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Fewer jobs, better jobs? An international comparative study of robots and 'routine' work in the public sector

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Abstract

Routine manual work is often considered particularly vulnerable to digitalisation. Alongside potential employment effects, jobs are expected to change in terms of task and skill requirements. This article contributes to debates on the pace of digitalisation and the impact on low-skilled manual work through a study of transport robots in public hospitals in Norway and Scotland. Drawing on qualitative research, the findings are used to analyse the role of unions, as part of 'country' and 'sector' effects, shaping digitalisation and its outcomes.

1 | INTRODUCTION

A range of commentators claim that a 'new' age of digital automation, driven by robotics and artificial intelligence, heralds a bleak future of mass unemployment (Brynjolfsson & McAfee, 2014, Ford, 2015, Frey & Osborne, 2017). A series of critiques have followed, questioning the pace of technological change and whether this will lead to widespread job destruction (Arntz et al., 2016). Critics highlight the cost of investing in automation, barriers presented by cheap labour and the disruptive nature of implementation (Fleming, 2019; Thompson, 2020; Upchurch, 2018). Besides job replacement, there are questions of how jobs change and whether workers benefit or not in terms of skills and job quality (Edwards & Ramirez, 2016). These debates have reignited discussions around the 'social shaping of technology' (MacKenzie & Wajcman, 1999) and the role of institutions, actors and power in shaping work outcomes (Lloyd & Payne, 2019).

‘Routine’ manual work, often described loosely as ‘low skilled’, is seen as particularly ripe for automation (Frey & Osborne, 2017). However, there are problems in determining what constitutes ‘routine’ work (Pfeiffer, 2016), with much of the discussion at a generalised or abstract level. Outside of the ‘gig economy’, evidence is lacking on actual developments in the use of digital technologies within particular sectors and workplaces. A few studies are beginning to emerge (Rolandsson et al., 2019; Stroud et al., 2020), but we still know little about the processes of implementation or how lower skilled jobs are changing, not least in the public sector.

To make substantive advances in identifying and explaining worker outcomes requires grounded research that can explore the inter-relationships between workplace, sector and national influences in shaping digitalisation (Lloyd & Payne, 2019). Focusing on a specific robotic technology used in logistics in public hospitals in Norway and Scotland, this article contributes to debates on digitalisation and low-skilled manual work, and whether beneficial outcomes are possible. It examines the role of national institutions, actors and power in shaping the pace of digitalisation, how jobs are being reconfigured at workplace level, and the potential for different worker outcomes across sectors and countries.

Scotland and Norway are selected for their highly contrasting labour market and welfare regimes, with Scotland part of the UK ‘neo-liberal’ model and Norway identified as ‘social democratic’ (Esping-Andersen, 1990). The strength of Norwegian unions and their role within institutional structures, from national policy to workplace level (Løken et al., 2013), would suggest a greater role in technological change and more scope to influence job design. However, Scottish hospitals do not conform to the ‘typical’ UK workplace, with relatively high union density and sector collective bargaining. The National Health Service (NHS) in Scotland also has a distinctive approach to governance and management, alongside stronger institutional forms of ‘partnership working’, compared with NHS England (Bacon & Samuel, 2017). The article considers, therefore, whether country differences in union involvement in digitalisation and work design are narrowed in the hospital sector, and what this might mean for worker outcomes.

The specific technology examined is an ‘automated guided vehicle’ (AGV)—a programmable robot capable of autonomously picking up and transporting carts and cages containing items such as waste, linen and food. It is claimed AGVs can replace lower-skilled, ‘routine’ manual work across many sectors, including healthcare (Frey & Osborne, 2017, pp. 260–261), bringing positive outcomes for workers' occupational health. Although AGVs have been around for decades in manufacturing (Dankbaar, 1988), their use in hospitals remains somewhat novel. The study explores the motivations for adopting AGVs in hospitals and, in the context of embedded collective organisation, the role that trade unions play in their introduction. It assesses the benefits and challenges of adopting these systems in practice, and how jobs are affected in terms of employment, tasks and skills. The findings contribute to debates around the pace of digitalisation, through assessing the potential for widespread diffusion of AGVs in hospitals and whether there are country differences in worker outcomes.

The article begins by situating the study within the critical literature on digital technologies and routine work. It then examines how AGVs have been promoted as a means of improving efficiency and occupational health in healthcare logistics and the challenges faced. The interplay between sector and country effects are highlighted by an overview of key features of public hospitals in Norway and Scotland. The methods section outlines the qualitative research undertaken in five hospitals using AGVs. The findings analyse the decisions driving investment, the process of implementation, the benefits and challenges of using AGVs, and the reconfiguration of jobs and skills. The final section discusses the contribution to an analysis of country and sector effects, the role of unions, and the potential for beneficial outcomes for workers.

2 | ROBOTS AND ROUTINE WORK

Much of the automation literature starts from the premise that 'routine', or 'programmable', jobs are subject to displacement, and that lower-skilled workers will be *particularly* exposed (Brynjolfsson & McAfee, 2014; Frey & Osborne, 2017). Although this view may have some merit, there are two main problems. First, the capabilities of digital technologies are often exaggerated, along with their applicability to different workplaces (Lloyd & Payne, 2019). Certain jobs are labelled as 'routine' and, *ipso facto*, 'replaceable' *without* detailed knowledge of the job itself (Pfeiffer, 2016). Second, automatability assessments fail to situate jobs in their socio-economic context, overlooking the distinction between what is technologically possible and what actually takes place in organisations (Thompson, 2020; Upchurch, 2018). Economic drivers are critical to decisions to invest, not least the relative costs of labour and capital and expected productivity gains (Upchurch, 2018, Fleming, 2019, Lewis & Bell, 2019). Alongside the costs of technology are the additional expenses and disruption involved in its integration into existing operations (Hirsch-Kreinsen, 2016, p. 9). Wages, especially in lower-skilled jobs, may be too low to justify investment.

These economic calculations relate to the socio-political environment at the sector and national level. At a national level, labour costs in Norway are substantially higher than in Scotland, which should incentivise investment in labour-saving automation (Lloyd & Payne, 2019). However, digital technologies that are designed to enhance efficiency through the monitoring and surveillance of workers might be thought less likely in Norway due to regulatory barriers and the power of unions to oppose such uses (Stroud et al., 2020). Capitalist competition and the drive for profit are the underlying motivations for investing in technology in the private sector. For the public sector, where governments set budgets, priorities and policies, an alternative analysis is required that incorporates political governance and decision-making.

The conceptual framework used in this article sees these political decisions as underpinned by the inter-relationships between the workplace, where technology is introduced and job tasks are re-constituted, and the sector, in this case public hospitals. The 'country effect', in terms of institutions, regulations and welfare systems, which reflect the power of organised labour within public policy, shape the sector and the power resources available at the workplace (Lloyd & Payne, 2016). If we return to previous research on job design, there is evidence of national variation in how work is organised and skill distributed, with the Nordic countries having so far proven 'relatively resilient' in their distinctive patterns of work, including high levels of task discretion and worker autonomy (Gallie, 2017, p. 228).

In public hospitals across many European countries, there remains strong collective organisation through trade unions and professional groups, with high membership and institutionalised collective bargaining (Bechter et al., 2012). These features enhance the power of workers and may allow greater opportunities to resist or shape technology (Briken et al., 2017; Edwards & Ramirez, 2016). The inclusiveness of collective organisation covers those in lower-skilled jobs, where we might see a 'union effect' in shaping technology use and its outcomes. It is important, therefore, to consider the role of unions and regulation for this group of workers. This is particularly the case given the emphasis by many academic and policy commentators on education and training interventions as the main way to support low skilled workers in coping with digitalisation (Frey & Osborne, 2017; Organisation for Economic Co-operation and Development, 2019).

The re-focusing of the automation literature towards changes to *tasks* rather than whole occupations is welcome (Arntz et al., 2016). However, there is little evidence on the '"unbundling" of tasks' from jobs (Lewis & Bell, 2019, p. 304), how tasks are changing and being reconstituted into jobs, and who is involved in such decisions. The few studies of outcomes in established workplaces indicate more limited changes than would be expected from the rather detached speculation on whether the net result will be 'skills upgrading' or 'skills polarisation' (Hirsch-Kreinsen, 2016). Work intensification, reduced physical strain, skills obsolescence and new skill demands have all been found to various extent (Jaerhling, 2018, Rolandsson et al., 2019, Haipeter, 2020), reflecting the indeterminate relationship between technology, work and skills and the 'contested' nature of outcomes (Briken et al., 2017). These studies suggest institutional arrangements and power relations, such as collective bargaining structures and strong union organisation, are important to job quality outcomes. Nevertheless, the evidence base is limited, particularly for those in low-skilled jobs.

3 | DIGITAL TECHNOLOGIES IN HOSPITALS

Digital technologies are seen as vital in healthcare for addressing challenges presented by an ageing population, and rising levels of interventions and treatments (Larsson & Teigland, 2020). With most provision funded by the state, politicians in Norway and Scotland have restricted budgets and sought to cut costs, while presenting digitalisation as a 'cost-effective' way of delivering better care quality and more client-focused services (Digital Health and Care Scotland, 2018; Norwegian Ministry of Local Government and Modernisation, 2019). Those predicting the impact of automation on hospital jobs generally agree that most medical and associated professionals are least threatened, with administrative workers, technicians, cleaners and porters more vulnerable (Frey & Osborne, 2017; Office for National Statistics, 2019).

Automating logistics promises large-scale efficiency savings in an area that is not directly patient-facing, and which avoids conflict with powerful professional groups such as doctors. Estimates suggest logistics account for around 30% of hospital expenditure (Benzidia et al., 2019). Recent innovations include AGVs, pneumatic tube systems, and radio-frequency identification (RFID) that allows tracking of items and people, including ordering of medical supplies using hand-held scanners. These systems can be combined to enable various levels of automation in the ordering and transfer of hospital supplies and equipment. AGVs are mobile robots that transport up to 500 kg of materials in carts around the hospital using navigation technologies, such as lasers, magnets and sensors (see Figure 1). Linked to computer software, their movements are tracked and monitored 'on screen' (Vis, 2006). The claim is that these systems can reduce costs and enhance care by replacing non-patient facing workers, improving stock control and traceability, and freeing-up nurses' time to concentrate on patients (Benzidia et al., 2019; Pedan et al., 2017).

The main group of workers directly affected by AGVs are logistics porters, whose tasks include receiving, moving and dispatching goods. Alongside potential job loss, the robotics industry claims that AGVs are inherently ergonomic, replacing repetitive and physically demanding tasks that can cause strain and injuries (Chikul et al., 2017). In other words, there are 'immanence' effects that derive from the technology itself, which workers and unions should welcome (Edwards & Ramirez, 2016). However, the actual impact on those workers still employed will depend on the non-automated tasks that remain and how they are reconfigured into jobs (Dankbaar, 1988). While the logistics literature has largely neglected the impact on workers, Benzidia et al.'s (2019) study in one French hospital addressed skill requirements. They report that logistic staff working with AGVs required skills in information technology and

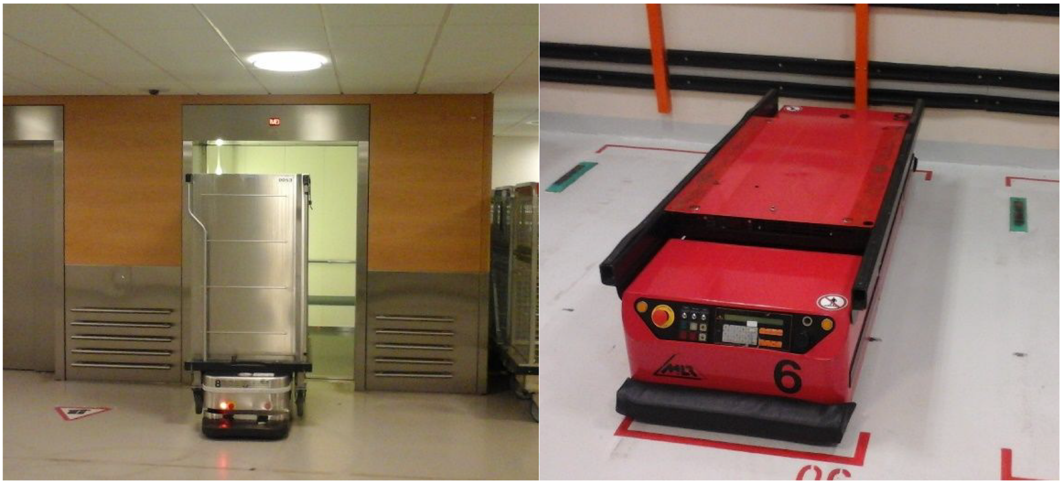

FIGURE 1 AGVs in hospitals © Caroline Lloyd [Colour figure can be viewed at wileyonlinelibrary.com]

logistic knowledge. Although providing little detail on the depth of skills and knowledge, they argue that these changes require the 'professionalising' of logistics staff (Benzidia et al., 2019, p. 17).

Despite promises of beneficial outcomes from AGV systems, existing studies provide little evidence of cost efficiency. The systems are expensive (Chikul et al., 2017, Pedan et al., 2017), whereas hospital layouts and the sharing of space with humans present different challenges compared with a warehouse or factory (Fragapane et al., 2018). For safety reasons, AGVs are designed to stop automatically when something comes close to, or impedes, their path which can cause hold-ups and blockages. The logistics literature also highlights numerous implementation challenges, such as the layout of flow paths, the number and location of delivery and pick-up stations, battery management, breakdowns and maintenance (Vis, 2006).

The likelihood of investing in AGVs and the outcomes for workers may also be affected by national political-institutional influences on the workplace. In Norway and Scotland, there are clear differences. Norway is classified as a social democratic welfare state (Esping-Andersen, 1990) with strong unions, extensive collective bargaining and strong coordination mechanisms involving the state, capital and labour in managing the economy, and relatively widespread diffusion of 'better' forms of work organisation (Gallie, 2017). There is an established tradition of unions engaging in workplace innovation and technological rationalisation (Rolandsson et al., 2019), although there is some suggestion that the public sector may be somewhat behind manufacturing (Bie-Drivdal, 2018). In Scotland, although governments since devolution in 1998 have adopted elements of a social democratic approach, they operate within the UK's 'neoliberal' economic and labour market policy regime. The UK has relatively weak unions, a lightly regulated labour market, weak employer coordination, and limited welfare supports. Evidence indicates that unions are rarely able to bargain over new technology or changes to work organisation (van Wanrooy et al., 2013, p. 21).

In healthcare, some of these country differences are narrowed due to the high levels of union organisation, collective bargaining and social partnership arrangements in Scottish hospitals, and the spread of New Public Management (NPM). NPM has been a feature of healthcare 'modernisation' affecting hospitals in both Norway and Scotland, even though it started earlier and went further in Scotland as part of the UK health system. Following devolution, successive Labour-led and SNP governments in Scotland dispensed with certain elements of NPM, including the 'internal market' and competition between hospitals. Hospitals are now managed by regional health boards with an emphasis on cooperative and collaborative relationships. Unions were also integrated into Scottish decision-making bodies leading to changes to strategic health policy, statutory backing for 'social partnership' at all levels within the NHS, and guarantees of no compulsory redundancies and no detriment to lifelong earnings (Bacon & Samuel, 2017). Initially, partnership working appeared to function reasonably well. However, there is concern that union influence has waned, with less involvement in strategic decisions (Thompson & Steel, 2017). One study of the introduction of digital technologies in a hospital pharmacy found evidence of formal partnership working, with mixed outcomes for job quality, amid concerns over weak consultation at the local level (Lindsay et al., 2014).

In Norway, the management of hospitals was historically built on consensus and trust, led by the medical profession. The introduction of NPM, although distinct from the UK approach, involved a shift towards the professionalisation of managers, money following the patient, and 'management by objectives' (Christensen et al., 2006; Neby, 2015). The centralisation of hospitals in 2002 saw ownership transferred to new regional health authorities, aimed at speeding up reforms by removing local politicians from decision-making processes. Tjerbo (2009) argues such aims were not realised because power lies with dispersed actors at the local and national level, who successfully opposed unpopular changes. A range of formal institutional mechanisms allow workers a voice in decision-making processes at hospital level; however, some union and occupational health representatives report that involvement in restructuring is too limited or happens too late (Trygstad & Anderson, 2015).

AGVs promise hospitals labour cost savings and improved logistics efficiency. They are expected to replace many of the tasks of the logistic porter, cutting jobs but also improving the occupational health of workers that remain. The decisions to invest in this technology and the processes of implementation take place within highly collectivised environments where there are institutionalised forms of social partnership. We might, therefore, expect union engagement in decisions over technology, particularly when job losses are possible.

4 | RESEARCH METHOD AND FINDINGS

To explore the introduction and outcomes of AGVs, qualitative research was undertaken in five hospitals, three in Norway and two in Scotland (Table 1). Hospitals using AGVs, which are still relatively few, were identified from discussions with hospital unions and internet searches of media and industry reports. Research access was agreed with participating hospitals through contacts with logistics managers and unions. The case studies are all large, general hospitals

TABLE 1 Case study AGV systems

AGVs	N-1	N-2	N-3	S-1	S-2
Year introduced	2015	2009	2006	2015	2010
Number	8	22	21	26	13
Operating hours per day	12	12	13	24	24
Operating days per week	5	5	5	7	7

TABLE 2 Individuals interviewed

	N-1	N-2	N-3	S-1	S-2
General logistics manager	2	2	1	2	
Supervisors/first-line managers				1	1
AGV lead	1	1[b]	1	1	1
AGV operative	[a]	1[b]		[a]	
Porters/service workers	1	3	1	1	[a]
Technical workers	2	1	1		
Trade unions	4	1	1	2	2

[a]Informal discussions during site tour.
[b]AGV lead also worked as AGV operative.

with over 5000 employees, and are either complete or partial new builds. Some have been using AGVs for over a decade, others more recently. The AGVs are owned and managed directly by the hospital concerned, with the exception of S-2 where an outsourced private service provider delivers a full range of portering, catering and cleaning services.

The research involved semi-structured, face-to-face interviews with senior and line managers in logistics, technicians involved in installing or maintaining AGVs, AGV operatives, porters, service assistants and union representatives (Table 2). Interviews with workers lasted between 30 and 60 minutes, and those with managers and unions between 60 and 90 minutes. Separate, overlapping interview proforma were developed to explore the main drivers behind AGV use, the process of implementation, perceived costs and benefits, the impact on employment, and changes to work design and skills. In total, 26 interviews with 34 participants were conducted in 2018–2019, a small number of which included between two and four participants.

The researchers were given a guided tour of areas where AGVs were in operation, discussing the technology *in situ* with those most directly affected, and were able to take notes. Interviews were audio-recorded and transcribed verbatim, and coded using a thematic approach. Themes and sub-themes were derived from the research questions and literature, and adjusted following discussions between the research team. Data were cross-checked and categorised to enable comparison across hospital and job role, and transcripts re-read to situate responses within the context of the interviewee's position and their workplace. The following sections examine why AGVs were introduced in the case-study hospitals, including the role of unions, the challenges involved in their implementation and perceived benefits. It then explores whether there are different worker outcomes in relation to job tasks and skills.

4.1 | The introduction of AGVs

The decision to invest in an AGV system occurs primarily within the context of new hospital builds or substantial rebuilds, as it is widely considered too costly and disruptive to adapt an old hospital site. A new general hospital is a substantial financial investment by government and, therefore, political decisions are central. A shiny, new hospital that includes the latest technology has strong appeal to health boards and local politicians, as reflected in interviews across the hospitals. A technician at N-1 recalled how the hospital director had wanted their hospital to be 'state of the art', whereas a union representative at S-1 described how a senior politician in the area had pushed for the new build to be 'all singing, all dancing ... the showcase'.

It is not just political decision-making that motivates the adoption of this new technology, but practical considerations. Some interviewees, who were involved at the time, suggested that cost reduction and saving labour were also important. As part of a shift towards one-bed rooms, merged hospitals in Scotland, and the centralisation of supply deliveries, hospitals were being designed with far longer corridors. The increased distances involved in transporting materials would require additional staff unless a technological solution was found. AGVs could service the buildings and save labour, with the added benefit of reducing occupational ill-health among logistics porters. Previously workers had pushed heavy wheeled carts and, in some cases, used assisted motors or small trucks. The facilities manager at S-1 noted for example:

> It will take a lot if you are pushing ... a tonne for a quarter mile, you are not going to last long ... it was more about the risk of getting [deliveries] out and actually servicing the building.

Porters' pay in Norway is more than two-thirds higher than in Scotland, but surprisingly management did not emphasise higher wage costs as a central driver in investment decisions.

Prior to implementation, some workers were said to have been anxious that they could lose their jobs or would not cope with using the technology. The collective agreement in Norway and the partnership agreement in Scotland provide for union involvement in decision-making and guaranteed continuity of employment for workers. In relation to AGVs, managers stressed the importance of communicating with staff and allaying any fears of potential redundancies. In Norway, interviewees confirmed that unions were automatically involved in high-level initial planning discussions, although one union leader at N-1 claimed that decisions on AGVs were 'decided already' by the hospital director.

In Scotland, managers referred to 'partnership working' where 'we brought the staff partners with us' (general manager, S-1) and 'there was plenty of communication, staff engagement' (logistics manager, S-1). Unions also felt they were actively consulted and involved through established partnership forums. One regional union official had even accompanied managers on a visit to a Norwegian hospital to see their AGV system, which helped to overcome initial scepticism. Partnership working is not without its problems, and as one union officer at S-2 noted, even allowing for consultation, 'in reality they [management] tend to do what they want'. Across both countries, the interviews suggested unions had some involvement, although it was more consultative than joint decision-making. Their efforts focused on redeployment and fair treatment rather than engaging with the implementation process.

4.2 | The implementation process

The initial outlay for an AGV system is substantial. Hospitals used between eight and 26 AGVs, with just one robot costing around £50,000. Investment is also required in software and adapting corridors, lifts and doors to enable AGVs to move around the hospital. In the Scottish hospitals, separate tunnel systems were built underground with dedicated lifts for AGVs, and only service staff allowed in these areas. In the Norwegian hospitals, AGVs share corridor space with general hospital staff and/or visitors which can significantly reduce implementation costs. The technical head at N-1 explained that building separate space would 'double ... or triple the price'.

In all cases, the implementation process was far from smooth and typically took two to three years for problems to be resolved. The main technical challenge confronting four of the hospitals was the software communication between the AGVs, lifts and doors. Even when the system was up and working, an upgrade in the software for the lift could disrupt communication with the AGV. Other issues included ineffective Wi-Fi and problems with AGV sensors; S-2 had to build a wall in their main hub to reduce condensation. The head of the technical department at N-1 noted: 'we used a year maybe to tune it … it will take time, that's our experience'. Referring to problems with 'the Wi-Fi system, loss of connections and lack of compatibility', an AGV manager at N-2 commented it had taken 'nearly four years' before the system was fully functioning.

Preparatory work also included integration with the logistics system. In four of the hospitals, logistics were overhauled with the centralisation of stock control and just-in-time systems enabling stock to be delivered directly from suppliers rather than via a central store. Hospitals had to negotiate with manufacturers of carts and suppliers to the hospital (such as laundry services) to ensure compatibility with the AGVs. A manager at S-1 commented that although they 'would like to think it would be less torturous to go through this process again', with so many 'local differences, you know planning assumptions, the way your hospitals are laid out, it will never be simple'. Only the logistics manager at S-2 claimed that implementation was relatively straightforward, primarily due to its limited integration with the ordering and inventory system.

Although some technological problems persisted, the interaction of robots with humans remained a major issue, particularly for the hospitals in Norway where they shared space. Staff would leave items in corridors, disrupting the path of an AGV, or would fail to place carts in the correct position in waiting bays or move them on delivery. An AGV manager (N-3) explained that areas became blocked simply from someone placing a box in a corridor:

> Then the AGV will be standing there waiting, waiting, waiting … that does not help if we put ten more AGVs in … it's quite a problem to the whole system.

An AGV manager at N-2 felt '85% of the problems' were 'human created' with most attributable to staff rather than visitors. In Scotland, separate tunnels and lifts mitigated problems around shared space but there were similar issues of timely and correct movement of carts by staff.

4.3 | Benefits of AGVs

AGVs are promoted as a labour-saving technology. These systems did reduce the number of logistics porters that would otherwise be needed, although exact figures were hard to ascertain as they were introduced into new hospitals alongside other changes. There were suggestions that without AGVs an additional 15 workers would have been required at N-2, between 15 and 20 at N-1, and 30 at S-2. Some new jobs and tasks were created (discussed below), but were relatively few. Expanding healthcare provision meant displaced workers could be absorbed into other similarly graded jobs, although some older workers had opted for 'early retirement', or a move to another hospital. The other main benefit is the integration of AGVs with the logistic system which improved automatic tracking and monitoring, allowing more control over inventories and reduced overstocking and shortages.

Strikingly, none of the hospital management had calculated whether the AGV system had saved money, and there was some scepticism as to cost-effectiveness:

> No, that was probably just set as a principle … it maybe saves something … I don't actually know (supply chain manager, N-1)

> We obviously did calculations at the beginning in terms of what the additional porters would be versus the cost of the AGV system but we haven't done it since … it could come very close (facilities manager, S-1)

The logistics manager at N-3 suggested that problems with implementation and day-to-day running meant: 'If we built a new hospital today, I'm not sure if we would have chosen AGVs … we see a lot of challenges'.

Notwithstanding such challenges, those who worked with the AGVs were generally very positive. AGV managers and operatives were proud of what they had achieved and enjoyed showing how they operated. An AGV porter at S-1 proclaimed that '99% of the time we're running and they don't let us down'. At N-2, a service worker felt 'they have their problems now and again but it's a fantastic system'. Workers particularly welcomed not having to push heavy carts over long distances. The following comment from a former logistics porter at N-1 is typical: 'I was very, very tired moving things manually … you know your shoulders when you drag things … When you come home … you have to lay down'. Managers reported lower sickness absence and a reduction in accidents; at N-2 absenteeism among logistics porters had fallen from 19% to 8%.

AGVs are not really 'autonomous' and require continuous human oversight. Only in the Scottish hospitals were they used at night and weekends, although deliveries were much reduced. In Norway, night working is strongly discouraged by law and higher basic pay, plus wage premiums for unsocial hours, makes 'out of hours' working particularly costly. Collective agreements over pay and working hours can, therefore, be seen as placing social and economic constraints on the use of AGVs, while also protecting workers' health.

4.4 | The reconfiguration of jobs and skills

The introduction of AGVs required new tasks to be carried out, including

- monitoring and controlling the AGVs on the computer to improve flow and resolve stoppages;
- maintenance and repairs;
- physically checking the AGV when problems occurred and identifying the causes (e.g. breakdowns, obstacles in pathways or signal failures with doors or lifts);
- ensuring removal and supply of carts to AGV bays; and
- inputting information to dispatch AGVs to drop-off and pick-up points.

How these tasks were incorporated into new and existing jobs, however, varied across the hospitals. In four of the hospitals, maintenance and repair of the AGVs was the responsibility of engineering technicians who were either already in place or recruited to work on a range of new technologies. The exception was S-1 where all but very basic maintenance was outsourced, at considerable cost, to the external company that supplied the AGVs. The additional jobs created among this group were very small, accounting for less than one full-time post in each hospital (as a mid/higher-skilled occupation, these jobs are not the focus of this article).

In Norway, the new position of AGV operative had been introduced to undertake the day-to-day running of the system. Between two and four operatives monitored AGV movements on a computer (located in a separate control room) and acted as a first-line response when problems arose. These were either new recruits or workers who had transferred from porter or logistic roles when the new hospitals were opened. The jobs are paid more than a porter but do not require any qualifications. There is a strict division of responsibilities between these operatives and engineering technicians, with the former restricted to 'rebooting' the AGVs if they stop using a simple menu operation. Only at N-3 were operatives allowed to go further and undertake simple tasks like wiping a dirty sensor. In Scotland, roles are less clear, with line managers and supervisors assuming more day-to-day responsibility for the AGVs, the control systems, and some basic maintenance tasks. A number of logistic porters were trained to work in a more limited way on the control system and monitor the AGVs, but they were not on a higher pay grade. At S-2, these workers could also undertake exterior cleaning of the AGVs.

In Norway, the AGV operatives often worked alone, spending most of their time sitting at the computer watching for imminent 'stops' or 'bottlenecks'. The skills required were not deemed particularly complex, involving some basic computer capabilities and on-the-job learning, acquired by practice, such as 'trying and looking' (operative, N-2) with the help of an experienced colleague. In the Scottish hospitals, less of the system oversight and monitoring was undertaken by logistics workers, with supervisors taking on more of the role. The manager responsible for AGVs at S-1 suggested the system was 'not actually that complicated' as most deliveries were pre-scheduled. Although this was not complex work, the amount of information involved meant that it could take 'months … to ease somebody into that position'. At S-2, the service manager explained that with few AGV 'stops', along with dedicated corridors and lifts, little oversight was required. Six porters had undertaken on-the-job training over 2 or 3 weeks to monitor the system.

The few workers who remained as logistics porters were mainly moving carts short distances to and from AGV drop-off points, ensuring that carts were in the right place, scanning deliveries into the system (where this was not automated) and doing some residual manual lifting. Most jobs had become physically less demanding, but heavy manual tasks had not been eliminated. A waste porter at S-1 described how 'we've still got to unload the bins into skips … so still quite a lot of lifting … when food comes in, you've still got to load up the cages'. A waste porter at N-2 had to lift '25 kg boxes' up to '25 times a day'. There are available technologies that could further alleviate heavy manual tasks, such as pneumatic tubes for moving laundry and waste straight into carts, which were installed in one hospital. However, once the hospitals were built, interviews with managers and unions indicated that tight budget restrictions limited investment in other assistive technologies. For these workers, little had changed in terms of skills although they still needed to be comfortable interfacing with the technology. Many interviewees noted that some, predominantly older, workers found the prospect of using any computer system daunting, and had opted for alternative jobs or early retirement.

In Norway, apart from a few specific areas of work, such as waste, many of these AGV-related logistic tasks were integrated with the broader job of service assistant, a relatively new role which included ordering, receiving and managing ward stock levels using semi-automated inventory checking. This job was not a direct consequence of AGVs, rather it reflects a trend in Norway towards shifting administrative tasks away from nursing staff. Workers transferring to service assistant welcomed these changes as they had greater task variety and intrinsic job satisfaction, seeing themselves as doing important work that enabled nursing staff to spend more time on patient care. However, at N-1 union representatives highlighted negative consequences of the shift to service assistants for some other workers. A number of general porters who previously undertook logistics and patient movements had been switched to the narrower job of 'patient porter'. A union rep complained of 'less variation in the working day. I used to sit on a truck, do the garbage, deliver food, and work with patients, now I walk 25 km every day [moving patients]'. Interaction with patients was personally rewarding, but only moving patients could become 'monotonous' and physically exhausting.

In two Norwegian hospitals (N-1 and N-2), there was a recognition that workers required some logistics knowledge to work alongside AGVs. A logistics manager at N-2 emphasised the need to 'see how everything is put together' which 'forces them to think why do we do this, why is there an empty wagon here, or why is the system stopping?' Norwegian law provides for a 'practice-based' route to skilled worker status for unqualified, experienced workers, which normally involves formal training at a local college. At N-1, 30 staff had been supported to attend a specially adapted course as part of gaining such certification. The quality and relevance of such training is less clear but under the hospital sector collective bargaining agreement certification confers an additional pay increment of around 10%. A supply chain manager noted: 'we like to invest in staff' and 'they actually get a paper [qualification] … which I guess is nice for a lot of people' (N-1). Similar programmes were available in the other Norwegian hospitals, although again how relevant they are in practice is unclear. There is no equivalent provision in Scotland, nor was there any off-the-job training to develop logistics knowledge and awareness.

5 | DISCUSSION

A central concern about digitalisation is the pace of change and the threat to workers' jobs, particularly those in lower-skilled, 'routine' occupations. For a technology, such as AGVs, it is important to explore the incentives and constraints on its introduction within the context of the sector and the national political-institutional environment. The study does not dispute that AGVs and an automated inventory system could bring improvements in service quality if used to free-up time for healthcare workers to focus on patients (Benzidia et al., 2019; Fragapane et al., 2018). The findings indicate that AGVs were used to improve hospital logistics, while removing many physically demanding tasks for logistics porters. However, the technology is expensive and, irrespective of national differences, implementation is invariably complex and slow. Moreover, some interviewees felt improvements could be undertaken *without* AGVs and question that their use 'undoubtedly improves efficiency' (Benzidia et al., 2019, p. 287).

For senior hospital managers, the choice of AGVs *primarily* reflects a mix of political decisions and an efficiency rationale, with occupational health gains an additional benefit. Being at the forefront of technological advances within a sector is attractive but also risky as predicted cost savings are based on little hard evidence. As these early innovators question their economic returns, further roll-out is likely to be slow and potentially faltering. AGVs are really only suitable for large, newly built hospitals; indeed, only one of the recently completed large hospitals in the UK appears to have adopted them. Unless the incentives shift substantially or there are other political drivers, the gap between what is possible and what happens (Thompson, 2020, p. 304) is likely to remain substantial.

AGVs were used to save labour, with fewer workers required compared with manual deliveries. Nevertheless, porters did not lose their jobs. Strong institutional structures and collective agreements in Norway and Scotland restrict the ability to make redundancies. For hospital managers, the size of the organisation and existence of other similarly graded jobs also makes redeployment less problematic given expanding healthcare provision. Crucially, *how* this technology was introduced mattered in addressing workers' anxieties around 'robots stealing jobs', and communication with staff and unions proved vital. For the most part, unions and workers welcomed an assistive technology (Edwards & Ramirez, 2016), once reassured of employment security.

The findings about job reconfiguration are more complex. By reducing heavy manual tasks AGVs exhibit positive 'immanence' effects (Edwards & Ramirez, 2016), although the impact on individual workers is not straightforward as it depends on how jobs are subsequently reorganised. Some heavy physical and repetitive tasks have *not* been replaced in both Norway and Scotland. Occupational health problems are, therefore, likely to persist if jobs are designed such that some workers spend most of their time performing these tasks, emphasising the importance of considering 'indirect' and 'unintended' effects (Edwards & Ramirez, 2016). Despite expectations that unions would be more engaged with job design issues in Norway, workplace unions in both countries focused predominantly on job security, redeployment and health and safety issues directly related to AGVs. Unions tended to be reactive rather than proactive in relation to indirect effects, only questioning job role changes once problems had arisen.

There were some national differences. The only new job category created was the higher paid 'AGV operative' in Norway. In Scotland, new tasks were integrated into the existing jobs of team leader or supervisor and a small group of logistics porters. The oversight of AGVs in Norway was undertaken on a day-to-day basis by operatives, without first-line management involvement. Such delegation of responsibility is more likely in Norway (Lloyd & Payne, 2016), although our study did not explore whether it applied to other jobs outside of logistics in the Norwegian hospitals. The more broadly designed service assistant job in Norway, which was generally viewed positively by workers, was not a direct result of AGVs. Neither this job, nor that of logistic porter in Scotland, had been radically transformed by AGVs. Rather there are small changes, with far less manual pushing of carts, more time spent on other duties, alongside some new tasks, including accurate placement and checking of carts, inputting orders into the system and ensuring corridors are kept free.

These new tasks require only minimal changes to skills, primarily involving basic 'digital skills'. Nevertheless, for some older workers, less accustomed to using computers and smart phones in their everyday lives, fear of digital technology remains a factor. There are incentives provided for workers in Norway to gain qualifications and additional pay that are not available in Scottish hospitals for lower skilled groups, and which reflect union influence within the VET system. In terms of the broader 'logistics knowledge' required to understand how the system functions and how their everyday actions impact on effectiveness, it is hard to see this amounting to 'professionalising logistics staff' (Benzidia et al., 2019, p. 289). Willingness to work with digital technology and learn the basics, often just scanning a barcode or a using a simple menu, would seem the main prerequisite.

6 | CONCLUSIONS

This article has explored the use of AGVs in public hospitals in Norway and Scotland, focusing on actual developments of digital technologies in the workplace. This technology is seen as both cost-saving and inherently beneficial for workers' occupational health (Benzidia et al., 2019) and, therefore, we might expect, or wish, to see its rapid deployment. The evidence from this research, however, indicates significant constraints on future investment, and fairly limited changes in both the number of jobs lost and the new tasks and skills that have emerged. AGV systems are anything but 'smart' or 'autonomous', requiring continual human oversight and intervention. Some may insist that incorporating 'smarter' artificial intelligence will solve this problem eventually, but such a future seems a long way off. The research underscores the cost and practical challenges involved in deploying technology in automating even ostensibly 'routine' manual work, explored at a more abstract level by Upchurch (2018).

The research extends existing analysis of digital technologies through the integration of sector and country effects. The process of implementing the technology and the technical difficulties encountered were quite similar in the Norwegian and Scottish hospitals. When it comes to how the technology is introduced and union involvement, we also find many similarities which reflect the narrowing of national institutional differences between Norway and Scotland in the healthcare sector. In particular, there is strong union organisation, driven by agreements at the sector level, that restricts the ability to make redundancies in the workplace, within a context of expanding healthcare provision. These findings suggest an important sectoral effect, including the role of political power in shaping change within the public sector. Sector dynamics appear to temper the dominant national institutional arrangements, although research in the health sector in other countries, including England, is required to confirm such a conclusion.

Overall, there has been some improvements in job quality, but not all workers have benefitted. Despite union involvement in the introduction of this technology, union power is not translated into negotiations around its application and the redesign of jobs. In Norway, we expected union involvement in such issues, and further research would help to establish whether this finding is sector or occupation specific. Country differences were observed in some work outcomes. In Norway, the study uncovered broader tasks and responsibilities for some workers, the limitation on working hours, and the use of the VET system to support workers in gaining qualifications and pay increases. These findings demonstrate the influential role that Norwegian unions play at a societal level which has an indirect effect on the use of technology at the workplace. Unpicking the complex inter-relationship between the societal level, sector and workplace in shaping technology is a major research challenge. It is also one that remains vital for shedding light on alternative possibilities, including the potential for union engagement with digital technologies and the organisation of work.

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