

OLDER WORKFORCE MANAGEMENT POLICIES AND DEGENERATIVE DISEASE RISKS IN LABOR INTENSIVE INDUSTRIES

Fayola Issalillah

Universitas Sunan Giri Surabaya

correspondence: fayolaissalillah@gmail.com

Abstract - Aging workforces in labor intensive industries require systematic management policies addressing physical decline and degenerative disease risks. This study constructs a conceptual framework explaining how job redesign, flexible working hours, and periodic health screening influence productivity and retention of workers over 50. A systematic literature review method was applied following established qualitative research procedures. Job redesign reduces physical strain through task modification, ergonomic equipment, and optimized layout design. Flexible hours accommodate changing circadian rhythms and recovery needs of aging workers. Periodic health screening enables early detection of hypertension, diabetes, osteoarthritis, and cardiovascular conditions. Productivity metrics must incorporate quality and problem solving contributions beyond simple output per hour. Retention depends on financial and non financial factors including respect, involvement in decisions, and mentoring opportunities. Workplace exercise programs maintain aerobic capacity and muscle strength with gradual progression principles. Material flow redesign reduces excessive movement that fatigues workers with limited mobility. Partnerships with local health facilities improve access to preventive care and treatment services. Proactive musculoskeletal injury prevention through ergonomic analysis is more effective than rehabilitation. Cognitive job demands require redesign due to age related declines in processing speed and working memory. Interventions begin with low cost adjustments before major capital investments.

Keywords: older workers, labor intensive industry, job redesign, flexible work, health screening.

INTRODUCTION

The global demographic shift toward an aging population carries major consequences for labor markets across countries. The number of workers aged over 50 has risen significantly alongside increasing life expectancy and declining birth rates. This trend is reinforced by retirement-age policies adopted by many countries to protect social security systems from insolvency. As a result, labor-intensive companies that have long relied on young, productive workers must adapt to an increasingly aging workforce composition. The manufacturing, textile, footwear, and electronics assembly industries face major challenges in managing older workers. This age group has different physical characteristics from younger workers, including declining musculoskeletal and cardiovascular function. The maximum productivity older workers can achieve may be lower than when they were younger (Debelak et al., 2023). However, the experience and wisdom they possess cannot be replaced by newly joined younger workers. Companies need to find a balance between leveraging the strengths of senior workers and accommodating their physical limitations. Managing an aging workforce is no longer a future issue but a reality that must be addressed now. The use of digital technology in remote work systems is also part of modern management practices that deserve attention (Mardikaningsih & Darmawan, 2022). The role of technology in this regard is twofold, as it can either ease or hinder an organization's adjustment to changes in workforce age structure (Darmawan, 2024). The age diversity that arises from this shift needs to be managed with an appropriate strategy so that it continues to support innovation and overall team performance (Darmawan, 2024).

Degenerative diseases pose a serious threat to the productivity and retention of workers over 50 in labor-intensive companies. Hypertension, diabetes mellitus, osteoarthritis, and coronary heart disease are the most common conditions found in this age group. Symptoms of degenerative disease such as joint pain, chronic fatigue, and shortness of breath interfere with workers' ability to meet production targets (Peng et al., 2020). A worker whose feet are swollen due to diabetes cannot stand at the assembly line for eight full hours. Lower back pain from osteoarthritis causes workers to frequently take leave to rest or seek treatment. High absenteeism disrupts the smooth running of the production process and burdens co-workers who must cover for sick colleagues. The cost of treating degenerative diseases also becomes a burden for both workers and companies without adequate insurance coverage. Without proper health management, senior workers will continue to decline until they are eventually unable to work at all. Losing experienced workers due to health problems that could actually have been prevented is a regrettable waste of human resources. Companies need to recognize that investing in the health of senior workers is an investment in the sustainability of the business itself. A paradigm shift has occurred from a short-term focus on financial gain toward a long-term approach that considers environmental and social sustainability (Mardikaningsih & Darmawan, 2021). The availability of quality health services also determines how satisfied workers are with the process of treating degenerative diseases (Khayru & Issalillah, 2022).

Job redesign is a management strategy that adjusts job demands to the physical capacity of older workers. Its basic principle is to reduce excessive physical strain without diminishing the value of workers' contributions to the production process (Moyers & Coleman, 2004). A concrete example of job redesign is moving senior workers from positions requiring heavy lifting to quality-control positions. Tasks requiring precision and experience are more suitable for senior workers than tasks relying on speed and muscular strength. Periodic task rotation also prevents excessive fatigue in certain muscle groups that can trigger musculoskeletal injury. Companies can also modify work equipment, such as lowering table heights or providing chairs with ergonomic backrests. Automating heavy tasks that endanger senior workers can be economically justified because it reduces injury and absenteeism. Job redesign does not always require large investments, as small changes often have a significant impact on comfort. Replacing tool handles with larger, easier-to-grip ones helps workers with arthritis in their hands. Providing shorter but more frequent breaks helps workers with cardiovascular fatigue recover better. Successful job redesign will increase the productivity of senior workers while extending their productive working life (Dahalan et al., 2022). This large-scale digital transformation ultimately has a major influence on shifts in work design due to automation, the emergence of new social classes in the digital era, the strengthening of digital leadership for team efficiency, and the need to ensure legal aspects related to data protection and the validity of AI-based electronic contracts (Darmawan, 2022). Reshaping work processes around automation still needs to take the human element into account, so that its implementation does not overlook worker comfort (Darmawan, 2023).

Flexible working hours are an important tool for retaining older workers in labor-intensive companies. A flexible organizational structure allows companies to quickly adjust work patterns to changing worker needs (Darmawan & Mardikaningsih, 2023). The physical and health needs of workers over 50 differ from those of younger workers, so rigid schedules are not suitable. Senior workers may be more productive in the morning and experience reduced energy after lunch. Offering earlier morning shifts or shorter afternoon shifts can accommodate this daily energy fluctuation. Workers with certain degenerative diseases may need longer midday breaks to restore their energy. Flexibility also means giving workers the freedom to choose which days of the week they work, with correspondingly adjusted compensation. For example, senior workers can work four ten-hour days or five eight-hour days depending on their physical condition. Part-time arrangements for senior workers approaching retirement age allow for gradual knowledge transfer. Workers who remain productive even with fewer hours still provide more value to the company than losing them entirely. Flexibility also includes the ease of taking leave for routine chronic-disease check-ups without administrative penalty (Wrocławska, 2020). Companies that implement this policy report higher senior-worker retention rates and better job satisfaction. The cost of more complex schedule coordination is worth the benefit of retaining experienced workers who are difficult to replace. Management should pay closer attention to arranging work schedules and wages appropriate to the job, so that employees feel comfortable and satisfied with their work environment.

Regular health screening programs for older workers are a preventive investment far cheaper than the cost of treating advanced disease. Routine screening enables early detection of degenerative disease at a stage when intervention can still effectively prevent permanent disability (Titilayo, 2016). Regular blood pressure checks can identify hypertension before it causes kidney damage or stroke. Fasting blood sugar measurement helps detect early-stage diabetes that can still be controlled through lifestyle changes. Lung function tests using spirometry detect declining capacity due to chronic industrial dust exposure. A simple electrocardiogram can record arrhythmia or ischemia that workers are unaware of because the symptoms are subtle. In fact, small risks that are ignored from the outset can accumulate and turn into major problems later on (da Silva et al., 2022). Social perceptions of certain health conditions can affect workers' willingness to undergo screening openly (Khayru & Gardi, 2024). An effective screening program must be integrated with follow-up counseling and referral to health facilities. Telling workers that their blood pressure is high without helping them control it will only cause anxiety with no benefit. Companies can collaborate with nearby health centers to provide affordable routine check-ups. Incentives for workers who regularly undergo screening, such as lower insurance premiums, can increase participation. Aggregate data from screening is also useful for companies in identifying dominant health issues in the workplace. Based on this data, specific interventions such as workspace modification or cafeteria menu adjustments can be designed appropriately.

The main problem is that many labor-intensive companies do not yet have a systematic policy for managing their aging workforce. They still apply the same work standards to all age groups without considering changes in physical capacity. As a result, senior workers are often placed in the same positions as younger workers with equivalent physical demands. Fatigue and injury become inevitable because the body is no longer able to meet the demands of heavy work (Okunribido et al., 2011). Companies also do not yet have a structured preventive health program to detect degenerative disease early. Screening is only limited to mandatory checks during recruitment, without systematic periodic follow-up. Data on the health status of senior workers is not properly collected, leaving companies blind to existing problems. Line managers often receive no training on how to manage teams with members from different generations. Feedback approaches that are not adjusted to the characteristics of each age group can reduce the accuracy of the evaluation given to workers (Mardikaningsih et al., 2025). They use the same approach to motivate both young and senior workers without understanding differing needs. Situational leadership requires leaders to identify the characteristics of each team member and adjust their approach to maximize each member's potential (Mardikaningsih & Darmawan, 2022). As a result, senior

workers feel undervalued and choose to leave before reaching normal retirement age. Prematurely losing experienced workers forces companies to recruit new employees who lack institutional knowledge. The costs of recruitment and retraining balloon unnoticed as a consequence of poor management of the aging workforce. A positive orientation toward correcting work mistakes requires ethical leadership from management to build a healthy and sustainable organizational culture (Mardikaningsih et al., 2022).

The second problem is the lack of standards for job redesign suitable to various types of labor-intensive work. Each industry has different physical load characteristics, so a solution that works in one place is not necessarily suitable elsewhere. The textile industry, where workers stand all day, has different problems from the automotive industry, which requires repeated bending movements. Companies often lack the internal expertise needed to conduct the ergonomic analysis required for effective redesign. They bring in consultants for a one-time project but fail to build internal capacity for continuous improvement. Internal knowledge management is an important factor so that the results of ergonomic analysis are not lost once the consulting project ends (Darmawan, 2023). It is not only held as a one-time event but also as part of a culture of continuous development (Fared & Darmawan, 2021). As a result, redesign only happens once and is never re-evaluated to see whether it still matches changing worker conditions (Macdonald & Oakman, 2022). Senior workers, who should be a valuable source of information about the difficulties they face, are rarely involved in the redesign process. Yet they are the ones who know best which parts of the job are most burdensome and need to be changed first. The lack of worker involvement produces solutions that are impractical and never used because they do not match conditions on the ground. Ergonomic equipment purchased at high cost sits unused because workers find it uncomfortable. Meanwhile, competing companies that carry out redesign correctly succeed in retaining their senior workers longer. This competitive advantage becomes increasingly difficult to catch up with as the gap continues to widen over time. Beyond interaction factors, strong social capital support and team collaboration serve as an important foundation for maintaining work quality within an organization (Putra et al., 2021).

The current employment situation demands that companies immediately adopt a systematic and measurable policy for managing an aging workforce. The number of workers over 50 will continue to rise for decades to come, as demographic factors cannot be changed. Companies that are not prepared will lose access to this increasingly large and valuable talent pool (Submitter et al., 2021). Senior workers have levels of loyalty and work competence that are hard to match among younger generations who change jobs more frequently. Knowledge of production processes gained only through years of experience cannot be taught through formal training. Losing this knowledge when senior workers retire early represents a leak of intellectual capital that is never recorded in financial statements. Meanwhile, labor-intensive companies face pressure to remain competitive amid rising minimum wages and global competition. Retaining productive senior workers is more efficient than recruiting new workers with uncertain productivity. The cost of job redesign, flexible working hours, and health screening is relatively small compared to the cost of recruitment and retraining. Investment in aging workforce management yields a high return on investment in the medium to long term. Companies that start early will gain a competitive advantage that latecomers will struggle to catch up with. An appropriate organizational innovation strategy is one of the driving factors behind a company's long-term resilience and competitiveness (Mardikaningsih et al., 2024). Efficient human resource management is a key factor enabling companies to gain long-term competitive advantage in the global market (Abdulah et al., 2021). Efforts to retain high-quality human resources can be made, among other things, through fair compensation (Eddine & Darmawan, 2021).

This study aims to systematically outline the relationship between older worker management interventions and productivity and retention outcomes. The resulting theoretical framework includes the mechanisms of the influence of job redesign, working hour flexibility, and health screening on senior worker capabilities. The theoretical contribution of this study is integrating the literature on ergonomics, occupational health, and human resource management into a cohesive model. Its practical contribution is providing guidance for labor-intensive companies in designing effective age-friendly policies. Production managers can use this framework to assess redesign needs on their respective lines. The human resource department gains an instrument to evaluate the effectiveness of ongoing senior worker health programs. The results of this study are expected to reduce the rate of injuries and fatigue among senior workers so that their productive working span can be extended.

RESEARCH METHODS

A systematic literature review approach is used in this study, as guided by the framework proposed by Tranfield et al. (2003) on evidence-based management knowledge development methodology. The selection of this approach is based on the research question's demand for the systematic identification and synthesis of all available theoretical evidence. Search protocols were established before the process began to avoid bias in data source selection. Keywords used include older workers, labor intensive industry, job redesign, flexible work arrangement, health screening, productivity, and retention. Searches were conducted across databases covering the disciplines of ergonomics, occupational health, human resource management, and epidemiology. Inclusion criteria were applied to articles discussing at least one older worker management intervention and one outcome. Articles discussing only older worker characteristics

without addressing interventions were excluded from the analysis process. The selection process was carried out in three stages, namely duplicate screening, assessment based on abstracts, and full-text reading. Each article that entered the final stage was analyzed to extract the concepts, mechanisms, and findings reported by the authors. The collected data was then organized into a thematic matrix to facilitate comparison among sources (Kumar & Ghoroi, 2020).

The analysis procedure in this study follows the guidelines outlined by Flick (2018) on qualitative research in the social sciences. Analysis begins with open coding to identify concepts appearing repeatedly in the collected literature. Concepts such as work ability index, physical workload, musculoskeletal disorder, and early retirement were identified as initial themes. The second step involves axial coding to group related codes into higher and more abstract categories. The categories formed include redesign interventions, schedule interventions, health interventions, as well as productivity and retention outcomes. The third step involves selective coding to identify the core category explaining the central mechanism of the overall model. The core category in this study is work ability maintenance, which serves as a bridge between interventions and positive outcomes. The validity of findings is maintained through source triangulation and cross-checking between propositions from different authors. The analysis process is conducted iteratively with the researcher moving back and forth between the data and the conceptual framework being built. The final result is a conceptual model on the influence of older worker management policies on productivity and retention. This model is tentative and requires further empirical testing through quantitative research.

RESULTS AND DISCUSSIONS

In an era of global workforce structural change, workforce composition is increasingly shaped by aging trends and age diversity. Pressure to extend working life, driven by demographic shifts and rising life expectancy, has introduced a new reality within organizational environments. The aging process involves many physical changes that can make construction-type work tasks more difficult for older workers. For example, physically demanding jobs may become difficult due to declining cardiac output and reduced tolerance for physical activity (Fitzgerald et al., 1997). Benjamin et al. (2008) argue that older workers may be unable to reduce their working hours or shift to less physically demanding jobs without risking the loss or reduction of their pension and/or health benefits. Thus, older workers may find themselves in a difficult financial situation when deciding whether to keep working. If they continue working for financial reasons, they may not be able to perform the same tasks as well or as safely as their younger colleagues (Schwatka et al., 2012). Individual differences among workers, including personality traits, also help explain why some employees maintain stable performance despite physical decline while others do not (Darmawan, 2017). Encouraging inclusive participation of older workers in the adoption of workplace digital technology can help ease this transition rather than leave them behind (Darmawan, 2023).

Job redesign for older workers in labor-intensive companies focuses on reducing physical strain while making use of their experience and wisdom. The main principle of redesign is moving senior workers from tasks that rely on muscular strength to tasks that rely on precision and decision-making (Dahalan et al., 2022). This is because older workers are prone to losing muscle mass and subsequent strength decline (Thomas, 2010). Workers who previously lifted heavy raw materials can be reassigned to finished-product quality-inspection tasks. Their years of experience make them highly skilled at detecting product defects that younger workers might miss. Assembly tasks requiring fine finger movement and high concentration are also suitable for senior workers with good motor skills. Conversely, tasks requiring fast repetitive movement with moderate loads are better assigned to younger workers. Older adults are also more susceptible to chronic inflammatory disorders, which are associated with arthritis and other conditions that can limit range of motion and joint function (Spector et al., 1997; Strandberg & Tilvis, 2000). Trade-offs between higher contributions to supplementary occupational pension schemes, investment in ergonomics, collaborative robots (cobots), and relocation of value-added activities must be considered (Bogataj et al., 2019). When older and younger workers are paired through task rotation, learning approaches that preserve cooperation and empathy between them help redesign succeed rather than create friction (Putra et al., 2024).

Modifying work equipment such as ergonomic chairs with back support reduces strain on the spine, which is prone to degeneration. Height-adjustable worktables allow senior workers to work in the most comfortable posture without excessive bending. Simple lifting aids such as levers or wheels reduce the need to bend and lift heavy loads manually. Brighter workspace lighting helps senior workers who may already have reduced visual acuity. Contrasting colors on floors and walls help spatial orientation for workers with reduced depth perception. Effective redesign requires input from workers themselves about which parts of the job burden them most. It is important to ensure that everyone involved receives fair treatment, decent employment opportunities, and safe working conditions (Barzani et al., 2022). Equitable access to technology, empowerment of local communities, and policies that support equal distribution of benefits are key to creating genuinely sustainable technological solutions (Essa & Mardikaningsih, 2023).

Flexible working hours for older workers must be designed based on an understanding of circadian rhythms that change with age. Senior workers tend to be more productive in the morning and experience declining energy in the late afternoon and evening. Offering earlier morning shift options for senior workers who naturally wake up earlier will

increase their productivity. Conversely, night shifts should be avoided for senior workers because sleep disruption will worsen existing health conditions. Recovery from fatigue also takes longer for senior workers, so adequate days off are essential. A part-time work model at 60 percent of normal working hours can be a solution for workers approaching retirement. Workers can still make valuable contributions through knowledge transfer without having to be present full-time every day. Flexibility also means giving senior workers the authority to arrange the order of their own tasks within reasonable limits. A worker who knows when their energy is highest can schedule heavy tasks for that time and lighter tasks for other times (Doan & Ngo, 2020). This kind of flexible, autonomy-based arrangement echoes findings on remote and distributed work, which show that greater control over one's own schedule can support psychological well-being and stable social relationships at work (Darmawan, 2023). Leave policies for routine chronic-disease check-ups without wage deductions increase treatment adherence. Good treatment adherence prevents disease complications that cause prolonged absenteeism and a drastic drop in productivity. Companies that implement this flexibility report a significant decrease in injury rates and a significant increase in senior-worker retention. Retention is also reinforced when flexibility is paired with attention to workers' mental health, since supportive mental health policies are known to strengthen long-term employee loyalty (Issalillah & Khayru, 2025). Work policies include flexible work schedules, family leave policies, and other policies aimed at addressing demands that conflict with work.

Regular health screening programs for older workers should include at least five main components relevant to the risk of degenerative disease. The first component is blood pressure measurement to detect hypertension, which is often asymptomatic but damages internal organs. The second component is fasting blood sugar testing to screen for type 2 diabetes, whose prevalence increases with age. The third component is a lipid profile to detect high cholesterol and triglycerides, which contribute to coronary heart disease. The fourth component is kidney function testing through urea and creatinine levels, since hypertension and diabetes damage the kidneys. The fifth component is liver function testing to ensure there is no damage from long-term medication use. Musculoskeletal screening through pain questionnaires and simple physical examination can detect osteoarthritis and lower back pain early. Lung function testing with spirometry is important in industries with chronic organic or inorganic dust exposure. Brief cognitive screening such as the Mini Mental State Examination detects cognitive decline that affects workplace safety. Running this screening program smoothly also depends on broader conditions in the national health system, including how easily workers can access services and how well infectious-disease risks in the workplace are managed (Harianto et al., 2024). Screening results must be followed up with individual counseling on lifestyle modification and medication adherence. Workers with high blood pressure need to be educated about a low-salt diet and the importance of regular check-ups at health facilities. Handling screening results also raises questions of confidentiality and fairness toward workers, which is why this process should be guided by the same ethical and legal principles that protect patients' rights in the broader health system (Herisasono et al., 2023). Companies can partner with local health centers to provide scheduled screening services at a subsidized cost. Incentives for workers who regularly participate in screening, such as lower insurance premiums, significantly increase program participation (Welch et al., 2017). Inclusiveness does not only depend on system design but also on infrastructure readiness and users' socio-economic conditions (Ramle & Mardikaningsih, 2022).

The productivity of older workers cannot be measured using the same metrics as younger workers because of their different work characteristics (Viviani et al., 2021). Senior workers may work at a slower pace but with a far lower error rate than younger workers. Productivity metrics that measure only output per hour will disadvantage senior workers because they ignore the quality of their work. Companies need to adopt composite metrics that cover speed, accuracy, and the rate of raw-material waste. Such a composite approach is closer to how employee productivity is best measured in the digital era, where creativity, problem-solving, and the quality of judgment matter as much as raw output (Darmawan, 2023). Senior workers are often more meticulous in checking product quality, reducing rework costs at the final stage of production. Their experience in solving technical problems also shortens machine downtime when breakdowns occur. A senior worker may know exactly which part of a machine tends to jam most often and how to fix it quickly. This tacit knowledge cannot be replaced by new workers who still have to learn through trial and error. The true productivity of senior workers should be measured by their contribution to the efficiency of the system as a whole. Isolating individual performance without considering its effect on team performance will produce a biased assessment. This kind of human-resource innovation, one that captures the real contribution of senior workers rather than judging them by raw speed alone, is part of what keeps a company competitive amid intensifying global competition (Abdullah et al., 2021). Companies that use balanced metrics for senior workers report that their contribution is equal to or even exceeds that of younger workers. Perceptions of declining productivity with age are often shaped more by age bias than by objective evidence of performance. This condition has brought a fundamental change in working methods; what was once based on direct interaction and physical supervision has now shifted toward systems that rely on digital communication and measurement of work output. This shift toward digital monitoring needs to be managed carefully, since how closely employees are monitored digitally can affect their sense of autonomy and professional responsibility at work (Mardikaningsih et al., 2024). This difference requires organizations to design differentiated reward systems rather than uniform ones.

Retention of older workers is shaped by financial and non-financial factors that must be managed together. These factors work in combination to determine how effectively an organization retains its workforce over time (Darmawan, 2024). Senior workers may keep working despite physically demanding conditions because of financial obligations toward their families (Sakai et al., 2024). Yet staying out of necessity differs from staying by choice, and the two produce different levels of performance. Workers who continue only because they have no other option tend to experience stress and low job satisfaction. This chronic stress accelerates the decline of physical and mental health, which eventually forces them to stop working as well. Companies need to build an environment where senior workers want to stay rather than feel forced to. Non-financial factors such as feeling valued, respected, and included in decision-making are essential. Giving senior workers genuine input into decisions strengthens their sense of autonomy and encourages them to contribute new ideas (Darmawan, 2024). Senior workers who feel their knowledge is valued develop an emotional bond with their workplace. Mentoring programs, where senior workers train new employees, give them a sense of purpose and valuable social standing. Public recognition from management for the contributions of senior workers also raises their pride and job satisfaction. The flexibility mentioned earlier is also a strong non-financial retention factor for senior workers. The ability to adjust work schedules around health conditions and family responsibilities is highly valued. Companies that succeed in retaining senior workers enjoy workforce stability and lower recruitment costs. This outcome reflects how loyalty grows once employees experience sound human resource management and quality of work life, and are treated as valuable contributors rather than mere labor (Darmawan et al., 2020; Eddine et al., 2023). Beyond that, employee satisfaction and morale in delivering excellent service should not be overlooked, since they directly affect the quality of work outcomes (Eddine & Darmawan, 2022). When employees feel valued and are treated well by their leaders, they develop a strong sense of attachment to the organization, making it harder for them to leave (Mardikaningsih et al., 2022).

Older workers' aerobic capacity and muscle strength can be maintained through physical exercise programs specifically designed for the workplace (Suorsa et al., 2022). The decline in fitness with age is partly caused by biological aging but mostly by reduced physical activity. Workers who stay physically active throughout their lives retain far better functional capacity than sedentary ones. Companies can provide simple exercise facilities such as treadmills or stationary bikes in designated areas. A fifteen-minute morning exercise routine before each shift improves blood circulation and reduces joint stiffness. Strengthening the back and abdominal muscles is essential to prevent injury when lifting work loads. Dynamic stretching before work and static stretching after work reduce the risk of acute musculoskeletal injury. Fitness instructors who understand the needs of senior workers need to be involved in designing safe exercise programs. Exercise that is too intense risks causing injury, so the principle of gradual progression must be upheld. Workers with certain degenerative conditions may need individualized exercise programs adjusted to their limitations. Successful programs not only improve physical fitness but also create opportunities for positive social interaction among workers. This interaction reduces the stress and sense of isolation that senior workers often experience in a predominantly young workforce. Investment in worker fitness programs pays off through reduced absenteeism and higher long-term productivity. In social interaction, psychological well-being serves as the foundation for a person's ability to build mutually beneficial and meaningful relationships (Hariani & Mardikaningsih, 2022).

Redesigning the material flow in the production process can reduce how much senior workers need to move around unnecessarily (Kondoh, 2023). This kind of layout improvement is part of a broader responsibility to invest in workplace infrastructure that protects worker health and safety (Gunena et al., 2024). An efficient factory layout places raw materials, production machinery, and finished-goods storage close together. Senior workers do not need to walk back and forth over long distances, which increases the risk of fatigue and accidents. Conveyor belts connecting work stations reduce the need to carry heavy components by hand. Rotating carousel storage racks bring items to the worker instead of requiring the worker to search for them. Cargo lifts and hydraulic platforms reduce the need to lift loads to heights that endanger the worker's back. Anti-slip flooring reduces the risk of falls, which increases as balance declines with age. Aisles wide enough for two people to pass at once allow senior workers to walk without turning sideways. Different paint colors for areas with different functions help orient workers with mild memory impairment. Signage with large, high-contrast letters is easier to read for workers with declining visual acuity. Even lighting without sharp shadows reduces eye strain and the risk of misidentifying objects. These layout changes require upfront investment but yield long-term savings through improved efficiency. Senior workers who are more comfortable and safe will work longer and more productively without injury.

Partnerships with local health facilities improve senior workers' access to preventive and treatment services for degenerative diseases (Macaulay, 2022). Hospitals or clinics located close to the workplace make it easier for workers to attend routine check-ups without losing much time. Companies can establish cooperation agreements to give priority queuing to employees who need examinations. Senior workers should not have to wait for hours at a public health center, which drains their energy and rest time. Health education programs organized together with partner health facilities improve workers' understanding of degenerative diseases. Workers who understand the mechanisms of their illness are more compliant with long-term treatment, which often feels burdensome. Training for workplace health cadres conducted by professional staff improves the capacity for early detection of health problems. Health cadres who are themselves senior workers are more easily accepted and trusted by their peers. Whatever form these partnerships take, their value

depends on clear accountability and consistent legal standards governing how health services are delivered and who bears responsibility for them (Wahyusetiawan et al., 2024; Waluyo et al., 2024). Company-facilitated telemedicine allows remote consultations for minor issues without needing to visit a health facility. Workers with mobility limitations due to severe osteoarthritis can consult from home without a painful trip. An integrated referral system ensures that workers who need specialist care do not get lost in complicated health bureaucracy. Such a system only works, however, when service delivery is genuinely reliable and free from the kind of negligence that can turn a helpful referral into a harmful one (Issalillah et al., 2025; Mansyur et al., 2024). Staff who understand workplace conditions can give relevant recommendations about the task modifications needed. Sustainable partnerships offer mutual benefit, since health facilities gain a stable patient base from the worker population. In the digital era, learning patterns are also changing through online interaction, which affects how students acquire information (Darmawan, 2021).

Proactive policies to prevent musculoskeletal injury are more effective than rehabilitation programs after an injury has already occurred among senior workers. Injuries that occur at an older age require longer recovery time with a higher risk of permanent disability (Audet & Lecours, 2024). Preventing the first injury is far cheaper and more humane than treating one that has already happened. Identifying high-risk jobs through systematic ergonomic analysis should be the first step in intervention. Jobs with high risk scores need to be prioritized for modification regardless of workers' current complaints. Modifications can be technical, such as assistive tools, or organizational, such as periodic task rotation. Training on proper lifting technique should be provided regularly, not only during new-employee orientation. Senior workers may have been lifting incorrectly for years and need retraining. The use of personal protective equipment such as back support belts needs to be evaluated for effectiveness, since not all research supports it. Maximum daily workload should be adjusted to the physical capacity of specific age groups. Senior workers should not be given the same production targets as younger workers if the tasks are identical. A physiologically fair workload standard accounts for the roughly one percent annual decline in aerobic capacity after age thirty. Policies that ignore the physiology of aging will keep producing unnecessary injuries and lost productivity. Companies must adjust job design to be more inclusive of the physiological needs of senior employees.

The cognitive demands of work also need attention in redesigning jobs for senior workers in labor-intensive companies (Kim, 2018). Age-related cognitive decline mainly affects processing speed and working memory. Senior workers may need more time to learn new procedures, but once mastered, they perform them very consistently. Simplified written work instructions with diagrams and pictograms help workers with reduced verbal memory. A visual checklist system at each work station reduces the burden of remembering long procedural sequences. Color-coding on components and tools enables quick identification without having to read small text labels. Alarms and audio signals for emergencies must use frequencies that workers with presbycusis can still hear. Presbycusis, or age-related hearing loss, begins at high frequencies, so low-pitched alarms are more effective. Training given in short, frequent sessions is more effective than one long session for senior workers. Training material connected to prior work experience is easier to understand because it can be linked to existing knowledge. Senior workers prefer learning by doing rather than sitting through long classroom lectures. Problem-based learning grounded in real workplace situations works better than artificial simulations that feel unrealistic. When new automated systems are introduced, this kind of engagement-based learning also helps senior workers build the knowledge needed to use them with confidence rather than avoid them (Darmawan, 2024). Good cognitive redesign allows senior workers to draw on their experience without being overwhelmed by excessive cognitive demands. Willingness to support one another in mastering new systems is essentially driven by positive psychological dimensions that sustain individual commitment to completing collective tasks (Darmawan & Mardikaningsih, 2021). This deserves attention, since senior workers already face measurable pressure on their mental health as digital productivity expectations rise, and employers carry some responsibility for managing that pressure (Khayru & Arifin, 2025). The dynamics of using this system present a distinct challenge for senior workers, who are required to maintain their health and productivity amid the large-scale adoption of artificial intelligence (Mardikaningsih & Darmawan, 2022).

The limitation of the conceptual framework produced by this study is the assumption that all senior workers have a homogeneous health and fitness profile (Sarah et al., 2022). Reality shows that variations among individuals are very large due to different genetic factors, lifestyles, and work histories. A chronological age of 50 can mean very different things between a worker who smokes and a worker who exercises regularly. Programs designed for the average senior worker may not be optimal for individuals at either end of the spectrum. A stratified approach based on health screening results allows for a more targeted allocation of interventions. Workers with advanced degenerative diseases require more aggressive redesigns compared to those who are still healthy and fit. Gender differences also affect the prevalence of certain diseases, such as osteoporosis being more common in women. Older female workers may require special attention to bone density and fracture risk. Another limitation is the dependence on the availability of trained health personnel, which may not be evenly distributed across all regions. Companies in remote areas may struggle to partner with competent healthcare facilities. Investing in recruiting their own healthcare staff may not be feasible for small companies with limited resources. Nonetheless, the basic principles of job redesign and flexibility can be applied without dependence on external health personnel. Companies can start with the simplest steps, such as observing worker complaints and making gradual modifications. This work system is projected to continue developing and become a common work pattern in the future,

in line with technological advancements that increasingly facilitate its implementation. It is important to tailor communication to various audiences within the organization, identify groups affected by change, and adjust messages to address their specific concerns and roles.

CONCLUSIONS

Policies for older worker management in labor-intensive companies include job redesign, flexible working hours, and regular health screenings that support one another. Job redesign reduces the physical burden on senior workers through task modification, equipment adjustments, and ergonomic workplace layout modifications. Flexible working hours accommodate changes in circadian rhythms and different rest needs of senior workers compared to younger workers. Regular health screenings enable early detection of degenerative diseases and preventive interventions before permanent disabilities occur. The productivity of senior workers cannot be measured by simple output-per-hour metrics because their qualitative contributions are significant. The retention of senior workers is influenced by financial and non-financial factors that must be managed in an integrated manner by management. Workplace physical exercise programs can maintain the aerobic capacity and muscle strength of senior workers for longer periods. Material flow redesign reduces the need for excessive movement that fatigues workers with mobility limitations. Partnerships with local healthcare facilities increase senior workers' access to preventive and treatment services. Proactive musculoskeletal injury prevention is more effective than time-consuming and costly rehabilitation. The cognitive load of jobs also needs to be redesigned due to decreases in processing speed and working memory with age.

The implication for managers of labor-intensive companies is the need to conduct participatory redesign needs assessments involving senior workers. Senior workers are the best source of information regarding which parts of the job are most burdensome and need to be modified first. Companies are advised to start with low-cost interventions such as schedule modifications and task rotation before making major investments. Aggregate health screening data should be used to design specific interventions that match the needs of the worker population. Future research can empirically test the effectiveness of various intervention combinations in a controlled factorial design. Longitudinal studies are needed to track changes in productivity and retention of senior workers over several years following interventions. Cross-industry comparisons will identify sector-specific factors that moderate the effectiveness of older worker management policies. Field experiments with control and intervention groups provide stronger evidence of causality than observational studies. Companies that successfully manage older worker labor forces are encouraged to share best practices through industry associations. Governments can provide tax incentives for companies implementing health programs and ergonomic redesigns for senior workers. Finally, managing older workers well is not only ethical but also beneficial for long-term business.

REFERENCES

- Abdullah, M. H. A. B., Gardi, B., & Darmawan, D. (2021). Innovation in Human Resource Management to enhance Organizational Competitiveness in the Era of Globalization. *Journal of Social Science Studies*, 1(1), 51–58.
- Audet, J., & Lecours, A. (2024). Which interventions are used in the rehabilitation, return, and stay at work process of aging workers having suffered an occupational injury? A scoping review. *Work*, 77(4), 1159–1172. <https://doi.org/10.3233/wor-230509>
- Barzani, L. A., Darmawan, D., & Zulkarnain, M. A. B. (2022). The application of sustainable supply chain management principles in the manufacturing industry to improve operational performance and corporate social responsibility. *International Journal of Service Science, Management, Engineering, and Technology*, 1(1), 38–45.
- Benjamin, K. L., Pransky, G., & Savageau, J. A. (2008). Factors associated with retirement-related job lock in older workers with recent occupational injury. *Disability and Rehabilitation*, 30(26), 1976–1983. <https://doi.org/10.1080/09638280701830206>
- Bogataj, D., Battini, D., Calzavara, M., & Persona, A. (2019). The ageing workforce challenge: Investments in collaborative robots or contribution to pension schemes, from the multi-echelon perspective. *International Journal of Production Economics*, 210, 97–106. <https://doi.org/10.1016/j.ijpe.2019.01.011>
- da Silva, B. dos S., Darmawan, D., & Gardi, B. (2022). A systematic approach to risk management to enhance information technology project success in a dynamic business environment. *Journal of Social Science Studies*, 2(2), 213–218.
- Dahalan, N. A., Hasri, S. N. M., Ibrahim, I., Othman, H., & Rahman, N. A. A. (2022). The need of ergonomics workplace for aging workforce. *International Journal of Health Sciences*, 6(S3), 2469–2476. <https://doi.org/10.53730/ijhs.v6ns3.6069>
- Darmawan, D. (2017). The Effects of The Big Five Personality on Job Performance. *Management & Accounting Research Journal*, 2(1), 36–42.
- Darmawan, D. (2021). Social interaction in digital society: Changes in online communication patterns and dynamics of virtual communities. *Studi Ilmu Sosial Indonesia*, 1(1), 325–350.
- Darmawan, D. (2022). Posthuman human resource management in organizations using generative artificial intelligence. *Studi Ilmu Sosial Indonesia*, 2(2), 97–124.
- Darmawan, D. (2023). Innovation Culture That Balances Technological Speed with the Depth of Humanistic Thought. *International Journal of Service Science, Management, Engineering, and Technology*, 4(1), 47–54.
- Darmawan, D. (2023). Knowledge Management as a Source Of Competitive Advantage in Information Technology Companies. *International Journal of Service Science, Management, Engineering, and Technology*, 3(2), 44–50.
- Darmawan, D. (2023). Measuring Employee Productivity in the Digital Era by Considering Human Creativity and Innovation. *International Journal of Service Science, Management, Engineering, and Technology*, 4(3), 47–53.

- Darmawan, D. (2023). Social Inclusion for Older Workers in the Implementation of Digital Technology within Organizations. *International Journal of Service Science, Management, Engineering, and Technology*, 4(2), 44–51.
- Darmawan, D. (2023). The Concept Of Remote Work: A Literature Review on its Impact on Work Dynamics, Psychological Well-Being, and Social Relationships Among Employees. *International Journal of Service Science, Management, Engineering, and Technology*, 3(3), 49–55.
- Darmawan, D. (2024). Distribution of Six Major Factors Enhancing Organizational Effectiveness. *Journal of Distribution Science*, 22(4), 47–58.
- Darmawan, D. (2024). Strategies for Enhancing Employee Knowledge and Engagement in Automated Routine Work. *International Journal of Service Science, Management, Engineering, and Technology*, 6(1), 65–71.
- Darmawan, D. (2024). The Influence of Empowering Leadership Style on Enhancing Team Members' Autonomy and Innovation Capacity. *International Journal of Service Science, Management, Engineering, and Technology*, 6(3), 48–55. Retrieved from <https://ejournalisse.com/index.php/isse/article/view/232>
- Darmawan, D. (2024). The Role of Technology in Promoting or Hindering Gender Equality in the Workplace. *International Journal of Service Science, Management, Engineering, and Technology*, 6(2), 67–73.
- Darmawan, D. (2024). Workforce Diversity Management Strategies for Enhancing Innovation and Team Performance. *International Journal of Service Science, Management, Engineering, and Technology*, 5(2), 53–59. Retrieved from <https://ejournalisse.com/index.php/isse/article/view/230>
- Darmawan, D., & Mardikaningsih, R. (2023). The Role of Flexible Organizational Structures in Enhancing Corporate Adaptability to Environmental Dynamics. *International Journal of Service Science, Management, Engineering, and Technology*, 3(1), 44–49.
- Darmawan, D., & Mardikaningsih, R. (2021). The role of positive psychological factors in enhancing employee engagement and commitment to work tasks. *International Journal of Service Science, Management, Engineering, and Technology*, 1(2), 37–44.
- Darmawan, D., Mardikaningsih, R., Sinambela, E. A., Arifin, S., Putra, A. R., Hariani, M., Irfan, M., Al Hakim, Y. R., & Issalillah, F. (2020). The quality of human resources, job performance and employee loyalty. *International Journal of Psychosocial Rehabilitation*, 24(3), 2580–2592.
- Debelak, K., Grah, B., & Penger, S. (2023). Ageing Workforce's Impact on Modern Organizations: How to Extend Working Lives? *Proceedings of the ENTRENOVA – Enterprise Research Innovation Conference*, 9, 142–151. <https://doi.org/10.54820/entrenova-2023-0016>
- Doan, T. M. H., & Ngo, Q. A. (2020). Flexibility and security policies for elderly workers: a case study in Vietnam. *E3S Web of Conferences*, 157, 04036. <https://doi.org/10.1051/e3sconf/202015704036>
- Eddine, B. A. S., & Darmawan, D. (2021). Professional employees, manual workers, and informal workers in achieving work-life balance. *Studi Ilmu Sosial Indonesia*, 1(1), 209–226.
- Eddine, B. A. S., & Darmawan, D. (2022). Social construction of work-life balance in cultural and organizational norms. *Studi Ilmu Sosial Indonesia*, 2(1), 213–234.
- Eddine, B. A. S., Darmawan, D., Mardikaningsih, R., & Sinambela, E. A. (2023). The Effect of Knowledge Management and Quality of Work Life on Employee Commitment. *Journal of Human Sciences*, 10(1), 87–100.
- Essa, N. E., & Mardikaningsih, R. (2023). Sustainable and fair technology for an equitable society. *Journal of Social Science Studies*, 3(1), 355–362.
- Fared, M. A., & Darmawan, D. (2021). Design and implementation of cross-functional training to improve team collaboration. *Journal of Social Science Studies*, 1(1), 215–220.
- Fitzgerald, M. D., Tanaka, H., Tran, Z. V., & Seals, D. R. (1997). Age-related declines in maximal aerobic capacity in regularly exercising vs. sedentary women: a meta-analysis. *Journal of Applied Physiology*, 83(1), 160–165. <https://doi.org/10.1152/jappl.1997.83.1.160>
- Flick, U. (2018). *An introduction to qualitative research* (6th ed.). SAGE Publications.
- Gunena, C. S., Gautama, E. C., Issalillah, F., & Khayru, R. K. (2024). Government and Private Sector Responsibility for Public Health in Large Infrastructure Development: A Review of the Legal Framework and Accountability Mechanisms in Indonesia. *Journal of Social Science Studies*, 4(2), 157–168.
- Hariani, M., & Mardikaningsih, R. (2022). The performance of authenticity and the commodification of parasocial bonds: Twin pillars of influencer culture on social media. *Studi Ilmu Sosial Indonesia*, 2(2), 385–412.
- Hariato, A. V., Vitrianingsih, Y., Issalillah, F., & Mardikaningsih, R. (2024). Challenges and changes concerning national health development in Indonesia: Legal perspectives, service access, and infectious disease management. *International Journal of Service Science, Management, Engineering, and Technology*, 5(2), 22–26.
- Herisasono, A., Darmawan, D., Gautama, E. C., & Issalillah, F. (2023). Protection of patient rights in the perspective of law and medical ethics in Indonesia. *Journal of Social Science Studies*, 3(2), 195–202.
- Issalillah, F., & Khayru, R. K. (2025). Mental Health Policies and Programs in Building Long Term Employee Loyalty. *International Journal of Service Science, Management, Engineering, and Technology*, 7(2), 39–47. <https://ejournalisse.com/index.php/isse/article/view/239>
- Issalillah, F., Jaatsiyah, A. E., Susanti, A., Nurhandayani, D. S., Ambarwati, A., Sirenden, M. T., Matius, D. N., Mengga, M., Agustina, L., & Halizah, S. N. (2025). State Sovereignty and Health Rights: A Study of Legal Frameworks for Service Delivery to Migrant Populations. *Legalis et Socialis Studiis* (L355), 3(2), 1–16.
- Khayru, R. K. (2022). Social Support Systems and its Implication for Healthcare provision for the Elderly Population. *Studi Ilmu Sosial Indonesia*, 2(2), 333–360.
- Khayru, R. K., & Arifin, S. (2025). Corporate Efforts and Strategies in Fulfilling Responsibility for Employee Mental Health in the Era of Digital Productivity Pressure. *International Journal of Service Science, Management, Engineering, and Technology*, 7(1), 44–52. <https://ejournalisse.com/index.php/isse/article/view/235>
- Khayru, R. K., & Gardi, B. (2024). Social Construction, Stigma, and Value Shifts in Contemporary Societal Mental Health. *International Journal of Service Science, Management, Engineering, and Technology*, 6(1), 35–42.
- Khayru, R. K., & Issalillah, F. (2022). Service quality and patient satisfaction of public health care. *International Journal of Service Science, Management, Engineering, and Technology*, 1(1), 20–23.
- Kim, I.-J. (2018). Ergonomic Intrusions for the Ageing Industry and Workforce. *Journal of Ergonomics*, 8(2), 1–3. <https://doi.org/10.4172/2165-7556.1000E179>
- Kondoh, S. (2023). Characteristic analysis of elderly workers in human-centric production systems using real observations and simulated constraints. *CIRP Annals*, 72(1), 405–408. <https://doi.org/10.1016/j.cirp.2023.04.028>
- Kumar, M. A., & Ghoroi, C. (2020). Initial Literature Review. *ResearchGate*. <https://doi.org/10.13140/rg.2.2.33436.92808>
- Macaulay, C. (2022). Health of seniors and their participation in social life. *Polityka Społeczna*, 582(9), 8–14. <https://doi.org/10.5604/01.3001.0016.0110>

- Macdonald, W., & Oakman, J. (2022). The problem with “ergonomics injuries”: What can ergonomists do? *Applied Ergonomics*, 103, 103774. <https://doi.org/10.1016/j.apergo.2022.103774>
- Mansyur, M., Mujito, M., Halizah, S. N., Gautama, E. C., & Khayru, R. K. (2024). The Negligence of Healthcare Workers in the Use of Herbal Medicines: Legal Implications and Impacts on Patients. *International Journal of Service Science, Management, Engineering, and Technology*, 6(2), 29–37.
- Mardikaningsih, R., & Darmawan, D. (2021). Business sustainability strategies in the facing of regulatory uncertainty and managerial challenges. *Journal of Social Science Studies*, 1(2), 111–118.
- Mardikaningsih, R., & Darmawan, D. (2022). Situational leadership strategies to improve change management and team performance. *Journal of Social Science Studies*, 2(1), 247–252.
- Mardikaningsih, R., & Darmawan, D. (2022). Situational Leadership Strategies to Improve Change Management and Team Performance. *Journal of Social Science Studies*, 2(1), 247–252.
- Mardikaningsih, R., & Darmawan, D. (2022). The role of self-efficacy in predicting employee adaptability to technological change in the workplace. *International Journal of Service Science, Management, Engineering, and Technology*, 2(3), 43–55.
- Mardikaningsih, R., Halizah, S. N., Darmawan, D., Masithoh, N., & Nuraini, R. (2022). Examining the Role of Authentic Leadership in Shaping Positive Work Climate and Organizational Citizenship Behavior. *International Journal of Service Science, Management, Engineering, and Technology*, 2(1), 52–59.
- Mardikaningsih, R., Halizah, S. N., Hariani, M., Darmawan, D., & Nuraini, R. (2025). Performance Feedback Accuracy Decline and Delay in Hybrid Work Arrangements. *International Journal of Service Science, Management, Engineering, and Technology*, 7(1), 53–62. Retrieved from <https://ejournalisse.com/index.php/isse/article/view/236>
- Mardikaningsih, R., Halizah, S. N., Nuraini, R., & Darmawan, D. (2022). The role of ethical leadership in shaping a positive and sustainable organizational culture. *International Journal of Service Science, Management, Engineering, and Technology*, 2(2), 48–55.
- Mardikaningsih, R., Hariani, M., Darmawan, D., Halizah, S. N., & Nuraini, R. (2024). The Impact of Digital Monitoring on Employee Work Autonomy and Professional Responsibility. *International Journal of Service Science, Management, Engineering, and Technology*, 5(3), 60–67. Retrieved from <https://ejournalisse.com/index.php/isse/article/view/231>
- Mardikaningsih, R., Hariani, M., Issalillah, F., & Nuraini, R. (2024). Organizational Innovation Strategies as Drivers of Business Resilience and Competitiveness in the Global Environment. *International Journal of Service Science, Management, Engineering, and Technology*, 6(3), 56–65. Retrieved from <https://ejournalisse.com/index.php/isse/article/view/233>
- Moyers, P. A., & Coleman, S. D. (2004). Adaptation of the older worker to occupational challenges. *Work*, 22(2), 71–78.
- Okunribido, O. O., Wynn, T., & Lewis, D. (2011). Are older workers at greater risk of musculoskeletal disorders in the workplace than young workers? – A literature review. *Occupational Ergonomics*, 10(2), 53–68. <https://doi.org/10.3233/OER-2011-0192>
- Peng, L., Yu, R. W. L., Chan, A. H. S., & Yim, H. P. (2020). Chronic health problems of older workers and their occupational safety: A meta-analysis. In *Advances in Safety Management and Human Factors* (pp. 365–380). https://doi.org/10.1007/978-3-030-50249-2_27
- Putra, A. R., Arifin, S., & Darmawan, D. (2024). Gamification-Based Learning that Preserves Cooperation and Empathy Among Employees. *International Journal of Service Science, Management, Engineering, and Technology*, 5(1), 43–50. <https://ejournalisse.com/index.php/isse/article/view/229>
- Putra, A. R., Mardikaningsih, R., & Darmawan, D. (2021). Organisational social capital and team collaboration as supports for total quality management. *Studi Ilmu Sosial Indonesia*, 1(1), 129–146.
- Ramle, N. L. B., & Mardikaningsih, R. (2022). Inclusivity in technology-based services: Access and skills challenges. *Journal of Social Science Studies*, 2(2), 225–230.
- Sakai, K., Nagata, T., Mori, T., Sueyoshi, N., Inoue, S., Odagami, K., Shibata, Y., & Mori, K. (2024). Determinants of job continuity among older workers: A mixed-methods research in Japan. *Industrial Health*, 62(5), 312–322. <https://doi.org/10.2486/indhealth.2024-0081>
- Sarah, B. M. F., Assunção, A., Carlos, F., & Filomena, C. (2022). The role of work conditions on the functional decline in senior workers in the automotive industry. *Work*, 71(2), 405–415. <https://doi.org/10.3233/WOR-213638>
- Schwatka, N. V., Butler, L. M., & Rosecrance, J. R. (2012). An aging workforce and injury in the construction industry. *Epidemiologic Reviews*, 34(1), 156–167. <https://doi.org/10.1093/epirev/mxr020>
- Spector, T. D., Hart, D. J., Nandra, D., Doyle, D. V., Mackillop, N., Gallimore, J. R., & Pepys, M. B. (1997). Low-level increases in serum C-reactive protein are present in early osteoarthritis of the knee and predict progressive disease. *Arthritis & Rheumatism*, 40(4), 723–727. <https://doi.org/10.1002/art.1780400421>
- Strandberg, T. E., & Tilvis, R. S. (2000). C-reactive protein, cardiovascular risk factors, and mortality in a prospective study in the elderly. *Arteriosclerosis, Thrombosis, and Vascular Biology*, 20(4), 1057–1060. <https://doi.org/10.1161/01.ATV.20.4.1057>
- Submitter, E. M., Yvonne, S., & Antón, G. (2021). Capturing the value of the experienced worker (SSRN Scholarly Paper No. 3788874). *Social Science Research Network*. <https://doi.org/10.2139/ssrn.3788874>
- Suorsa, K. I., Mattila, V., Leskinen, T., Heinonen, O. J., Pentti, J., Vahtera, J., & Stenholm, S. (2022). Work ability and physical fitness among aging workers: The Finnish Retirement and Aging Study. *European Journal of Ageing*, 19(4), 1301–1310. <https://doi.org/10.1007/s10433-022-00714-1>
- Thomas, D. R. (2010). Sarcopenia. *Clinics in Geriatric Medicine*, 26(2), 331–346. <https://doi.org/10.1016/j.cger.2010.02.012>
- Titilayo, A. (2016). Periodical screening and health education at work: Producing healthy workforce. *Texila International Journal of Public Health*, 4(4), 318–327. <https://doi.org/10.21522/TIJPH.2013.04.04.ART029>
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, 14(3), 207–222. <https://doi.org/10.1111/1467-8551.00375>
- Viviani, C., Bravo, G., Lavallière, M., Arezes, P., Martínez, M., Dianat, I., Bragança, S., & Castellucci, H. I. (2021). Productivity in older versus younger workers: A systematic literature review. *Work*, 68(3), 577–618. <https://doi.org/10.3233/WOR-203396>
- Wahyusetiawan, R., Herisasono, A., Khayru, R. K., Vitrianingsih, Y., & Issalillah, F. (2024). Health Facility Accountability for Terminal Patient Palliative Care Services Under Health Law. *International Journal of Service Science, Management, Engineering, and Technology*, 6(2), 45–57.
- Waluyo, A., Vitrianingsih, Y., Mardikaningsih, R., Issalillah, F., & Negara, D. S. (2024). Legal Regulation of Multinational Corporate Health Services and Local Legal Obligations. *Journal of Social Science Studies*, 4(1), 359–370.
- Welch, L. S., Dement, J. M., Ringen, K., Cranford, K., & Quinn, P. (2017). Impact of secondary prevention in an occupational high-risk group. *Journal of Occupational and Environmental Medicine*, 59(1), 67–73. <https://doi.org/10.1097/JOM.0000000000000925>
- Wrocławska, T. (2020). General remarks on flexibility in employment as the determinant for prolonging working life of older people. In *Extended Working Life in Contemporary Societies* (pp. 33–52). https://doi.org/10.1007/978-3-658-28511-1_3