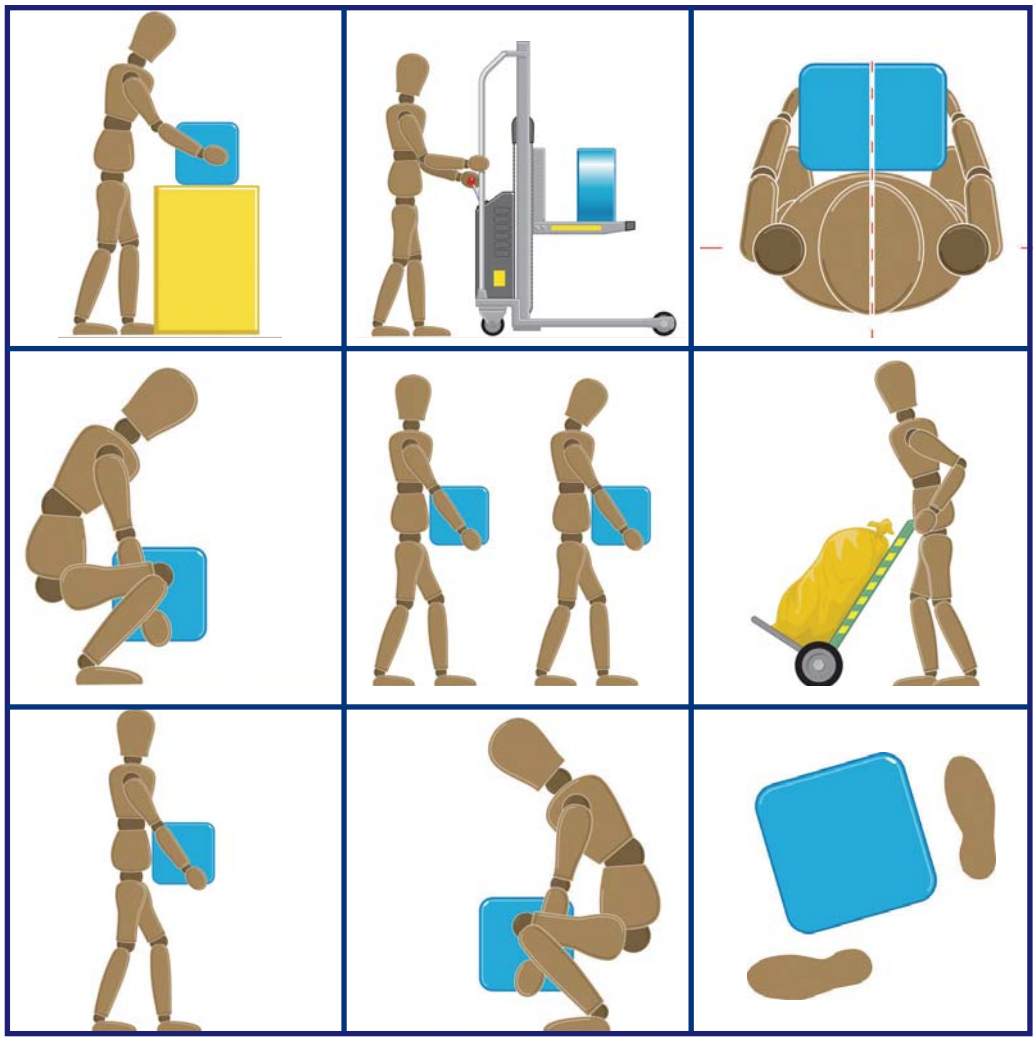
HEALTH AND SAFETY AUTHORITY



Best Manual Handling Practices at Dublin Airport

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FINAL REPORT

BEST MANUAL HANDLING PRACTICES AT DUBLIN AIRPORT

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Abstract

This document is the Final Report of the project "Best Manual Handling Practices at Dublin Airport". It outlines the rationale and background of the project. Future trends in the aviation industry along with the manual handling hazards associated with specific airport work are highlighted. A description of the findings of a literature review, an airport benchmarking exercise and primary research studies is provided. Recommendations derived from primary and secondary research, and airport benchmarking are presented under the following headings: check-in work, baggage handling work, the handling of a person with reduced mobility, and the musculoskeletal health of passengers. These recommendations are categorised under the following four headings: building infrastructure and design, mechanical aids / assistive devices, operational procedures and guidelines, and people behaviour. The main conclusion from the project is that solutions to reducing manual handling related injuries among airport workers are, in the short term, to be found in the introduction of mechanical aids, but in the long term, through the implementation of higher levels of automation.

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Glossary of terms

ACI: Airports Council International

Baggage handler: a person who loads or unloads baggage and or cargo from commercial transport aircraft. It includes those persons who work within the airport terminal who handle baggage and those who consolidate baggage and cargo for particular flights (Dell 1997)

CTA: Canadian Transportation Agency

ECAC: European Civil Aviation Conference

HSA: Health and Safety Authority

IATA: International Air Transport Association

ICAO: International Civil Aviation Organisation

ITAA: Irish Travel Agents Association

IWA: Irish Wheelchair Association

NDA: National Disability Authority

Person with Reduced Mobility (PRM): a person whose mobility is reduced due to any physical disability (sensory or locomotor), an intellectual impairment, age or any other cause of disability when using transport, and whose situation needs special attention or adaptation of services ordinarily available to all passengers (ACI 2001)

PIAB: Personal Injuries Assessment Board, Ireland.

SSCI: Self-service check-in system

Executive Summary

Since 2000, manual handling has been the primary cause of all reportable workplace injuries to the Health and Safety Authority (HSA 2000-2003). The predominant body part affected is the back/spine with sprain/torn ligaments the most common type of injury suffered. This trend in back injury occurrence directly attributable to manual handling activities at work is evident worldwide and airport workers are one occupational grouping not immune to such injuries. In an effort to address the large proportion of work-related manual handling injuries in Ireland, the Health and Safety Authority (HSA) have implemented several projects over the past three years to address the issue industry wide. An alliance was formed between the Health and Safety Authority, the Irish Airports Authority (Aer Rianta) and the National University of Ireland, Galway (NUI,Galway) to investigate manual handling practices in the aviation industry. A research project entitled "Best Manual Handling Practices at Dublin Airport" evolved with the primary focus on manual handling of baggage by airport workers, and the handling of a person with reduced mobility (PRM); baggage handling by passengers was also explored. This project coincides with the 4-year Manual Handling Programme currently being implemented by the Health and Safety Authority since 2001 (HSA 2001). This programme involves activities such as a manual handling inspection programme across five sectors, development of guidelines for inspectors, research, and the review of existing guidance on manual handling. It is anticipated that the findings and recommendations from this project will contribute to the overall efforts of the Health and Safety Authority to combat the problem of manual handling related workplace injuries.

Technological and industry-wide advances may reduce, in the long term, the level of manual handling at airports. The evolution of the self-service check-in system has had a positive impact on the work of check-in agents as it effectively reduces their repetitive computer work and handling of passenger baggage. Baggage handling technology such as containerised loading and a fully automated baggage handling systems are, to a certain extent, eliminating tasks ordinarily performed by baggage handlers. The manual handling associated with embarking and disembarking a person with reduced mobility has also been addressed as a motorized hoist system, which eliminates manual handling inside the aircraft, arrived on the market earlier this year. Musculoskeletal strain imposed on passengers by their baggage has to a certain extent been reduced due to improvements in baggage design such as the addition of wheels to suitcases and lumbar support belts to rucksacks. Although all of these advances are gradually becoming the norm, in the interim, it is necessary that measures be taken to address the current health and safety risks associated with handling baggage and handling a PRM at Dublin Airport.

Ergonomic research has highlighted the extent of the baggage handling problem. Check-in agents demonstrate high levels of musculoskeletal disorders primarily of the back and neck, which cause a significant level of interference with their work (Rosskam 2003). The musculoskeletal health of baggage handlers is also affected as this group have high prevalence rates of low back and knee conditions (Rückert and Rohmert 1991). The consequences of these conditions such as high levels of absenteeism, transfer or termination of employment, and personal injury claims, must be highlighted as the catalyst for improving the working life of these two groups of airport workers. In terms of the most hazardous baggage handling postures, research has identified the task of unloading and loading baggage inside the hold of narrow-bodied aircraft as imposing the greatest biomechanical and physiological strain (Rohmert et al 1989, Rückert et al 1992, Dell 1997). The use of in-plane loading systems has been shown to reduce the extent of the strain imposed by the geometry of the baggage

compartment workspace (Dell 2000). No research exists on the adverse effects of handling passengers with reduced mobility. The main manual handling activity associated with a PRM is embarking and disembarking aircraft. Evidence of the musculoskeletal strain of transferring a PRM from a wheelchair into an aisle chair and into an aircraft seat, can be extrapolated from healthcare research. Similar transfers performed regularly in the hospital environment, such as transferring from a wheelchair into a chair, have been identified as contributing to the development of musculoskeletal disorders (Hignett 1996, Ore 2003). The use of assistive devices and proper transfer techniques are two strategies shown to decrease musculoskeletal strain (Elford et al., 2000, Zhuang 2000).

The handling of baggage by passengers is a topic greatly under-explored therefore research is imperative to reiterate the importance of passengers packing baggage that they themselves can handle safely i.e. baggage weights should be no greater than 25-30% of the passengers body weight.

A benchmarking exercise involving the three Irish international airports, at Dublin, Shannon, and Cork, and three European airports, at Birmingham, Düsseldorf, and Frankfurt, highlighted where improvements could be made at Dublin Airport regarding the manual handling of baggage and also the handling of PRMs. Aspects of airport infrastructure, ground handling operations, and specialist PRM handling operations at the airports were deemed best practice e.g. job rotation for check-in staff in Frankfurt Airport, and the use of mobile baggage conveyor systems for all bulk loaded aircraft at Düsseldorf Airport. The findings from both a literature review and the benchmarking exercise were the determinants of the primary research conducted as part of this project. Each study was categorised into a Primary Research Package.

The necessity to minimise manual handling related injuries among airport workers is now being recognised by several national authorities for workplace health and safety. The Irish Health and Safety Authority commissioned this project in 2000 due to the lack of research-based manual handling guidelines for airport workers. The American Occupational Safety and Health Administration (OHSA) in 1996 produced ergonomic guidelines relating to the performance of baggage handling tasks and also the handling of a PRM; these have been updated in 2003 (OHSA 1996 and 2003). Similar to OHSA, the UK Health and Safety Executive (HSE) in the summer of this year produced guidelines derived '*from experience*' (HSE 2004). This HSA / Aer Rianta / NUI,Galway research project has been in progress since 2001 and the recommendations made in this report are research-based as they are derived from the findings of primary and secondary research and airport benchmarking. A holistic approach was adopted to aid in reducing the occurrence of musculoskeletal disorders. This incorporated acknowledgement of the cause of musculoskeletal disorders as being multi-faceted and thus advocating that an improvement in manual handling procedures through ergonomic operational guidelines should be complimented with efforts to improve the general health and lifestyle of the workers through health promotion programmes. This approach involved establishing the extent of the baggage handling problem i.e. the prevalence of musculoskeletal conditions among baggage handlers, and thus the contributing factors e.g. work and lifestyle. Once an insight was gained into the possible causative factors of musculoskeletal conditions, recommendations could thus be made regarding ergonomics-based manual handling practices and occupational health / health promotion services.

Solutions to the problem of manual handling injuries are dependent on the concerted action of passengers, the airport authority, the relevant airport workers i.e. those performing the manual handling tasks, and their employers which includes airlines, ground handling companies, and specialist handling companies.

Evidence-Based Recommendations

This section outlines the specific evidence-based recommendations that have been derived from findings of the secondary research (the literature review), the airport benchmarking, and the primary research (original studies conducted as part of this project).

A. CHECK-IN WORK

1. For the ground handling companies (self-handling airlines and third-party handlers)

1.1. Building infrastructure design and layout

1.1.1. Adopt a participatory approach to any design aspect of check-in workstations

1.2. Operational procedures and guidelines

1.2.1. Implement task rotation on every shift for each check-in agent

1.2.2. Provide ergonomics training on computer workstations (e.g. workstation layout, and stretching exercises)

1.2.3. Revise procedural guidelines to incorporate ergonomics issues such as the elimination of the need to move passenger baggage and the elimination of over-reaching when returning passengers documentation

1.3. People behaviour

1.3.1. Conduct pre-employment medical assessments on potential check-in staff

1.3.2. Implement a multidimensional musculoskeletal disorder prevention programme (e.g. ergonomics programme, health education, back and abdominal muscle strengthening exercises, back school)

1.3.3. Implement health promotion programmes tailored to check-in agents i.e. the Happy Heart at Work Programme, which incorporates advice on healthy eating, smoking cessation, and exercise in the workplace and at home. Provide health information sessions and healthy food options in work canteen

2. For the airport operator

2.1. Building infrastructure design and layout

2.1.1. Provide self-service check-in systems for all airlines

B. BAGGAGE HANDLING WORK

1. For the ground handling companies (self-handling airlines and third-party handlers)

1.1. Building infrastructure design and layout

1.1.1. Ensure participation of baggage handlers in any infrastructure design concerning baggage handling e.g. design and layout of baggage hall

1.1.2. Conduct regular ergonomics audits at key decision points in the design process of any new system introduced and used by baggage handlers

1.1.3. Conduct risk assessments throughout any design process

1.1.4. In the baggage hall: designate a specific section along the baggage conveyor as the loading bay i.e. all lifting of baggage must be performed in this area thereby minimising unnecessary carry distances.

1.2. Mechanical aids / assistive devices

1.2.1. In the baggage hall: provide mobile non-powered roller conveyor units to assist in transferring baggage between baggage conveyors and baggage carts used for loose-loaded aircraft

1.2.2. On the ramp: use both standard size and small-scale mobile baggage conveyors for unloading and loading all aircraft

1.2.3. Install in-plane loading systems in suitable aircraft (self-handlers)

1.3. Operational procedures and guidelines

1.2.1. Ensure ongoing task specific risk assessments of baggage handling in the baggage hall, on the ramp and in the baggage compartments of aircraft. Implement the appropriate controls including safe work practices. Consideration must be made of the risk assessments conducted in the design phase of building infrastructure

1.2.2. Regularly rotate baggage handlers between the baggage hall and the ramp

1.2.3. In the baggage hall: revise procedural guidelines in conjunction with the baggage handlers for the loading of baggage into carts and containers to include good ergonomic principles i.e. eliminate the need for unnecessary carry distances

1.2.4. On the ramp: provide operational guidelines on the optimal use of mechanical aids for unloading and loading narrow-bodied aircraft e.g. adjusting the mobile baggage conveyor to an optimal working height and the strategic parking of baggage carts in relation to the conveyor

1.2.5. Implement a strict protocol on adherence to a heavy bag tag policy

1.2.6. Implement a preventive maintenance programme for all baggage carts, containers, and mobile baggage conveyors

1.2.7. Purchase baggage carts that have hinged side panels to facilitate easier loading and unloading of baggage

1.3. People behaviour

1.3.1. Conduct pre-employment medical assessments of all potential baggage handling staff

1.3.2. Conduct medical check-ups on each baggage handler every three years

1.3.3. Implement a multidimensional musculoskeletal disorder prevention programme (e.g. ergonomics programme, health education, back and abdominal muscle strengthening exercises, back school)

1.3.4. Implement health promotion programmes tailored to baggage handlers i.e. the Happy Heart at Work Programme, which incorporates advice on healthy eating, smoking cessation, and exercise in the workplace and at home. Provide health information sessions and healthy food options in work canteen

1.3.5. Provide task-specific manual handling training at induction i.e. training on working in the baggage hall, on the ramp, and in the baggage compartments of aircraft

1.3.6. Provide refresher manual handling training three years after induction training

1.3.7. Implement a formal Return-To-Work Programme for injured baggage handlers

2. For the airport operator

2.1. Building infrastructure design and layout

2.1.1. Adopt a participatory approach to the design of any aspect of baggage handling e.g. design and layout of the baggage hall

2..2. Operational procedures and guidelines

2.2.1. Promote the use of in-plane loading systems in narrow-bodied aircraft

2.2.2. Explore the feasibility of Airports Council International (ACI) – Europe introducing a policy on airport baggage item weight limits

2.2.3. Implement a policy on a baggage item weight limit irrespective of whether or not it becomes an ACI-Europe recommendation i.e. no one single baggage item either entering or departing from the airport can weigh greater than 32kg

2.2.4. Implement a policy on the application of heavy bag tags i.e. all baggage items weighing 20kgs and over are tagged with a heavy bag tag

2.3. People behaviour

2.3.1. Provide task-specific manual handling training for airport operator staff working at oversize baggage belts. Advise not to perform any manual handling of passenger baggage

3. For ground service equipment manufacturers:

3.1. Re-design baggage carts in order to minimise over-reaching.

C. HANDLING OF A PERSON WITH REDUCED MOBILITY (PRM)

1. For companies providing handling assistance to a PRM

1.1. Mechanical aids / assistive devices

1.1.1. Use ambu-lifts for all lift-on / lift-offs of a PRM for aircraft not interfaced with the terminal building via an airbridge

1.1.2. Use motorised hoist systems, similar to the ErgoPort, when providing assistance to paraplegics with transfers between wheelchair, aisle chair, and aircraft seat and vice versa. If systems not available, transfer boards should be used.

1.2. Operational procedures and guidelines

1.2.1. Conduct pre-employment medical assessments of all potential staff

1.2.2. Implement a multidimensional musculoskeletal disorder prevention programme (e.g. ergonomics programme, health education, back and abdominal muscle strengthening exercises, back school)

1.2.3. Implement health promotion programmes tailored to baggage handlers i.e. the Happy Heart at Work Programme, which incorporates advice on healthy eating, smoking cessation, and exercise in the workplace and at home. Provide health information sessions and healthy food options in work canteen

1.2.4. Implement a preventive maintenance programme for all wheelchairs

1.2.5. Conduct weekly maintenance checks on the ambu-lift

1.2.6. Comply with the lease agreement for the ambu-lift by providing the vehicle to the leaser for maintenance at the predetermined intervals.

1.3. People behaviour

1.3.1. Provide task-specific manual handling training on the handling of a PRM

1.3.2. Provide disability awareness training for all staff at induction and every three years thereafter

2. For the airport operator

2.1. Building infrastructure design and layout

2.1.1. Provide a wheelchair-friendly check-in desk and information desk

2.1.2. Consider a universal design approach for any airport extensions or modifications

2.1.3. Maintain flooring of airbridges in good condition

2.2. Mechanical aids / assistive devices

2.2.1. Provide a lease of an appropriate ambu-lift to the company providing passenger assistance at the airport. This should incorporate a preventive maintenance programme with which the handling company must comply

2.3. Operational procedures and guidelines

2.3.1. Implement the Airports Council International (ACI) Special Protocol for the Handling of PRMs

2.3.2. Appoint a Complaints Resolution Officer to deal with complaints made by PRMs regarding the airport infrastructure and services

2.3.3. Implement a policy on compulsory use of ambu-lifts to perform all lift-on / lift-offs for all aircraft not interfaced with the terminal building via an airbridge

2.3.4. Liaise with the National Disability Authority and the Department of Transport in order to devise a Code of Practice on the handling of a PRM at Dublin Airport

2.4. People behaviour

2.4.1. Provide disability awareness training for all airport operator staff at induction and every three years thereafter

3. For the airlines

3.1. Provide moveable arm-rests on all seats on a minimum of two rows of seats on every aircraft

4. For the government (Department of Transport)

4.1. Produce regulations on the provision of services to a PRM at Irish airports; this should include the use of ambu-lifts, and recommended personnel training of persons providing the assistance

4.2. Liaise with the National Disability Authority and Dublin Airport Authority to produce a Code of Practice on the handling of PRMs at Dublin Airport

D. MUSCULOSKELETAL HEALTH OF THE PASSENGER

1. For the air traveller

1.1. Business travellers should use a suitcase on wheels that can also support a laptop bag (thereby eliminating the one-shoulder load carriage)

1.2. Purchase suitcases that have appropriate retractable handles and rucksacks that have both a lumbar waist belt and wide padded shoulder straps

1.3. Pack baggage weighing no greater than 33% body weight for males and 25% for females and passengers should reduce the weights if they have any pre-existing musculoskeletal or cardiac condition

1.4. Take care when lifting and lowering baggage items as these activities cause the back and shoulder muscles to exert the greatest muscular forces

1.5. Avoid one-shoulder load carriage by changing the load carriage method to a suitcase or to two shoulder carriage (i.e. via a rucksack, or even dividing the load in two, and wearing two shoulder bags thereby distributing the load across the both shoulders)

1.6. Use baggage trolleys at airports (to eliminate the carrying of loads)

2. For the airport authority

2.1. Building infrastructure design and layout

2.1.1. Provide self-service check-in systems (SSCI) for all airlines operating at the airport

2.1.2. Provide posters throughout the airport including car-parks, bus-stops, taxi-ranks, advising passengers to use baggage trolleys, to be cautious when lifting baggage, and to pack lighter bags for their subsequent trips

2.1.3. Provide signage at the front of each check-in desk, SSCI, and at the oversize baggage counter indicating how check-in baggage should be safely placed on baggage conveyors

2.2. Mechanical aids / assistive devices

2.2.1. Ensure a sufficient number of baggage trolleys are placed at strategic locations throughout the airport car parks, taxi-ranks, bus stops and in the terminal building. Provide hand-baggage trolleys in the departures area

2.2.2. Provide hand baggage trolleys in the departure lounge

2.3. Operational procedures and guidelines

2.3.1. Include advice on weights of bags, use of trolleys, and safe manual handling techniques in airport media advertisements regarding travel through the airport

2.3.2. Maintain car park terrain and all walking areas around the airport in good condition

2.3.3. Implement a preventive maintenance programme for all baggage trolleys

3. For the travel agencies, airline companies, and bag manufacturers

3.1. Initiate a public awareness campaign on the health effects of heavy baggage. Provide information regarding packing baggage, acceptable baggage weights, and safe manual handling of baggage. This advice could be provided on the relevant web sites, holiday brochures, and issued along with tickets

3.2. Airlines should strictly enforce individual baggage weight limits to deter over-packing

3.3. Bag manufacturers should provide sports bags etc. made of lightweight material such as canvas. Retractable handles on suitcases should be height adjustable and suitable for both pushing and pulling. The option of purchasing suitcases on four wheels should be provided.

4. For other organisations:

4.1. The Irish Health Promotion Unit should provide advice relating to the safe weights of baggage for air travel in their Back Care information booklet

4.2. The National Disability Authority should produce travel advice documents for persons with reduced mobility, and continue to liaise with the Department of Transport and also Dublin Airport Authority in order to devise a Code of Practice on the handling of a PRM at Dublin Airport.

Chapter 1 Introduction

In November 2001, the Health and Safety Authority (HSA) formed an alliance with the Irish Airports Authority (Aer Rianta) and the National University of Ireland, Galway (NUI,Galway), to address the issue of manual handling related injuries among airport workers. The role of NUI,Galway was to devise evidence-based best practice guidelines for the handling of baggage and the handling of a person with reduced mobility (PRM) within the airport environment.

According to a European workplace survey, 33% of workers complain of back pain and the associated absenteeism is high (European Foundation for the Improvement of Living and Working Conditions 2001). Certain types of industries and occupations demonstrate high prevalence rates of back conditions, however, those involving workplace manual handling activities are particularly affected. The large proportion of work-related manual handling injuries incurred over the past few years is having a direct impact on workers, their employers, and the State. Workers must suffer the significant financial and social costs of musculoskeletal disorders whilst their employers are subjected to a high level of absenteeism, a high staff turnover rate, personal injury claims, and many more tangible costs. The State also incurs the costs of work-related musculoskeletal disorders as Occupational Injury Benefit is paid to those who are absent from work for more than three days as a result of their injury. A noteworthy fact is that one of the main injury benefit claims is for disc injuries particularly of the back and neck (Department of Social and Family Affairs 2003).

The project was undertaken by an ergonomics researcher from NUI,Galway. A Project Liaison Committee comprising of representatives from the Health and Safety Authority, Aer Rianta, and NUI,Galway was formed to steer the project. The Aer Rianta Health and Safety Department at Dublin Airport facilitated establishing contacts with health and safety personnel in both Shannon and Cork airports and at the three European airports namely at Birmingham, Düsseldorf, and Frankfurt. The invitation to participate in the project was provided and accepted by all five airports. Experts on health and safety in the aviation industry were liaised with through the avenue of the European Aviation Group for Occupational Safety and Health (EAGOSH). Members of this group provided insight into the extent of the problem of baggage handling and the handling of a PRM at airports throughout Europe. This group also highlighted the industry-wide attempts being made to ameliorate these problems. All of the ground handling companies in the three Irish airports were contacted and invited to participate in the project. Ground handling companies at the three European airports were contacted via the health and safety personnel of the various airport operators. Representatives of the Irish Wheelchair Association (IWA) provided the necessary information, guidance and continued support during the lifetime of the project. Discussions were held with those involved in the manual handling practices and these provided an overview of their tasks; whilst discussions with persons who avail of specialist handling during their air travel gave their views on how the service provided could be improved.

Membership of Project Liaison Committee:

Caroline Duignan, *Ergonomics Researcher*, Centre for Occupational Health, Safety, Engineering and Ergonomics (COHSEE), Department of Industrial Engineering, National University of Ireland, Galway. (Project Researcher),

Enda Fallon, *Head of Industrial Engineering Department*, National University of Ireland, Galway. (Project Supervisor),

Frank Power, *Ergonomist / Inspector*, Health and Safety Authority,

Denis Murray, *Health, Safety, and Environment Manager*, Dublin Airport Authority (Formerly Aer Rianta)

Chapter 2 Manual handling in the aviation industry - issues and concerns

This chapter describes the effects on specific airport workers of two manual handling activities, namely the handling of baggage and the handling of persons with reduced mobility. The extent of the musculoskeletal problem among check-in agents, baggage handlers, and those providing the specialist handling services is highlighted along with the measures currently being implemented to address the issue. A brief outline of the current and future trends in the aviation industry is provided to create awareness of the anticipated increase in air travel traffic which may have both positive and negative repercussions on the airport workers required to accommodate the increase.

2.1. TRENDS IN AIR TRAVEL

Irish air travel has progressed significantly since 1936 when the first ever journey by air was made between Ireland and the rest of the world. The past 60 years have realised a transformation of the aviation industry, as air travel is no longer exclusive to the affluent in society. A new phenomenon deemed the low-cost carrier revolution has facilitated air travel accessibility for all members of society. It is anticipated that over the next few years, the demand for air transport will grow faster than any other mode of transport. The forecast for now until 2015 is that worldwide annual growth rates will remain steady at 4-6% (measured in revenue passenger kilometres) and will begin to decrease beyond 2015 (ATAG 2002). Based on these predictions, air traffic growth when compared with 1995 will grow by 50% until 2005. Dublin Airport anticipates its passenger traffic figures to double by 2020, bringing it to 32 million passengers a year.

In terms of employment, the air transport sector directly employs over 3.9 million people worldwide (IATA 2000, ATAG 2000). In Europe, 0.2% (346,500) of all employees work in this sector (Eurostat 2000). In the United States, where this sector employs 1.5 million people, the Bureau of Labor Statistics in 2000, revealed that airline workers demonstrated the highest number of lost time injuries due to musculoskeletal disorders with rates five times the national average (Tumulty 2002). Although these figures are not decomposed into occupational groups, it is recognised through anecdotal evidence and research that both check-in agents and airport baggage handlers are two groups of airport workers exhibiting a high rate of musculoskeletal disability.

2.2. HAZARDS OF CHECK-IN WORK

Check-in agents are susceptible to low back and neck disorders as a consequence of their work. The concomitant discomfort can greatly interfere with their work performance and can lead to temporary or even permanent disability. Habitual computer work coinciding with preparation of passenger baggage are the recognised causative factors. However, technological advances in the form of self-service check-in (SSCI) have resulted in positive changes for check-in staff, airport authorities and ultimately passengers. Speed and convenience of the check-in process via the SSCI reduces the queue time at check-in desks and therefore space within the departures area. The decrease in the number of passengers that require manual check-in represents a decrease in computer workload; this thus reduces the level of awkward and repetitive work postures associated with check-in work. Passengers themselves obtain their boarding pass and choose their seat. Baggage tags can also be printed, however this is a feature particular to European airports as it is not permissible in the USA for security reasons. The reduction in the level of baggage tagging performed by check-in agents should ease the

musculoskeletal strain on the back as this specific task has been identified as one of the main causes of musculoskeletal pain (Rosskam 2003).

2.3. HAZARDS OF BAGGAGE HANDLING WORK

Baggage handlers are another group of airport workers exhibiting high prevalence rates of low back, knee, and shoulder conditions. Manual handling, which is a recognised cause of back injuries, is an integral component of their work. This is inherent in the definition of a baggage handler as "a person who loads or unloads baggage and or cargo from commercial transport aircraft. It includes those persons who work within the airport terminal who handle baggage and those who consolidate baggage and cargo for particular flights" (Dell 1997). Back injuries sustained by baggage handlers impose significant costs on their employers. A research study involving 15 airlines and a ground handling company revealed that back injuries to baggage handlers cost them an average of $US21 million per annum over the period 1992-1994 (Dell 1997). Also established was that the average cost of a back injury was $10,000. In Ireland due to the establishment of the Personal Injuries Assessment Board (PIAB), it is now more feasible for companies to determine the potential cost of a workplace back injury, as claimants can be awarded 11,700 to 85,900 depending on the level of associated disability. The PIAB is a statutory body entrusted to provide independent assessments of workplace personal injury compensation claims. Technological advances in the form of in-plane loading systems for narrow-bodied aircraft such as the Sliding Carpet Loading System and RTT were designed to minimise the risks associated with working inside the aircraft baggage compartment. Mechanical aids have also been designed for use in the baggage hall. However, these systems are available but not yet the industry norm.

Although the low-cost carrier revolution brings positive changes to air travel it also imposes negative repercussions in particular on ground handling service providers. Shorter turnaround times results in decreased time for unloading inbound and loading outbound baggage. Although the times to unload and load have been reduced, the number and weight of baggage items have not. With air passenger figures showing a rapid increase, consumer demands are being met by baggage manufacturers designing baggage with "extra capacity".

2.4. HAZARDS OF MANUALLY HANDLING PERSONS WITH REDUCED MOBILITY

The airport workers who perform the manual handling of persons with reduced mobility are at risk of musculoskeletal injuries as similar tasks performed in the healthcare industry have been shown to result in such injuries particularly to the back. The main assistance required by persons with reduced mobility is to embark and disembark aircraft, which is classed as a lift-on / lift-off or a passenger assist. The person must be transferred from his or her own wheelchair into a special aisle chair, which is suitable for using inside an aircraft. If the aircraft is not interfaced with the airport terminal building via an airbridge then it is recommended that a purpose built vehicle known as an ambu-lift be used to transport the person from ground level to the aircraft doorsill. The use of this vehicle eliminates the need for two lifters to physically carry the person in the aisle chair up the aircraft stairs. The risk of a musculoskeletal injury increases when there is non-conformance with this industry recommendation. Technological advances have been made recently in relation to the manual handling of a PRM inside the aircraft. The manual handling associated with transferring a person from an aisle chair into the aircraft seat and vice versa can be eliminated with the use of a mechanised hoist system known as "ErgoPort" which came on the market this year.

At Dublin Airport, 8-11 passenger assists are being performed daily since 1999. With passenger growth figures for Dublin Airport expected to increase, a corresponding increase in the provision of passenger assists is inevitable. With cheaper air travel, persons with disabilities should like all others in society enjoy the benefits. This involves the aviation industry accommodating a proportion of the 37 million people with disabilities in Europe, and the estimated 360,000 people living with a disability in Ireland (NDA 2002). More accurate figures on the number with a mobility impairment is expected over the coming years as the Health Research Board is establishing a database of people with physical or sensory disability.

The fundamental necessity for passenger assists has resulted in the Airports Council International (ACI) coining the abbreviation PRM to denote a person with reduced mobility. By definition this is a person "whose mobility is reduced due to any physical disability (sensory or locomotor), an intellectual impairment, age or any other cause of disability when using transport, and whose situation needs special attention or adaptation of services ordinarily available to all passengers". This industry recommendation to adapt services is somewhat compulsory when equality and disability legislation is considered. In Ireland, under the Equal Status Act 2000, persons cannot be discriminated against on the grounds of having a disability. Transport and travel services ordinarily available to the general public must also be available to those with a disability. With the establishment of the National Disability Authority (NDA), an independent statutory body, people with disabilities now have an advocate ensuring their rights are met. Within the past 12 months, monumental strides have been made in terms of the rights of the disabled as several keynote documents and pieces of legislation have been published by the NDA and the Government, respectively. The National Disability Strategy 2004 was produced by the NDA to operate in tandem with the Disability Bill drafted by the Government in 2004. One component of the Bill requires the Department of Transport to address the issue of accessibility to transport and the proposed work is outlined in an adjunct document, the Sectoral Plan, which details the department's exact plan of action. The ultimate aim of the Sectoral Plan is to implement a comprehensive programme of accessible public transport for all people with disabilities (DOT 2004). The plan covers all modes of transport (air, rail, road) and was devised after consultation with relevant transport organisations. The Department is currently working with the NDA to devise guidelines regarding accessibility of the State airports for persons with disabilities. The Sectoral Plan also acknowledges the recommendations made by the NDA in their report entitled "Towards Best Practice in Provision of Transport Services for People with Disabilities in Ireland, 2003" (NDA 2003). However, the efforts to improve air travel accessibility for the disabled is evident in Section 8 of the Sectoral Plan as the Minister for Transport made two requests on Aer Rianta:

a) The establishment of a user's group comprising of people with disabilities to provide advice on accessibility issues

b) The establishment of a complaints and redress structure at each airport to deal with issues concerning accessibility to services

The Plan only requires the new restructured airports to comply with the latter request.

It is evident from this chapter that musculoskeletal disorders among three specific groups of airport worker is a significant problem that must be addressed. The manual handling elements of their work may be causing or contributing to these disorders. Technological advances in the long term will aid in eliminating or minimising the risk factors, however in the interim, prompt, feasible solutions are required. The next chapter describes the modus operandi of the project, which culminated in the production of evidence-based solutions to the problem.

Chapter 3 Project Methodology

This chapter outlines the development of the project from its inception to its completion. A detailed description is provided of the method of working to achieve the project objectives. Participation by the relevant organisations and companies in the project is highlighted along with difficulties encountered.

3.1. PROJECT INCEPTION

In 2000, the Health and Safety Authority (HSA) formed an alliance with the former Irish Airports Authority, Aer Rianta, currently the Dublin Airport Authority, and a research project entitled "Best Manual Handling Practices at Dublin airport" evolved. A steering committee was formed comprising of Aer Rianta health and safety staff, representatives from the airlines, ground handling companies, and external bus operators, and a representative from the Irish Wheelchair Association. The committee identified three critical manual handling activities, which warranted best practice guidelines:

1. Baggage handling - outbound
2. Baggage handling - inbound
3. Handling of Persons with a Disability

It was also decided to address the baggage handling risks from both an occupational and public health perspective thereby acknowledging the necessity for promoting safe manual handling practices among air travellers. A proposed methodology was agreed upon which entailed:

a) Conducting airport benchmarking of the three critical manual handling activities at three European airports, namely Frankfurt, Düsseldorf and Birmingham Airport

b) Reviewing research literature and relevant publications (secondary research)

c) Conducting primary research on aspects of the three critical manual handling activities in order to produce best practice guidelines

In November 2001, a project alliance was formed between the Health and Safety Authority, Aer Rianta, and NUI,Galway, with the latter organisation providing an ergonomic researcher to work on the project according to the proposed methodology. All alliance parties agreed on a 3-year project time frame broken down into two phases. Phase 1 involved airport benchmarking, a literature review, data collection, and planning, and had a time frame of 12 months. Phase 2 incorporated conducting primary research to produce recommendations for the specified manual handling activities and the time frame for this stage was 24 months. For the benchmarking exercise it was decided by the alliance to use six international airports namely Dublin, Cork and Shannon airports; Birmingham International in the UK, and both Düsseldorf International and Frankfurt International in Germany. For the purpose of benchmarking, the three critical manual handling activities identified by the steering committee were classified further into nine specific manual handling activities, (6 stages of baggage handling and three stages of handling a person with reduced mobility). The focus of interest concerning the activity of handling the disabled passenger was narrowed to concentrate on the handling of persons specifically with reduced mobility, as this disability group require manual handling assistance to embark and disembark aircraft. The following were the nine manual handling activities:

Three *Outbound* baggage handling activities

1. Check-in process
2. Baggage handling in the baggage hall

3. Baggage handling on the ramp

Three *Inbound* baggage handling activities

4. Baggage handling on the ramp
5. Baggage handling in the baggage hall
6. Baggage handling in the reclaim area

Three activities involving the handling of *Persons with Reduced Mobility* (PRM)

7. Check-in process
8. Assistance with boarding aircraft (wheelchair push)
9. Lift on / lift off.

3.2. PHASE 1

A set of work tasks and their schedules, outlined in a working document entitled Project Work Plan, were established in order to achieve the objectives of Phase 1. Through the avenue of Project Liaison Committee Meetings between all three parties the proposed work tasks and schedules were revised and updated as required according to circumstances arising. These meetings were held every 2-3 months. Airport familiarisation was the first task of the project and the researcher spent the first six months of Phase 1 at Dublin airport working in conjunction with the Aer Rianta Health and Safety Department. During this period, work commenced on the benchmarking exercise with site-visits to the participating airports and subsequent visits made throughout Phase 1. Feedback on the benchmarking exercise was provided at meetings of the Project Safety Forum, which comprised of the participants in the project, namely Aer Lingus, Aviance, Servisair, Greencaps, AirCoach and the Irish Wheelchair Association (IWA). In Phase 1, each work package was completed on schedule within the limitations and constraints that applied.

Three major issues influenced the completion of the project work. Firstly, no other participants besides Aer Rianta and the HSA were contractually bound to the project. The implication of this was that NUI,Galway was dependent upon the goodwill of the airlines, ground handling companies, other airport authorities and domain experts to provide information necessary for the successful completion of each task. The second major issue that impacted on the nature of the research was the collating of benchmarking data from the involved airports. Due to the nature of change, it was noted and accepted that a significant amount of the task description work from the airports would be out of date within six to twelve months. The third major issue was confidentiality regarding injury rates, medical records, and costs of accidents. Ground handling companies, airlines and other relevant companies did not provide this information due to the fact that they were not contractually bound to the project and therefore not obliged to provide the relevant statistics. In addition, the majority of this information is not available in a format suitable for analysis, as many companies do not have such systems in place to collate and manage this information.

3.3. PHASE 2

The programme of work for Phase 2 evolved from the work conducted in Phase 1. A review of the published research pertaining to the topics of interest identified areas for investigation through primary research. Additional work tasks were devised and included in the Project Work Plan working document. Several minor research projects were formulated based on the literature review, benchmarking data, and meetings with relevant bodies such as the Irish Wheelchair Association

(IWA) Transport Committee. A planned work programme and schedule was produced for Phase 2. The sub-projects included both ergonomic analysis and occupational health assessments and were organised and co-ordinated by the project researcher. A large number of the sub-projects were completed as part of Minor theses of students undertaking a Masters of Science in Occupational Health and Ergonomics, and as Final Year Projects for Industrial Engineering students. A major research project, in conjunction with a manufacturing company in Sweden, Telair International, was conducted in the latter part of Phase 2 and a research assistant was involved in this large project. In total, 19 pieces of primary research were completed in relation to the two specific manual handling activities; these are summarised into Primary Research Packages (PRP) in the Table 1. The nine manual handling activities were further revised and are presented below. *(A list of the research conducted on each of the nine manual handling tasks is provided in the Appendix)*.

Four *Outbound* baggage handling activities

1. Check-in process
2. Baggage handling in the baggage hall
3. Baggage handling on the ramp
4. baggage handling in the aircraft hold

Three *Inbound* baggage handling activities

5. Baggage handling on the ramp
6. Baggage handling in the baggage hall
8. Baggage handling in the reclaim area

Two activities involving the handling of *Persons with Reduced Mobility* (PRM)

9. Check-in process
10. Assistance with boarding aircraft (Lift on / lift off

Table 1: Primary Research Packages

Primary Research Packages (PRP)	Completed
1. Postural analysis of all baggage handling tasks **(PRP 1)**	2003 / 2004
2. Ergonomic assessment of the use of specific mechanical aids in the performance of baggage handling tasks	2002 / 2003
a) A mobile baggage conveyor system on the ramp **(PRP 2a)**	2004
b) In-plane loading systems in the hold of an aircraft **(PRP 2b)**	
3. Ergonomic assessment of the use of an assistive device for the manual handling of a person with reduced mobility	2004
a) A transfer board **(PRP 3)**	
4. Ergonomic design of a wheelchair-accessible check-in desk	2002
5. Ergonomic evaluation of the uniform worn by baggage handlers **(PRP 5)**	2004
6. Survey of the prevalence of musculoskeletal disorders and the lifestyles of baggage handlers **(PRP 6)**	2004
7. Survey of air travel accessibility for persons with reduced mobility **(PRP 7)**	2004
8. Ergonomic assessment of the use of 3 different load carriage methods by passengers **(PRP 8)**	2003

This section has described the structured programme of work used throughout the lifetime of the project. Also highlighted was that through the avenue of regular meetings of the Project Liaison Committee every stage of the project was agreed upon prior to its commencement. This structured approach facilitated the achievement of the overall project objective, which was evidence-based recommendations derived from three core activities, primary and secondary research and airport benchmarking. The findings of these activities are outlined in the next chapter.

Chapter 4 Summary findings of literature review, airport benchmarking, and primary research

This chapter is structured so as to provide justification for conducting the primary research studies. A summary of the literature review and the core findings of the benchmarking exercise provide insight into the topic areas requiring research investigation. The conclusions from the primary research conducted as part of the project are also provided.

4.1. LITERATURE REVIEW FINDINGS

A thorough literature review was conducted throughout Phase 1 and Phase 2. All research studies pertaining to the topic areas were reviewed and critiqued with research gaps identified. Relevant legislation, codes of practice, and guidelines available worldwide were identified. Prior to this project, no Irish research has ever been conducted on the area of manual handling in the aviation industry.

4.1.1. Check-in work

Research on the health effects of check-in work is relatively non-existent. Only one study has being conducted investigating this topic area (Rosskam 2003). The survey of 132 check-in workers based at three different airports in Canada and Switzerland revealed that musculoskeletal disorders are prevalent among this occupational group with over 50% suffering from low back pain or neck pain and nearly 75% claiming that this pain interfered with their job. In general the study showed that workstations were poorly designed and had a poor layout. Also highlighted was that the task of applying baggage tags was perceived as the most harmful on the musculoskeletal system.

4.1.2. Baggage handling work

With less than thirty English language research studies investigating the health effects of baggage handling it is evidently a topic area warranting further exploration. The prevalence rates of musculoskeletal disorders, particularly of the back, among baggage handlers is high at 43-81% (Rückert and Rohmert 1991, Lima and Peixoto 1995). This large range can be attributed to the use of various classifications of back disorders and different tools to determine the prevalence rate. Low back pain / disability has been identified as the most common reason for transfer or termination of employment by baggage handlers; cardiovascular disease is the second most common reason (Froom et al., 1996). No research prior to this project has determined the lifestyles of baggage handlers, which is a known risk factor of back pain and heart disease.

The subjective perception of baggage handlers is that the task of unloading / loading inside the aircraft baggage compartment is the most difficult of all baggage handling tasks (Dell 1997). This justifies the research conducted over the past 20 years determining the biomechanical, physiological and psychophysical effects of this particular task. In terms of the physiological effects this task places the greatest cardiovascular strain on the body in terms of heart rate measures (Rückert et al., 1992), and imposes significant biomechanical stress on the spine (Rohmert et al., 1989). Research has also determined that the loading task is more strenuous than the unloading task in biomechanical terms (Stålhammer et al., 1986). The use of mechanical aids such as in-plane loading systems (the Telescopic bin) significantly reduces the working heart rate, energy expenditure, and shoulder muscle activity of

the aircraft loader (Jørgensen et al., 1987). The use of the Sliding Carpet Loading system was also found to reduce the heart rate by 4.8% compared to when not using the system (Dell 2000). It is unknown however how the latter finding was derived as no information on the methodology is provided in the conference paper outlining the study. Also, with reference to baggage handling tasks performed in the baggage hall and on the ramp, prior to this project no detailed ergonomic assessments had been conducted of baggage handling in the latter area, transferring baggage between carts and mobile baggage conveyors. In terms of factors that may influence the performance of baggage handling tasks, again, no prior research has investigated the effects of work clothing on range of motion or thermal comfort.

Various aviation organisations have produced operational guidelines and recommended practices pertaining to baggage handling. The International Civil Aviation Organisation (ICAO) is a United Nations agency established to harmonise civil aviation operations through international standardisation. Their international standards and recommended practices are categorised into eighteen annexes, with Annex 9 (Facilitation) directly referring to baggage handling tasks and the use of mechanical means (ICAO 2004). The International Air Transport Association (IATA) is a trade organisation serving the airline industry. It produces working standards and operational guidelines for airlines, airports, and other service providers within the airport environment. Their Airport Development Reference Manual, which acts as a planning guideline for airport design, makes recommendations for the design of check-in counters and baggage conveyors in baggage halls (IATA 1995). Several sections in their Airport Handling Manual (AHM) addresses baggage handling issues (IATA 2000), however, two sections have particular relevance:

a) AHM 695, Section 2: Recommendations - advises that "consideration be given to aircraft being fitted, whenever practical, with mechanised in-plane loading systems".

b) AHM 695, Section 8: Baggage and Material Handling - states that "manual handling of baggage is a primary cause of personnel injuries"

4.1.3. The handling of a person with reduced mobility (PRM)

The handling of a person with reduced mobility within the airport is a research area greatly under-explored. No research to date has been conducted to determine the task of transferring a PRM from their wheelchair into an aircraft seat. Research investigating patient handling techniques in the healthcare environment can be extrapolated to the handling of air travellers with reduced mobility. Patient transfers have been identified as tasks requiring awkward body postures, which can contribute to the development of musculoskeletal conditions among nurses and disability care-workers (Hignett 1996, Ore 2003). Research has shown that the use of patient handling aids imposes less biomechanical stress on the body compared to manual assistance (Garg et al., 1991, Elford et al 2000). The use of these aids is also rated by both the users and the persons being transferred as being more comfortable and safer than the manual method (Zhuang 2000). Proper training in patient transfer techniques has also been shown to improve work techniques thereby leading to less discomfort for the lifters (Johnsson et al., 2002). However, training on how to fold and unfold wheelchairs has been deemed insufficient although it is a task, which forces the worker to adopt harmful postures (White and Kirby 2003). Under the Canada Transportation Act 1996, regulations have been formulated to provide guidance for training in the handling of persons with reduced mobility. Personnel Training for the Assistance of Persons with Disabilities Regulations requires task-specific training in the provision of physical assistance and the handling of mobility aids (CTA 1996). A description of a proposed training program is also provided.

Two major conferences have been held over the past 10 years focusing specifically on accessibility of air travel for disabled persons, one by the European Civil Aviation Conference (ECAC), and the other by the UK Chartered Institute of Transport (CIT) (ECAC 1995, CIT 1997). These conferences provided useful anecdotal information from various perspectives such as disability organisations, airport authorities, aircraft manufacturers and airlines. With regard to the users of specialist handling services, research has been conducted by the Canadian Transportation Agency in 2000 among persons with disabilities to determine their experiences and grievances with services provided in Canada. The study concluded that improvements should be made in relation to three specific issues, the relay of information to and by airlines, the provision of accessible seating on aircraft, and the training of staff providing assistance to PRMs to embark and disembark aircraft.

Aviation organisations make recommendations to airports and airlines for accommodating a PRM. The International Civil Aviation Organisation's (ICAO) recommended practices outlined in Annex 9 (Facilitation) describe the measures necessary to facilitate a PRM such as accessibility to the airport, communication, and assistance with embarking and disembarking aircraft. To complement and support these recommendations the European Civil Aviation Conference (ECAC), which is an intergovernmental organisation, compiled a Policy Statement in the Field of Civil Aviation Facilitation of Persons with Reduced Mobility (ECAC 2003). It also produced a "Code of Good Conduct in Ground Handling for PRMs". The Airports Council International (ACI) is a representative body for airports worldwide. In 2001, the ACI-Europe region established 11 "Airport Voluntary Commitments on Air Passenger Service", with Commitment Number 1 specific to PRMs. This requires all member airports to publicise the services they provide to PRMs and to adopt the Special Protocol to meet the needs of PRMs (ACI-Europe 2001). ACI have also produced a handbook for airport operators entitled "Airports and Persons with Disabilities". The "Airport Development Reference Manual" previously mentioned, makes recommendations such as the provision of low-level check-in counters, and the use of ambu-lifts for aircraft not interfaced with the terminal building via an airbridge (IATA 1995).

Disability legislation has evolved over the past few years, especially in Ireland. With the publication of the Disability Bill and the adjunct Outline of the Sectoral Plan for Transport in September 2004, steps are being taken to produce guidelines for access to and within the State airports for people with mobility and sensory impairments (Department of Transport, Ireland, 2004). Irish Airport legislation is also in existence with the State Airport (Amendment) Bye-Laws 1999, requiring service providers and other business providers at the airport to accommodate the needs of PRMs. Although disability legislation exists in many countries including the UK, USA, Canada, and Australia specific legislation has also been produced pertaining to air travel accessibility for disabled persons in the latter three countries. In the USA, under the Air Carriers Access Act 1986, the Air Carrier Access Rules were devised to minimise the difficulties experienced by disabled passengers (Department of Transport, USA, 1989). These rules delineate the responsibility of the air traveller, airline and airport operator. Advisory circulars have also been produced by the American Department of Transportation. In Canada the Air Transport Regulations derived from the Canadian Transportation Act 1996 require Canadian air carriers operating in Canada to provide adequate services and information to persons with a disability (CTA 1996). In Australia, the "Disability Standards for Accessible Public Transport 2002" and the associated guidelines were developed as a form of framework for ensuring compliance with the Disability Discrimination Act 1992 (Australian Government 2002).

Codes of Practice and guidelines to ensure accessibility of air travel for persons with a disability have been produced by various organisations worldwide. In the UK, the Department for Transport issued a

"Code of Practice – Access to Air Travel for Disabled People" in 2003, which is for all those involved in air travel such as UK airlines, airports, and ground handling companies (Department of Transport, UK, 2003). An adjunct guidance document for disabled persons was also produced providing information on every aspect of air travel from planning the journey to disembarking the aircraft at the destination airport (DPTAC 2003). In Canada, a "Code of Practice for Aircraft Accessibility for Persons with Reduced Mobility" is also in effect (CTA 1995).

Disability organisations are also proactive in improving air travel accessibility for PRMs. The National Disability Authority (NDA) produced a report entitled "Towards Best Practice in Provision of Transport Services for People with Disabilities in Ireland" (NDA 2003). This document details the research conducted to determine the quantum and range of service provision for people with disabilities in Ireland. One of its main recommendations was to promote the adoption of the ACI Voluntary Airline and Airport Passenger Service Commitments by all airports and airlines in Ireland (ACI 2001). The NDA has also produced a compilation of building guidelines entitled "Building for Everyone: Inclusion, Access and Use", which incorporates design guidelines for airport terminal buildings in order to facilitate persons with a disability (NDA 2002). Disability organisations also provide information booklets and advice to persons with reduced mobility.

Ergonomic guidelines for airport workers have been produced by two national authorities for safety and health in relation to the handling of baggage and the handling of wheelchair persons at the airport (OHSA 1996 / 2003, HSE 2004). Although both documents address each of the tasks outlined in this project, their guidelines and recommendations unlike this project are not explicitly research-based.

4.1.4. Passengers

With regard to air travellers in general, a dearth of research exists investigating the effects of baggage type and load carriage. Efforts were made in the late 1970's to address rail carriage luggage handling systems in order to determine passenger preferences for luggage dimensions and for storing their luggage whilst on rail journeys (Williams 1977). The provision of information to passengers through their airlines, airports, and travel advice websites was reviewed as part of this project. The websites of 35 airlines and 8 tour operators were reviewed and no information on personal safety concerning baggage handling was provided on any (Collins and Duignan 2004). In 2001, during the initial stages of this project, the Irish Travel Agents Association (ITAA) was contacted to determine if any information regarding the packing of lighter baggage was provided to their members. At the time, no pertinent information was provided to their members or presented on their website. A recent review of their website identified a section entitled "Packing Tips" which advises air travellers to reduce their proposed baggage weight by 10-12% at the packing stage. Equivalent American and British travel agents associations do not provide any such advice. Baggage manufacturers are another group failing to provide adequate information to air travellers on the packing and handling of their baggage. A review of the websites of two leading baggage manufacturers, Samsonite, and Tutto Ltd., revealed that only the latter explicitly states that their products are designed to maintain a healthy back.

Air travel advice websites exist and provide standard information regarding bookings and health care whilst flying. However, specific advice regarding packing lighter baggage is non-existent. One noteworthy website is that of a seat manufacturing company in India who provide detailed advice on maintaining a healthy back whilst travelling (Godrej (n.d)). Recommendations are made by several aviation organisations such as ECAC and ACI-Europe to directly facilitate passengers and their baggage. Section 4 of the ECAC Policy Statement in the Field of Civil Aviation Facilitation and

Commitment 7 of the ACI-Europe Commitments require airports to ensure that a sufficient number of baggage trolleys are available, in good working order, and suitably located throughout the airport (ECAC 2003).

4.2. BENCHMARKING FINDINGS

Airport benchmarking can be described as the process of identifying and learning from best practices in other airports. This exercise was conducted in 2002 / 2003 and involved six airports: Dublin, Cork, Shannon airports, Birmingham International Airport, Frankfurt Airport, and Düsseldorf International Airport. Health and Safety benchmarking was conducted on the handling of baggage and the handling of a PRM. Information was also collated on factors influencing the performance of these two activities such as airport infrastructure, design and layout. The rationale for this exercise was to determine if specific improvements could be made in existing practices at Dublin Airport thereby achieving "Best Manual Handling Practices at Dublin Airport". The following were the main findings from the six airports:

For the travelling public:

- **Portage Service:** no portage service was provided at Cork Airport or Birmingham Airport
- **Wheelchair-friendly check-in counters:** Frankfurt Airport have these counters however, they are only for passengers of Lufthansa and their associate airlines.
- **Baggage trolleys for passengers:** Düsseldorf Airport trialled three different types of baggage trolleys before choosing one.

For check-in agents:

- **Task description:** Lufthansa (operating in both Frankfurt and Düsseldorf Airport) operated a task rotation system for check-in agents to prevent prolonged check-in work (i.e. 70% of shift spent at different check-in desks, 30% working at boarding gate and doing other tasks).

For baggage handlers:

- **Pre-employment medical assessments:** Aviance at Dublin Airport and Servisair (a Third Party Handler in Dublin, Shannon, Cork, and Birmingham International Airport) did not conduct pre-employment medical assessments of potential baggage handling staff. Aer Lingus (operating in all three Irish International airports), Aviance (in Birmingham Airport), Fraport (in Frankfurt Airport), and FDG (in Düsseldorf Airport) conducted such assessments. Also Fraport at Frankfurt Airport and FDG at Düsseldorf Airport conduct periodic medical check-ups for their employees (i.e. every 3 years).
- **Back training programmes:** Düsseldorf Airport and Frankfurt Airport provided machine-based back training programmes for baggage handling staff at the induction stage and for rehabilitation purposes.
- **Back support belts:** Baggage handlers in Düsseldorf Airport and Frankfurt Airport were offered these as part of their uniform.
- **Return to work programmes:** Düsseldorf Airport and Frankfurt Airport had a formal return to work programme for injured baggage handling staff.
- **Mobile baggage conveyor systems:** Düsseldorf Airport was the only airport using mobile

baggage conveyors to load / unload all aircraft i.e. both a standard size and a equivalent small-scale mobile baggage conveyor was used

- **In-plane loading systems:** Düsseldorf Airport was the only airport offering a reduced ground handling fee to airlines using a Sliding Carpet In-Plane Loading System.
- **Mechanical aids in baggage hall:** Both Düsseldorf Airport and Frankfurt Airport trialled the use of a baggage handling mechanical lift system for handling inbound and outbound baggage. Both airports have discontinued its use. In Frankfurt International Airport a mobile non-powered monorail unit was available for use in transferring baggage between conveyors and baggage containers /carts.
- **Inbound and outbound baggage conveyors in baggage halls:** Düsseldorf Airport was the only airport to design the dimensions of these conveyors using a participatory approach.
- **Work clothing:** Baggage handlers in Düsseldorf Airport wore a pair of dungarees and polo shirt as opposed to a pair of trousers and polo shirt which is the uniform worn by all other ground handling providers at the airports. A participatory approach was used to design the uniforms in Düsseldorf Airport.
- **Baggage handling systems:** In Frankfurt Airport and Birmingham Airport a computerised passenger reconciliation system was in operation. This system requires the baggage handler to use a hand-held laser scanner to scan each baggage item prior to it being loaded into baggage containers or onto baggage carts.

For companies handling persons with reduced mobility

- **Lift-on / Lift-off of PRMs:** In Shannon Airport and Cork Airport, the Lift-on / Lift-off was performed by the baggage handlers providing the ground handling service for the particular flight the PRM was boarding. All other airports had specialist handling companies providing this service.
- **Mechanical aids:** Aer Lingus in Shannon and Cork Airport and Servisair at Shannon Airport used a catering truck to facilitate PRMs embarking and disembarking aircraft. Specialist vehicles known as ambu-lifts were available for use in all other airports.
- **Training for manual handling of persons:** Baggage handlers employed by both Aer Lingus and Servisair at Shannon and Cork Airport did not formally receive specific training on how to manually handle persons with reduced mobility.

4.3. PRIMARY RESEARCH FINDINGS

This section provides the findings of the research projects conducted within the remit of this project. Nine specific studies are outlined along with the main scientific findings and conclusions.

4.3.1. Postural analysis of check-in work and baggage handling work (2004)

Using a postural analysis tool, the Rapid Upper Limb Assessment (RULA) devised by McAtamey and Corlett (1993), postures were classed according to the Action Categories (AC) 1-4 outlined in the RULA table. However, for this project each category was assigned a rating phrase to differentiate each category: AC 1 = "acceptable postures", if not maintained or repeated for long periods; AC 2 = "somewhat awkward" postures requiring further investigation and possible changes; AC 3 = "awkward"

postures requiring investigation and definite changes; AC 4 = "very awkward" postures requiring immediate investigation and changes.

Check-in work (at Dublin Airport and Birmingham Airport)
The postures imposed by three tasks were assessed: retrieving passenger's documents, completing computer work, and tagging baggage. The main findings were:

- Overall, the majority of postures adopted whilst performing the check-in procedure were in AC 2, and thus deemed "somewhat awkward", however, the task of tagging baggage imposed worse postures compared to the tasks of retrieving tickets and computer work. Tagging baggage imposed postures classed as "awkward" thereby indicating that changes in the performance of the task must be implemented in the short term whilst long term measures to reduce the levels of exposure to risk factors are planned.
- Unnecessary over reaching was performed for two task elements, i.e.
  - in handling passenger's documents especially when indicating to passengers their boarding gate number printed on the boarding pass.
  - in applying tags to baggage items due to the inadequate use of the check-in conveyor to bring the baggage item within working range of the check-in agent

Baggage handling work
The postures imposed by the lift, carry, and lower of both the unloading and loading tasks were assessed. The following were the main findings:

- Overall, the unloading tasks performed in both the baggage hall and on the ramp imposed more awkward postures than the loading tasks in these same areas. The opposite was the case for work inside the aircraft hold as the loading task imposed more hazardous postures than the unloading task. For work inside the hold, pushing the baggage as opposed to throwing it along the aircraft floor was identified as less hazardous. The use of a mobile baggage conveyor on the ramp was found to be less hazardous than the non-use of the conveyor.
- Baggage hall (In Dublin Airport, Birmingham Airport, and Düsseldorf Airport)
  - The task of unloading inbound baggage imposed more hazardous postures than the task of loading outbound baggage. In terms of postures classed as "very awkward" the unloading task had a greater percentage of postures in this high risk AC 4 in all three airports.
  - During both unloading and loading, the carry element was found to be hazardous as 100% of the postures were in the higher AC 3 and AC 4 thereby requiring prompt action to minimise the risks.
  - The lift and lower elements of both the unloading and loading tasks differed between the three airports, especially for the latter task. Postures adopted when performing these two task elements for both tasks were in the lower safer action categories in Düsseldorf Airport and in the higher action categories in Dublin Airport and Birmingham Airport. The safer postures associated with these task elements in Düsseldorf Airport can be attributed to the heights of both the baggage conveyors and baggage carts. The postural assessments of the lift element of the unloading / loading tasks differed between Dublin Airport and Birmingham Airport. In the latter airport the assessments showed that a greater proportion of the loading postures were in the high risk categories which can be attributed to the fact that for 100% of the time spent loading, the baggage handler used one-handed lifting and held the laser scanner in his dominant hand.

- ▲ The ramp (Dublin Airport and Birmingham Airport)
  - Assessments at Dublin Airport revealed that in comparison with the loading task, the unloading task using a baggage conveyor on the ramp imposed more hazardous work postures.
  - In Birmingham Airport, unloading without the use of mobile baggage conveyor was deemed more hazardous than when using a conveyor especially for the lift element of the task as 100% of the postures were in the higher action categories. In comparing the unloading and loading tasks without the use of the conveyor, unloading imposed more hazardous postures.
- ▲ In the hold (Dublin Airport and Birmingham Airport):
  - Assessments at Dublin Airport showed that for the worker positioned at the door of the aircraft, the task of loading baggage imposed more hazardous postures than the task of unloading. For the loading task, 83% of all postures were in AC 3 and AC 4 compared to only 38% in these categories for the unloading task. Several explanations for this disparity exist, for example, the loading task was performed at a greater work rate (i.e. 16 bags/minute were loaded, whilst 4 bags/minute were unloaded); the baggage handler adjusted the bag before lifting 100% of the time thereby forcing more awkward postures, and the releasing or lowering of baggage items also imposed more awkward postures.
  - It was noted that for 88% of the baggage items loaded, the baggage handler pushed the items along the aircraft floor instead of throwing it, so reducing the proportion of awkward postures in the carry element of the task.
  - In comparing the postures of the baggage handler at the door of the aircraft (Position 1) with the baggage handler unstacking the baggage (Position 2), all of the postures for both positions were in the higher risk categories. However, Position 2 imposed more "very awkward" AC 4 postures for both the lift and lower elements whilst the carry element was the same for both positions.
  - When comparing the carry elements of the unloading task whilst in Position 2, and the loading task whilst in Position 1, pushing the baggage along the aircraft floor was shown to be as less hazardous than throwing the baggage as this resulted in twice as many postures in the high risk categories.

4.3.2. Physiological and psychophysical assessment of using a mobile baggage conveyor system to load / unload aircraft (2002)

Physiological assessments (heart rate and blood pressure), and psychophysical assessments (ratings of perceived exertion via the Borg RPE Scale) were conducted of five baggage handlers whilst loading / unloading on the ramp. The following were the main findings:

- ▲ When compared with the unloading task, the loading task resulted in a higher average working heart rate (108bpm v 103bpm) and a marginally greater average energy expenditure (24kcal v 22kcal).
  - 80% (4) of the participants were working at levels greater than 50% of their predicted heart rate maximum for the loading task, whereas only 60% (3) worked above this rate for the unloading task.
  - Overall, both the unloading and loading tasks were perceived by the baggage handlers as being "somewhat hard". In comparing this subjective rating with working heart rate

measures, the majority (80%) tended to over-estimate the work intensity for both the unloading and loading task i.e. the heart rate recordings were lower than the perceived exertion level of the task.

- 60% (3) had elevated resting blood pressure levels, with one subject demonstrating possible mild hypertension.

4.3.3. Ergonomic assessment of using a mobile baggage conveyor system to unload / load aircraft at Dublin Airport (2003)

Physiological assessments (heart rate and blood pressure), biomechanical assessments (postural analysis via RULA) and psychophysical assessments (ratings of perceived exertion via the Borg RPE Scale) were conducted of fifteen baggage handlers whilst unloading / loading on the ramp. The main findings were:

▲ The average working heart rate for both the unloading and loading task was the same at 106 bpm thus classifying both tasks as "moderate work" (Åstrand and Rodahl, 1986). A difference however did exist between both tasks in relation to the average energy expenditure as more kilocalories were burned during the loading task (53 kcal V 37 kcal).

- 74% (11) of the participants were working at levels greater than 50% of their predicted heart rate maximum for both the loading and unloading task.
- Overall, both the unloading and loading tasks were perceived by the baggage handlers as being "somewhat hard". In comparing this subjective rating with working heart rate measures, the majority of baggage handlers tended to over-estimate the work intensity for both the unloading and loading task i.e. the heart rate recordings were lower than the perceived exertion level of the task.
- 100% (15) of subjects had fitness levels ranging from low to moderate
- 53% (15) of subjects had a resting blood pressure level above normal
- 53% (15) of the subjects were classed as overweight (BMI 25-29kgm^2).

The aforementioned results indicate that the combination of being overweight, with elevated resting blood pressure, and a poor to moderate level of physical fitness is a cause of concern for baggage handling staff.

4.3.4. Ergonomic assessment of the use and non-use of assistive in-plane loading devices to unload / load baggage inside the baggage compartment of aircraft (2004)

Physiological assessments (heart rate, blood pressure, fitness test), biomechanical assessments (postural analysis via RULA and electrogoniometer analysis), psychophysical assessments (ratings of perceived exertion via the Borg RPE Scale) were conducted of thirteen baggage handlers performing unloading / loading tasks under three different conditions in an aircraft mock-up: no in-plane loading devices, the use of the Sliding Carpet Loading System (SCLS), and the use of both the SCLS and the RTT Longreach (a belt loader extension).The following were the main findings:

▲ The use of an in-plane loading device halves the number of staff required when the device is not used without placing any additional cardiovascular strain on the baggage handler

▲ Overall, less hazardous postures were adopted when using both assistive in-plane loading devices compared to when not using the devices for both the unloading and loading tasks

▲ For the unloading task:

- The use of both assistive in-plane loading devices reduced the number of hazardous postures (AC 3 and AC 4) by 8% when compared to the non-use of the devices

- For the loading task:
  - The use of both assistive in-plane loading devices reduced the number of hazardous postures (AC 3 and AC 4) by 34% when compared to the non-use of the devices
  - The use of both assistive in-plane loading devices resulted in a 7.5% decrease in the average heart rate when compared to the non-use of the devices
  - The use of both assistive in-plane loading devices was perceived by the baggage handlers to demand the least amount of physical exertion when compared to the non-use of the devices

4.3.5. A thermal comfort evaluation and range of motion study of four different types of baggage handler work uniforms (2004)

Physiological assessments (mean skin temperatures) and biomechanical assessments (shoulder, trunk, and back lateral flexion range of motion via a flexometer) were conducted of twelve subjects wearing four different baggage handler uniforms. The following were the main findings:

- A uniform comprising of dungarees, as opposed to a top and trousers, resulted in a statistically significant reduction in upper body range of motion of the shoulder and trunk
- No significant differences in skin temperature of the workers were found for the four uniforms
- The uniform with the highest percentage of polyester created the greatest level of thermal discomfort

4.3.6. A survey of the musculoskeletal conditions and the lifestyles of baggage handlers in Ireland and the UK (2004)

The prevalence and cause of musculoskeletal conditions along with the general health, exercise, smoking habits, alcohol consumption, and diet of baggage handlers from one company in Dublin Airport and one company in Birmingham Airport were determined.
In Ireland (Dublin Airport, Company A), the following were the main findings:

Musculoskeletal discomfort (ache / pain)

- Lifetime prevalence: 68% have low back discomfort, 56% have knee discomfort, 49% have neck discomfort, and 38% have shoulder discomfort
- 59% attribute their low back discomfort to their work as a baggage handler and 45% took at least one day off work with low back discomfort
- 31% attribute their knee trouble to their work as a baggage handler and 33% took at least one day off work with knee discomfort

Survey of lifestyle attitudes and nutrition

- 21% are obese, 42% are overweight, 37% are normal weight
- 53% have had a medical check-up in the past three years; 14% have medical cards, 41% have private health insurance
- 12% have never had their blood pressure checked whilst 53% have never had a cholesterol check
- Although 90% perform some level of exercise, this is not performed on a regular basis as only 10% perform mild exercise three times a week

- 56% believe their job is very physically active; 49% work over 40hrs a week
- 39% are regular smokers, and of these 68% have never tried to quit. More willpower, confidence and less stress were identified as the most important requirements to help quit smoking
- Overall, 25% of baggage handlers consume more than the recommended weekly limits of alcohol. Although 86% have consumed alcohol during the past month, 60% drink on a weekly basis. 17% drink five or more days a week. 20% missed days from work due to a hangover
- 90% believe they could eat healthier. 12% eat fried food 4-6 times a week, and 64% add salt to their food. 20% get a home delivery/takeaway food once a week or more
- More money is perceived as the greatest requirement for better health.

In the UK (Birmingham International Airport, Company B), the following were the main findings:

Musculoskeletal discomfort (ache / pain)

- Lifetime prevalence - 58% have low back discomfort, 37% have knee discomfort, 32% have neck discomfort, and 34% have shoulder discomfort
- 68% attribute their low back discomfort to their work as a baggage handler and 32% took at least one day off work due to their low back discomfort
- 71% attribute their knee discomfort to their work as a baggage handler and 38% took at least one day off work with knee discomfort

Survey of lifestyle attitudes and nutrition

- 25% are obese, 46% are overweight, 26% are normal weight, 3% are underweight
- 57% have had a medical check-up in the past three years; 55% have medical cards and 5% have private health insurance
- 6% have never had their blood pressure checked whilst 57% have never had a cholesterol check
- Although 80% perform some level of exercise, it is not performed on a regular basis as only 35% perform mild exercise three times a week
- 71% believe their job is very physically active, 18% work greater than 40 hrs a week
- 18% are regular smokers, and of these 12% have never tried to quit. More willpower, less stress, and advice from doctors and nurses were identified as the most important requirements to help quit smoking
- Overall, 26% of baggage handlers consume more than the recommended weekly limits of alcohol. Although 79% have consumed alcohol during the past month and 60% drink on a weekly basis. 20% drink five or more days a week. No respondents have been absent from work due to a hangover
- 74% believe they could eat healthier. 8% eat fried food 4-6 times a week, and 57% add salt to their food. 14% get a home delivery / takeaway food one a week or more
- A change in weight is perceived as the greatest requirement for better health.

The findings of the questionnaire revealed that an average of 63% of all respondents suffer from low back conditions with 64% of those attributing it to their work as a baggage handler and 39% having taken at least one day off work as a result. In terms of weight classification based on Body Mass Index calculations, 34% are overweight or obese, however, 84% believe they could eat healthier. The greatest disparity in lifestyle behaviours between both companies relates to smoking as there are less smokers in Company B and of those who do smoke a greater proportion have tried to quit smoking.

In comparing the findings from Company A and Company B, it is evident that in terms of low back discomfort Company A has a higher prevalence rate and level of associated absenteeism. In terms of general health, a greater proportion of respondents in Company B were classed as overweight or obese. Similar trends exist between both groups in relation to proportions having regular health checks, however Company A respondents were less knowledgeable about their blood pressure and cholesterol levels. The difference between the health care systems in Ireland and the UK is highlighted through the statistics produced relating to the number of medical cardholders and those with private health insurance. More respondents from Company B in the UK have medical cards however only a minority have private health insurance. Regular exercise is not common in both groups however alcohol consumption and regular smoking is more common among Company A respondents. Similar proportions in both groups (approximately 25%) consume greater than the recommended weekly allowance, however absenteeism from a hangover was more common in Company A. With reference to smoking, a greater proportion of respondents in Company B made attempts to quit. Both groups identified more willpower as the key to help quit smoking. The majority in both groups felt they could eat healthier, however, Company A respondents had poorer food habits as they eat fried foods more regularly during the week, and more respondents add salt to their food. Overall, when comparing the findings between the two companies, Company A has a higher prevalence of musculoskeletal disorders and rate of associated absenteeism. Their lifestyles are less healthy due to the fact that they work longer hours in the week and a greater proportion are smokers, eat fried foods on a weekly basis, and add salt to their cooked food.

4.3.7. Ergonomic design of a wheelchair accessible airport check-in desk (2002)

A computer aided design (CAD) package was used to make an ergonomic evaluation of the existing check-in desks and then design a desk that could accommodate wheelchair users. This design is now available as an ergonomics benchmark.

4.3.8. Ergonomic assessment of the use and non-use of a transfer board to assist passengers with reduced mobility (2004)

Using a postural analysis tool (RULA), postures were classed according to Action Categories (AC) 1-4. AC 1 = "acceptable postures", if not maintained or repeated for long periods; AC 2 = "somewhat awkward" postures requiring further investigation and possible changes; AC 3 = "awkward" postures requiring investigation and definite changes; AC 4 = "very awkward" postures requiring immediate investigation and changes. The following were the main findings:

- Overall, in performing the lift-in and the lift-out task, the use and the non-use of the transfer board imposed the same proportion of hazardous postures for the person facing the PRM whilst assisting in the transfer, i.e. the Lifter 1 position. The analysis can be further explained by the following results:
  - 75% of the postures adopted by Lifter 1 were classed as "awkward", thereby indicating that changes in the performance of the task must be implemented in the short term whilst long-term measures to reduce the level of exposure to risk factors are planned

- When the lift-in and the lift-out tasks are decomposed into a lift, carry, and lower, the lower into and the lift out from the aircraft seat imposed "awkward" postures irrespective of whether or not a transfer board was used. However, the transfer board imposed less musculoskeletal stress for the lift from aisle chair to aircraft seat and vice versa, as these postures were only "somewhat awkward".
- When not using a transfer board, a second lifter, Lifter 2, is required to assist in the transfer of the upper body of the PRM. This person stands behind the PRM. The postural analysis of working in this position are explained in the following results:
- Overall, the postures adopted by Lifter 2 for both the lift-in and lift-out tasks were "somewhat awkward". There were no posture differences between the lift, carry, and lower elements of the lift-in task, however the lift element of the lift-out task, was classed as "awkward".
- By using a transfer board, no further risk is imposed on Lifter 1 compared to when not using the board. The benefit of using the board is that only one lifter is required, and so the overall level of risk is thus halved.

▲ All five persons with reduced mobility surveyed have used transfer boards previously, believe transfer boards are useful assistive devices, and feel that they should be used to assist all disabled persons embarking and disembarking aircraft

▲ All five persons recommended improving aspects of seating such as having moveable armrests and standard seat allocations. Three of the five persons consider the transfer from the aisle chair into the aircraft seat as being more difficult than the initial transfer into the aisle chair.

4.3.9. A survey of the experiences and opinions of passengers with reduced mobility with regard to air travel accessibility (2004)

A questionnaire was distributed to a subset of wheelchair users in Ireland. The following were the main findings:

▲ 50% required assistance to transfer from their manual wheelchair into the aircraft aisle chair; 55% required assistance to transfer from the aisle chair into the aircraft seat. All respondents were satisfied their needs were met to some extent

▲ 80% of participants stated they were not allowed to store their manual wheelchair in the aircraft cabin

▲ 11% had their wheelchair damaged/lost with no replacement or reimbursement provided

▲ 15% felt their was no relay of information on special requirements between the booking agent and the airlines check-in staff

▲ The seat feature mostly commonly requested was a moveable armrest, however, this request was not met for any of the respondents

▲ The majority (85%) self-identified as a disabled person when booking their trip.

4.3.10. Physiological and psychophysical assessment of three types of load carriage methods used by air travellers (2004)

Physiological assessments (back and shoulder muscle activity) and psychophysical assessments (ratings of perceived exertion) were conducted of 12 subjects wearing 15% and 25% of their body weight in

three different load carriage methods: a suitcase on two wheels, a rucksack with lumbar support belt, and a shoulder bag and laptop bag combination. The main findings were:

- The preferred method of load carriage type was the suitcase, as the subjects did not want to have to physically support the load
- The worst method of load carriage in terms of subjective perceptions and muscle force measurements was the shoulder bag and laptop bag combination
- The shoulder bag and laptop bag was perceived to cause the greatest interference with natural arm swing, balance of the body, and walking when compared to both the suitcase and rucksack. They were also more uncomfortable to carry than the rucksack
- In comparing the three different load carriage methods, the greatest level of both Erector Spinae and Trapezius muscular force were exerted when using the shoulder bag and laptop bag combination.
  - Trapezius muscular force doubled when the shoulder bag with 25% body weight was worn.
  - An increase in the weight of both the rucksack and the shoulder bag and laptop bag combination resulted in a greater increase in the force exerted by the Erector Spinae and the Trapezius muscles. An increase in the weight of the suitcase resulted in a slight decrease in the force exerted by the Erector Spinae and an increase in the Trapezius muscular force. This latter result can be understood when the subjective perceptions of subjects is considered i.e. that the heavier the suitcase the more difficult it is to control it, as there is an increase in shoulder muscular strain. Also the body tries to compensate for this strain by maintaining an erect posture thereby reducing the activity of the spinal musculature.

Chapter 5 Conclusion

The primary aim of this chapter is to justify the evidence-based recommendations derived from this 3-year research project, which will ultimately facilitate "Best Manual Handling Practices at Dublin Airport". A brief overview of the project will also be provided.

Manual handling can be classed as an occupational hazard of work performed in several industries. The aviation industry, in particular airport work, necessitates the performance of diverse manual handling activities, however, the handling of passenger baggage and the handling of persons with reduced mobility are two specific activities that may cause or exacerbate a musculoskeletal condition. High absenteeism, personal injury claims and staff turnover can collectively act as the catalyst for employers to eliminate or minimise musculoskeletal disorder risk factors.

The *raison d'être* of this ergonomics project was to identify the risk factors of baggage handling and the handling of persons with reduced mobility and thus through the avenue of research devise best practices in the form of evidence-based recommendations. Such recommendations would then aid in reducing the risk of musculoskeletal injury associated with both manual handling activities. In order to achieve this project objective work was conducted in accordance with a structured programme from the commencement of the project in November 2001 until its completion in November 2004. Phase 1 of the project yielded literature review and airport benchmarking findings that ultimately prescribed the primary research for Phase 2. The overall conclusion of the project is that in order to reduce the risk of specific airport workers incurring a manual handling related injury or developing a musculoskeletal disorder, both long and short-term solutions are imperative.

Solutions should be based on the health and safety "General Principles of Prevention" with the predominant focus on Principle 1: the avoidance of risks (HSA 1999). With reference to long-term solutions for improving check-in work, the avoidance of risk is feasible by introducing self-service check-in systems (SSCI) for all airlines at the airport. This would eliminate the awkward body postures associated with performing elements of the check-in procedure as determined via a postural analysis conducted for this project. Combating the risks at source could be achieved through a re-design of the check-in desk workstation such as raising the height of the computer screen to eye-height and by using a flat-panelled display. An increase in the slope of the baggage conveyor would facilitate tagging the baggage at optimal working height. Also the use of a sit / stand workstation would be of benefit. The long-term solution to eliminating specific baggage handling tasks is the use of containerised loading, however this is only feasible for wide-bodied aircraft. For narrow-bodied aircraft, mechanical in-plane loading systems such as the Telair Sliding Carpet Loading System should be used to combat the risks at source, and this is a recommendation derived from the research conducted as part of this project (Telair 2004). For the handling of a PRM, the use of a motorised hoist system such as ErgoPort would eliminate the risks associated with the lift-on / lift-off of PRMs (KS ApS 2004).

The evidence-based recommendations from this project are primarily the short-term solutions to the problem. With particular reference to the primary research, the focus of interest was on the main measures recommended by EU manual handling legislation, which reduces the risk of incurring a manual handling related injury i.e. organisational operations and procedures, and the use of mechanical aids. The necessity for considering both measures simultaneously was identified via each of the ergonomic research studies listed in the Primary Research Packages previously referred to in Chapter 3. An example of this approach as the foundation for an evidence-based recommendation is

evident when considering two interlinked research packages and the airport benchmarking findings. It was established from the postural analysis work package (PRP 1) that on the ramp, the use of a mobile baggage conveyor system is more ergonomically satisfactory than the non-use of the system. However, from the ergonomic assessment of the use of the conveyor system (PRP 2b), it was determined that its effectiveness, in biomechanical, physiological, and psychophysical terms, is dependent upon its correct use which involves adjusting the height of the conveyor to an optimal working height and strategically parking baggage carts in relation to the conveyor. The airport benchmarking findings revealed that standard size mobile baggage conveyor systems were used in all six airports involved in the project, however, equivalent small-scale systems were also in use in Düsseldorf Airport. Therefore, based on the findings of both the primary research and airport benchmarking it can be recommended that ground handling companies at Dublin Airport use both standard size and small-scale mobile baggage conveyor systems on the ramp to improve the baggage handling task of unloading and loading all aircraft types. Similar to the aforementioned example, all recommendations are derived from the primary and secondary research and the airport benchmarking findings.

It can be concluded, therefore, that short-term solutions to the problem of manual handling injuries among specific groups of airport workers are both practical and feasible, and if implemented would improve compliance with EU manual handling legislation.

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Appendix

Primary research studies (19) classified under each of the nine manual handling activities.

A. FOUR *OUTBOUND* BAGGAGE HANDLING ACTIVITIES

1. Check-in process
   - 1.1. Job and task analysis (at Dublin Airport and Birmingham Airport) (2004)
   - 2. Baggage handling in the baggage hall
   - 2.1. Job and task analysis (at Dublin Airport, Birmingham Airport, Düsseldorf Airport) (2004)
3. Baggage handling on the ramp (unloading baggage carts)
   - 3.1. Job and task analysis (at Dublin Airport and Birmingham Airport) (2004)
   - 3.2. Physiological and psychophysical assessment of using a mobile baggage conveyor system to unload / load aircraft (2002)
   - 3.3. Ergonomic assessment of using a mobile baggage conveyor system to load / unload aircraft at Dublin Airport (2003)
4. Baggage handling in the aircraft hold (unloading)
   - 4.1. Job and task analysis (at Dublin Airport and Birmingham Airport) (2004)
   - 4.2. Ergonomic assessment of the use and non-use of mechanical aids to unload / load baggage inside the baggage compartment of aircraft (2004)

B. THREE *INBOUND* BAGGAGE HANDLING ACTIVITIES

1. Baggage handling inside the aircraft hold (loading)
   - 1.1. Job and task analysis (at Dublin Airport and Birmingham Airport) (2004)
   - 1.2. Ergonomic assessment of the use and non-use of mechanical aids to unload / load baggage inside the baggage compartment of aircraft (2004)
2. Baggage handling on the ramp
   - 2.1. Job and task analysis (at Dublin airport and Birmingham airport) (2004)
   - 2.2. Physiological and psychophysical assessment of using a mobile baggage conveyor system to unload / load aircraft (2002)
   - 2.3. Ergonomic assessment of using a mobile baggage conveyor system to unload / load aircraft at Dublin airport (2003)
3. Baggage handling in the baggage hall
   - 3.1. Job and task analysis (at Dublin airport, Düsseldorf airport, Birmingham airport) (2004)

C. TWO ACTIVITIES INVOLVING THE HANDLING OF *PERSONS WITH REDUCED MOBILITY* (PRM)

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   - 1.1. Ergonomic design of a wheelchair accessible airport check-in desk (2002)
2. Assistance with boarding aircraft (wheelchair push and lift on/lift off)
   - 2.1. Ergonomic assessment of the use and non-use of a transfer board to assist passengers with reduced mobility (2004)

D. HANDLING OF BAGGAGE BY PASSENGERS

1. Physiological and psychophysical assessment of three types of baggage used by air travellers (2004)

E. ADDITIONAL BAGGAGE HANDLING RESEARCH

1. A thermal comfort evaluation and range of motion study of three different types of baggage handler work clothing (2004)
2. A survey of the musculoskeletal conditions and the lifestyles of baggage handlers in Ireland and the UK (2004)

F. ADDITIONAL RESEARCH ON THE HANDLING OF A PRM

1. A survey of the experiences and opinions of passengers with reduced mobility with regard to air travel accessibility (2004)

Best Manual Handling Practices at Dublin Airport

Achieving a Healthy and Safe Working Life -Together

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