
EP4	Jobs are designed to remove repetitive movement.				
EP5	Ergonomic strategies are used to improve workstations/ work areas				
EP6	Work rotations or changes in job responsibilities are used to minimize exposure to ergonomic risks.				

EP7	Ergonomic factors are considered where purchasing new tools, equipment, or furniture.				
EP8	Ergonomic approaches are used to assist injured employees in returning to work.				
EP9	The organization provides training on ergonomics to minimize the risk of injury.				
	What other Ergonomic practices can you suggest that are not covered?				

DM INDICATORS AND METRICS VALIDATION SURVEY

Instructions

Please read Table 1, 2, and 3 to review the validation criteria definition, the metrics, and the indicators, respectively.

Table 1 Validation criteria for proposed metrics and indicators.

Validation criteria	**Criteria definition**
Relevance	The quality of relationship between proposed metrics/indicators in this study from one hand, and the goal of DM benchmarking on the other hand.
Practicability	• The feasibility of collecting data for proposed metrics in construction companies. • The feasibility of implementing proposed indicators in construction companies and tracking them.
Appropriateness	The quality of being proper: • How much the proposed metrics are valid to obtain proper data? • How much the proposed indicators and their practices are trustable?
Uniqueness	The uniqueness proposed metrics nad indicators.

Demographic Information

1. Name:…….
2. How many years have you been in the field?

☐ Less than 10 years ☐ 10 – 20 years ☐ 20 or over years

3. What is your field of specialty?.....

Section 1: DM indicators

CP (Communication practices) definition: These practices aim to provide information to all employees on disability, injury and safety in the workplace, along with specific information about the strategy of the organization with respect to health and safety.

CP practices: Information routes, Policy change communications, Open communication, Management with employees, Early intervention communication, Employee knowledge assessment

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
17. Implementing CP in construction companies is important.	○	○	○	○	○
18. All CP's key practices fit to its title and definition.	○	○	○	○	○
19. CP specifies DM maturity in construction companies.	○	○	○	○	○
20. It is useful to use CP as a DM maturity index in construction companies.	○	○	○	○	○
21. CP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
22. Assessing CP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
23. Assessing CP can help improving DM performance in construction companies.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Practicability	○	○	○	○	○
24. Implementing all CP's key practices is easy for every construction company.	○	○	○	○	○
25. Implementing all CP's key practices is practical for every construction company.	○	○	○	○	○
26. Implementing CP's practices may need training in the company level.	○	○	○	○	○
27. Implementing CP in construction companies may have some other prerequisites.	○	○	○	○	○
28. Evaluating CP's implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
29. If CP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
30. The result of CP implementation level will be reliable.	○	○	○	○	○
31. The result of CP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
32. CP does not replicate existing DM Indicators	○	○	○	○	○

CMP (Case management practices) definition: These practices aim to plan, implement, coordinate, monitor and evaluate the options and services required to meet employee health and rehabilitation needs.

CMP practices: Post-RTW monitoring and coordination, Initial assessment of physical and functional rehabilitation, Occupational rehabilitation counseling and job skill retraining.

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing CMP in construction companies is important.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2. All CMP's key practices fit to its title and definition.	○	○	○	○	○
3. CMP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use CMP as a DM maturity index in construction companies.	○	○	○	○	○
5. CMP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing CMP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing CMP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all CMP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all CMP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing CMP's practices may need training in the company level.	○	○	○	○	○
11. Implementing CMP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating CMP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If CMP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of CMP implementation level will be reliable	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
15. The result of CMP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
16. CMP does not replicate existing DM Indicators	○	○	○	○	○

RAP (Return to work and accommodation practices) definition: These practices aim to integrate employees who have been injured or have a disability back to the workplace by providing services such as job needs assessment and modified work.

RAP practices: Job needs assessment, Job analysis, Functional assessment, Job and workstation modification, Vocational assessment and job placement for employees unable to return to original positions, Intermediate evaluation of progress.

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing RAP in construction companies is important.	○	○	○	○	○
2. All RAP's key practices fit to its title and definition.	○	○	○	○	○
3. RAP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use RAP as a DM maturity index in construction companies.	○	○	○	○	○
5. RAP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing RAP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing RAP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all RAP's key practices is easy for every construction company.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
9. Implementing all RAP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing RAP's practices may need training in the company level.	○	○	○	○	○
11. Implementing RAP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating RAP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If RAP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of RAP implementation level will be reliable	○	○	○	○	○
15. The result of RAP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
16. RAP does not replicate existing DM Indicators	○	○	○	○	○

CLP (Claims management practices) definition: These practices aim to manage claims related to occupational and non-occupational injuries or illnesses that may entitle individual employees to long-term disability benefits.

CLP practices: Claims management from initial injury to claim resolution, Evaluation of long-duration claims.

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing CLP in construction companies is important.	○	○	○	○	○
2. All CLP's key practices fit to its title and definition.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3. CLP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use CLP as a DM maturity index in construction companies.	○	○	○	○	○
5. CLP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing CLP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing CLP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all CLP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all CLP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing CLP's practices may need training in the company level.	○	○	○	○	○
11. Implementing CLP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating CLP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If CLP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of CLP implementation level will be reliable	○	○	○	○	○
15. The result of CLP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
16. CLP does not replicate existing DM Indicators	○	○	○	○	○

DIP (Disability and injury prevention practices) definition: These practices aim to provide preventative measures to alleviate injuries and educate employees on these aspects before the occurrence of disabling injuries.

DIP practices: Workplace safety programs Hazard management, Health and welfare programs, Project site safety, First aid, Educational safety awareness programs, Mental health and stress management programs

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing DIP in construction companies is important.	○	○	○	○	○
2. All DIP's key practices fit to its title and definition.	○	○	○	○	○
3. DIP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use DIP as a DM maturity index in construction companies.	○	○	○	○	○
5. DIP is a representative of how to evaluating DM maturity in construction companies.	○	○	○	○	○
6. Assessing DIP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing DIP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all DIP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all DIP's key practices is practical for every construction company.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. Implementing DIP's practices may need training in the company level.	○	○	○	○	○
11. Implementing DIP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating DIP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If DIP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of DIP implementation level will be reliable	○	○	○	○	○
15. The result of DIP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
16. DIP does not replicate existing DM Indicators	○	○	○	○	○

PAP (Physical accessibility management practices) definition: These practices aim to improve the physical accessibility of construction workplaces to people with disabilities and as such cover physical workplace accessibility requirements.

PAP practices: Workplace and project site accessibility, Training for staff on physical implications of disability, Workstation accessibility.

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing PAP in construction companies is important.	○	○	○	○	○
2. All PAP's key practices fit to its title and definition.	○	○	○	○	○
3. PAP specifies DM maturity in construction companies.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4. It is useful to use PAP as a DM maturity index in construction companies.	○	○	○	○	○
5. PAP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing PAP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing PAP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all PAP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all PAP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing PAP's practices may need training in the company level.	○	○	○	○	○
11. Implementing PAP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluate PAP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If PAP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of PAP implementation level will be reliable	○	○	○	○	○
15. The result of PAP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
16. PAP does not replicate existing DM Indicators	○	○	○	○	○

SMP (Senior management support practices) definition: These practices aim to provide continuous and consistent support from senior management to ensure the effective implementation of DM programs

SMP practices: Senior management role, Management and financial support of safety programs, Management support of RTW, modified work and related financial commitments

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing SMP in construction companies is important.	○	○	○	○	○
2. All SMP's key practices fit to its title and definition.	○	○	○	○	○
3. SMP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use SMP as a DM maturity index in construction companies.	○	○	○	○	○
5. SMP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing SMP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing SMP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all SMP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all SMP's key practices is practical for every construction company.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. Implementing SMP's practices may need training in the company level.	○	○	○	○	○
11. Implementing SMP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating SMP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If SMP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of SMP implementation level will be reliable	○	○	○	○	○
15. The result of SMP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
16. SMP does not replicate existing DM Indicators	○	○	○	○	○

PEP (Program evaluation practices) definition: These practices aim to assess DM procedures, regulations and practices within the organization.

PEP practices: Workplace incidents data collection, Case management evaluation, RTW evaluation, Injury and illness statistics analysis, Program modifications and improvements.

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing PEP in construction companies is important.	○	○	○	○	○
2. All PEP's key practices fit to its title and definition.	○	○	○	○	○
3. PEP specifies DM maturity in construction companies.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4. It is useful to use PEP as a DM maturity index in construction companies.	○	○	○	○	○
5. PEP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing PEP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. Assessing PEP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all PEP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all PEP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing PEP's practices may need training in the company level.	○	○	○	○	○
11. Implementing PEP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating PEP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If PEP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of PEP implementation level will be reliable	○	○	○	○	○
15. The result of PEP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
16. PEP does not replicate existing DM Indicators	○	○	○	○	○

RCP (Regulatory and compliance policies) definition: These policies aim to ensure the compliance of practices developed by an organization to accommodate injured and disabled employees with existing guidance at the federal and provincial levels.

RCP practices: Salary replacement policies, Job accommodation and transitional policies, Employment and budgetary responsibility policies, Vocational training policies.

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing RCP in construction companies is important.	○	○	○	○	○
2. All RCP's key practices fit to its title and definition.	○	○	○	○	○
3. RCP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use RCP as a DM maturity index in construction companies.	○	○	○	○	○
5. RCP is a representative of ??? evaluating DM maturity in construction companies.	○	○	○	○	○
6. Assessing RCP's application level fits the purpose of benchmarking DM performance.	○	○	○	○	○
7. It is clear why RCP needs to be assessed in construction companies.	○	○	○	○	○
8. Assessing RCP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
9. Implementing all RCP's key practices is easy for every construction company.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. Implementing all RCP's key practices is practical for every construction company.	○	○	○	○	○
11. Implementing RCP's practices may need training in the company level.	○	○	○	○	○
12. Implementing RCP in construction companies may have some other prerequisites.	○	○	○	○	○
13. Evaluating RCP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
14. If RCP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
15. The result of RCP implementation level will be reliable	○	○	○	○	○
16. The result of RCP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
17. RCP does not replicate existing DM Indicators	○	○	○	○	○

RRP (Recruitment and retention policies) definition: These policies aim to assess the recruitment process of employees by a construction organization as well as the procedures in place to ensure the retention of injured employees. The principle of non-discrimination should be respected throughout the process.

RRP practices: Recruitment polices (diversity management), Pre-employment tests and selection criteria, Retention and gradual resumption of work measures, Support and technical advice to identify any opportunities and adjustments

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Implementing RRP in construction companies is important.	○	○	○	○	○
2. All RRP's key practices fit to its title and definition.	○	○	○	○	○
3. RRP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use RRP as a DM maturity index in construction companies.	○	○	○	○	○
5. RRP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○
6. Assessing RRP's application level fits the purpose of benchmarking DM performance in this research.	○	○	○	○	○
7. Assessing RRP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all RRP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all RRP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing RRP's practices may need training in the company level.	○	○	○	○	○
11. Implementing RRP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating RRP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
13. If RRP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of RRP implementation level will be reliable	○	○	○	○	○
15. The result of RRP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
16. RRP does not replicate existing DM Indicators	○	○	○	○	○

EP (Ergonomic practices) definition: These practices aim to ensure the design of work processes and spaces that minimize injuries, complaints, staff turnover and work absenteeism.

EP practices: Jobs designed to reduce heavy lifting, Ergonomic strategies for workstations and work areas, Ergonomic considerations in purchasing new tools, equipment, or furniture, Ergonomic approaches to assist disabled employees

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Implementing EP in construction companies is important.	○	○	○	○	○
2. All EP's key practices fit to its title and definition.	○	○	○	○	○
3. EP specifies DM maturity in construction companies.	○	○	○	○	○
4. It is useful to use EP as a DM maturity index in construction companies.	○	○	○	○	○
5. EP is a representative of how to evaluate DM maturity in construction companies.	○	○	○	○	○

Indicator assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6. Assessing EP's application level fits the purpose of benchmarking DM performance in this research.	○	○	○	○	○
7. Assessing EP can help improving DM performance in construction companies.	○	○	○	○	○
Practicability	○	○	○	○	○
8. Implementing all EP's key practices is easy for every construction company.	○	○	○	○	○
9. Implementing all EP's key practices is practical for every construction company.	○	○	○	○	○
10. Implementing EP's practices may need training in the company level.	○	○	○	○	○
11. Implementing EP in construction companies may have some other prerequisites.	○	○	○	○	○
12. Evaluating EP implementation level can be done for an acceptable sample size of construction companies.	○	○	○	○	○
13. If EP's practices are not implemented in a company already, it is easy for the company to initiate applying the practices.	○	○	○	○	○
Appropriateness					
14. The result of EP implementation level will be reliable	○	○	○	○	○
15. The result of EP implementation level will be verifiable	○	○	○	○	○
Uniqueness	○	○	○	○	○
16. EP does not replicate existing DM Indicators	○	○	○	○	○

Section 2: DM metrics

DM1 definition: Percentage of employees their safety representatives involved in the planning of DM.

DM1 formula= (Total number of employees and their safety representatives involved in the planning of DM / Total number of employees) *100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM1 is important for every construction company.	○	○	○	○	○
2. Tracking DM1 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM1 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM1's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM1 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM1 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM1 is easy for every construction company.	○	○	○	○	○
8. Tracking DM1 is practical for every construction company.	○	○	○	○	○
9. Tracking DM1 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM1 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM1's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM1's values from each construction company will be practical.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
13. Collecting DM1's values from each construction company can be done over a reasonable time period.	○	○	○	○	○
14. Collecting DM1's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness** 15. Data collected for DM1 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM1 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness** 17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM2 definition: Percentage of employees provided with health and safety training.

DM2 formula= (Total number of employees provided with health and safety training/ Total number of employees)*100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance** 1. Tracking DM2 is important for every construction company.	○	○	○	○	○
2. Tracking DM2 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM2 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM2's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM2 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM2 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability** 7. Tracking DM2 is easy for every construction company.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
8. Tracking DM2 is practical for every construction company.	○	○	○	○	○
9. Tracking DM2 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM2 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM2's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM2's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM2's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM2's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness** 15. Data collected for DM2 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM2 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness** 17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM3 definition: Percentage of employees participating in site safety meetings.

DM3 formula= (Total number of employees participating in site safety meetings / Total number of employees)*100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance** 1. Tracking DM3 is important for every construction company.	○	○	○	○	○
2. Tracking DM3 can help improving DM performance in every construction company.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3. DM3 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM3's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM3 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM3 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM3 is easy for every construction company.	○	○	○	○	○
8. Tracking DM3 is practical for every construction company.	○	○	○	○	○
9. Tracking DM3 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM3by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM3's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM3's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM3's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM3's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM3 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM3 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM4 definition: Percentage of injured employees who were provided with physical accommodation.

DM4 formula= (Total number of injured employees who were provided with physical accommodation/ Total number of injured employees requiring physical accommodation)*100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
16. Tracking DM4 is important for every construction company.	○	○	○	○	○
17. Tracking DM4 can help improving DM performance in every construction company.	○	○	○	○	○
18. DM4 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
19. DM4's definition includes clear explanation of its variables.	○	○	○	○	○
20. It is useful to use DM4 as a DM performance measure in construction companies.	○	○	○	○	○
21. DM4 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
22. Tracking DM4 is easy for every construction company.	○	○	○	○	○
23. Tracking DM4 is practical for every construction company.	○	○	○	○	○
24. Tracking DM4 by construction companies may need training in the company level.	○	○	○	○	○
25. Tracking DM4by construction companies may have some requirements (other than training).	○	○	○	○	○
26. Collecting DM4's values from each construction company will be easy.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
27. Collecting DM4's values from each construction company will be practical.	○	○	○	○	○
28. Collecting DM4's values from each construction company can be done over a reasonable period.	○	○	○	○	○
29. Collecting DM4's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
30. Data collected for DM4 in construction companies is reliable.	○	○	○	○	○
31. Data collected for DM4 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
32. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM5 definition: Percentage of employees who returned to work.

DM5 formula= (Total number of employees who returned from injury leave /Total number of injuries that resulted (required) in days away, modified or restricted work) *100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM5 is important for every construction company.	○	○	○	○	○
2. Tracking DM5 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM5 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM5's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM5 as a DM performance measure in construction companies.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6. DM5 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM5 is easy for every construction company.	○	○	○	○	○
8. Tracking DM5 is practical for every construction company.	○	○	○	○	○
9. Tracking DM5 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM5 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM5's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM5's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM5's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM5's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM5 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM5 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM6 definition: Percentage of injuries that required case management.

DM6 formula= (Total number of injuries that required case management/Total number of injuries) *100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM6 is important for every construction company.	○	○	○	○	○
2. Tracking DM6 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM6 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM6's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM6 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM6 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM6 is easy for every construction company.	○	○	○	○	○
8. Tracking DM6 is practical for every construction company.	○	○	○	○	○
9. Tracking DM6 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM6 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM6's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM6's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM6's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM6's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
15. Data collected for DM6 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM6 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM7 definition: Percentage of employees off due to injury.

DM7 formula= (Total number of employees off due to injury/ Total number of injuries) *100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM7 is important for every construction company.	○	○	○	○	○
2. Tracking DM7 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM7 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM7's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM7 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM7 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM7 is easy for every construction company.	○	○	○	○	○
8. Tracking DM7 is practical for every construction company.	○	○	○	○	○
9. Tracking DM7 by construction companies may need training in the company level.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. Tracking DM7 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM7's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM7's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM7's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM7's values can be done for any size of construction company	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM7 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM7 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM8 definition: he cost of claims against the number of claims.

DM8 formula= (Total cost of claims/Total number of claims)

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM8 is important for every construction company.	○	○	○	○	○
2. Tracking DM8 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM8 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4. DM8's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM8 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM8 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM8 is easy for every construction company.	○	○	○	○	○
8. Tracking DM8 is practical for every construction company.	○	○	○	○	○
9. Tracking DM8 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM8 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM8's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM8's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM8's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM8's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM8 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM8 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree

DM9 definition: Percentage of employees who were placed on modified work.

DM9 formula= (Total number of employees placed on modified duties / Total number of injuries that resulted (required) in days away, modified or restricted work)*100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM9 is important for every construction company.	○	○	○	○	○
2. Tracking DM9 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM9 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM9's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM9 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM9 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM9 is easy for every construction company.	○	○	○	○	○
8. Tracking DM9 is practical for every construction company.	○	○	○	○	○
9. Tracking DM9 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM9 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM9's values from each construction company will be easy.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
12. Collecting DM9's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM9's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM9's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM9 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM9 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM10 definition: Percentage of employees who transitioned from temporary work to their original work.

DM10 formula= (Total number of employees who transitioned from temporary work to their original work / Total number of employees placed on transitional work) *100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM10 is important for every construction company.	○	○	○	○	○
2. Tracking DM10 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM10 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4. DM10's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM10 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM10 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM10 is easy for every construction company.	○	○	○	○	○
8. Tracking DM10 is practical for every construction company.	○	○	○	○	○
9. Tracking DM10 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM10 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM10's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM10's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM10's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM10's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM10 in construction companies is reliable.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
16. Data collected for DM10 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM11 definition: Percentage of jobs designed to reduce heavy lifting and repetitive movement.

DM11 formula= (Total number of jobs designed to reduce heavy lifting and repetitive movement/ Total number of jobs)*100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					
1. Tracking DM11 is important for every construction company.	○	○	○	○	○
2. Tracking DM11 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM11 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM11's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM11 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM11 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM11 is easy for every construction company.	○	○	○	○	○
8. Tracking DM11 is practical for every construction company.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
9. Tracking DM11 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM11 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM11's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM11's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM11's values from each construction company can be done over a reasonable period.	○	○	○	○	○
14. Collecting DM11's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM11 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM11 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

DM12 definition: Percentage of new tools, equipment, or furniture purchased taking into account ergonomic factors.

DM12 formula= Total number of new tools, equipment, or furniture purchased taking into account ergonomic factors/ Total number of new tools, equipment, or furniture purchased) *100

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
• **Relevance**					

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Tracking DM12 is important for every construction company.	○	○	○	○	○
2. Tracking DM12 can help improving DM performance in every construction company.	○	○	○	○	○
3. DM12 has been defined well/in unambiguous terms, and is understandable.	○	○	○	○	○
4. DM12's definition includes clear explanation of its variables.	○	○	○	○	○
5. It is useful to use DM12 as a DM performance measure in construction companies.	○	○	○	○	○
6. DM12 is a representative of evaluating DM performance in construction companies.	○	○	○	○	○
• **Practicability**					
7. Tracking DM12 is easy for every construction company.	○	○	○	○	○
8. Tracking DM12 is practical for every construction company.	○	○	○	○	○
9. Tracking DM12 by construction companies may need training in the company level.	○	○	○	○	○
10. Tracking DM12 by construction companies may have some requirements (other than training).	○	○	○	○	○
11. Collecting DM12's values from each construction company will be easy.	○	○	○	○	○
12. Collecting DM12's values from each construction company will be practical.	○	○	○	○	○
13. Collecting DM12's values from each construction company can be done over a reasonable period.	○	○	○	○	○

Metric assessment criteria	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
14. Collecting DM12's values can be done for any size of construction company.	○	○	○	○	○
• **Appropriateness**					
15. Data collected for DM12 in construction companies is reliable.	○	○	○	○	○
16. Data collected for DM12 in construction companies is verifiable.	○	○	○	○	○
• **Uniqueness**					
17. The Metrics does not replicate existing DM metrics.	○	○	○	○	○

Appendix B

AHP INSTRUCTION SHEET

Introduction

The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pairwise mode. To do so, the AHP uses a fundamental scale of absolute numbers that has been proven in practice and validated by physical and decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to quantitative and qualitative attributes just as well or better than other scales. It converts individual preferences into ratio scale weights that can be combined into a linear additive weight w(a) for each alternative a. The resultant w(a) can be used to compare and rank the alternatives and, hence, assist the decision maker in making a choice. Given that the three basic steps are reasonable descriptors of how an individual comes naturally to resolving a multicriteria decision problem, then the AHP can be considered both a descriptive and prescriptive model of decision-making. The AHP is perhaps, the most widely used decision-making approach in the world today. Its validity is based on the many hundreds (now thousands) of actual applications in which the AHP results were accepted and used by the cognizant decision makers (DMs).

There are three basic principles of AHP: decomposition, comparative judgments, and hierarchic composition or synthesis of priorities (Saaty 1994b). The decomposition principle is applied to structure a complex problem into a hierarchy of clusters, subclusters, sub-sub clusters and so on. The principle of comparative judgments is applied to construct pairwise comparisons of all combinations of elements in a cluster with respect to the parent of the cluster. These pairwise comparisons are used to derive 'local' priorities of the elements in a cluster with respect to their parent. The principle of hierarchic composition or synthesis is applied to multiply the local priorities of the elements in a cluster by the 'global' priority of the parent element, producing global priorities throughout the hierarchy and then adding the global priorities for the lowest level elements (usually the alternatives).

Determination of Parameter Weights

The performance parameters will be prioritized by determining parameter weights the twelve primary indicators (defined below) using pairwise comparison (Saaty, 1987). The five Construction experts will be engaged in determining the parameter weights for the different units DM. Table 1 shows an example of a completed pairwise comparison matrix. The comparisons will be performed using the fundamental scale for pairwise comparison (see Table 2) developed by Saaty (1987). Table 3 shows that the comparisons will be performed for half of the table; the blank boxes will be the opposite reciprocal of the filled boxes. A minimum of five such pairwise comparisons will be completed for each unit and aggregated using geometric means (Yee-Ching Lilia & Bernadette Elea, 1991). In its use of AHP, the Construction Disability Management Disability Maturity Model (CDM3) considers the indicators as being the decision alternatives.

Questioning Format (Comparison criteria):

When comparing indicators A & B (on line 1), the decision criteria would assign figures as follows:

- 1 means A and B are equally important.

- 3 means A is moderately more important than B, 1/3 or .033 means B is moderately more important than A.
- 5 means A strongly more important than B, and 1/5 or 0.2 means the opposite.
- 7 means A has been demonstrated to have very strong importance than B and 1/7 or 0.14 means the opposite.
- 9 means A is extremely more important than B, 1/9 means the opposite.

The following values 2, 4, 6, and 8 can also be used if one is not certain how important one is more than the other, or when compromise is needed.

Table E1: Determination of indicator weights using pairwise comparison

	A	B	C	D	E	F	Parameter Weight (w)
A	1	c1	c2	c3	c4	c5	w1
B		1	c6	c7	c8	c9	w2
C			1	c10	c11	c12	w3
D				1	c13	c14	w4
E					1	c15	w5
F						1	w6
Sum (Σ)	Σ1	Σ2	Σ3	Σ4	Σ5	Σ6	

Blank boxes or spaces will be the reciprocal of their diagonal value as shown for B, (AHP, is directional and only applies one way either up or down.

Table E2: Fundamental scale for pairwise comparison

Intensity of Importance	Definition	Explanation
1	Equal importance	Two indicators contribute equally to the objective/goal
3	Moderate importance	Experience and judgment slightly favor one indicator over another
5	Essential or strong importance	Experience and judgment strongly favor one indicator over another
7	Very strong importance	An indicator strongly favored over another and its dominance demonstrated in practice

9	Extreme importance	The evidence favoring one indicator over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between adjacent judgments	When compromise is needed
Reciprocal	If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

References

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Saaty, T. L. (1994b). Fundamentals of Decision Making, RWS Publications, Pittsburgh, PA.

Saaty, T. and Vargas, L. (2001). Models, Methods, Concepts and Applications of the Analytic Hierarchy Process. Kluwer Academic Publishers, Boston, USA.

Yee-Ching Lilia, C., and Bernadette Elea, L. (1991). Performance evaluation and the analytic hierarchy process. Journal of Management Accounting Research, 3, 57-87

Table E3: Pairwise comparison Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1. Communication Practices	**1.000**											
2. Case Management		**1.000**										
3. Return to Work			**1.000**									
4. Claims Management				**1.000**								
5. Disability and Injury Prevention					**1.000**							
6. Transitional Program Management						**1.000**						
7. Physical Accessibility Management							**1.000**					
8. Senior Management								**1.000**				
9. Program Evaluation Practices									**1.000**			
10. Regulatory and Compliance policies										**1.000**		
11. Recruitment and Retention Policies											**1.000**	
12. Ergonomic Practices												**1.000**

Appendix C

DM BENCHMARKING TOOL PILOT FEEDBACK SURVEY

1. As part of your feedback on the developed online disability management and return to work tool, on average, how much do you agree or disagree with the following statements?

		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
a)	The tool was easy to access and log into.	○	○	○	○	○
b)	Once logged in, the confidentiality statement was clear and easy to understand.	○	○	○	○	○
c)	Instructions for using the tool were clear and easy to understand.	○	○	○	○	○
d)	Instructions for using the tool were thorough and comprehensive.	○	○	○	○	○
e)	The structure and format of the tool were easy to follow.	○	○	○	○	○
f)	The navigation buttons on the tool were easy to access and use.	○	○	○	○	○
g)	Aesthetically, the tool was visually appealing.	○	○	○	○	○
h)	The survey questions were clear and easy to understand.	○	○	○	○	○

i)	The metrics section was clear and easy to understand.	○	○	○	○	○
j)	The entries for the metrics could be done easily.	○	○	○	○	○
k)	The analytics section was clear and easy to understand.	○	○	○	○	○
l)	The analytics section was easy to navigate.	○	○	○	○	○
m)	There was enough information to interpret the analytics.	○	○	○	○	○
n)	The recommendations provided as part of the analytics were thorough and comprehensive.	○	○	○	○	○
o)	Overall, the tool is well designed.	○	○	○	○	○

2.	Were there any survey questions that were difficult to understand? If yes, please specify them.	○	Yes …….	○	No
3.	Did you have any difficulties completing the different sections of the survey? If yes, please explain.	○	Yes ……..	○	No
4.	Were there any DM metrics that were	○	Yes …….	○	No

	difficult to understand? If yes, please specify them.					
5.	Did you have any difficulties with completing the DM metrics? If yes, please explain	○ Yes ……..		○ No		
6.	The length of survey was….	Too Long	Long	About right	Short	Too short
		○	○	○	○	○
7.	How long did it take you to complete the entire tool, i.e., survey and metrics?	Hours…… Minutes……				
8.	Do you have any other suggestions for improving the DM tool?	……				