

## Biometrics, Biometric Screenings, and Occupational Safety and Health An Overview

## Biometria, Biometriai Szűrések, Munkaügyi Biztonság és Egészségügy Áttekintés

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### Abstract

Biometrics is defined as the science that measures human features for identification purposes. Biometric technology in the workplace uses biometric characteristics such as fingerprint, iris, and face recognition systems to access company facilities and monitor employees' tardiness and attendance. The acquisition of other biometric characteristics such as height, weight, blood, and urine has become predominant in the workplace by introducing biometric screening events.

Employers recognize the importance of occupational safety and health initiatives within a business.

Our paper offers an overview of biometrics, its usage in the workplace, and the biometric screening process, including tests and measures. Additionally, it reviews industrial safety concepts and biometric screening's implication in safety as an incentive tool and performance influencing factors.

### Keywords

Biometrics, screenings, occupational safety

### Absztrakt

A biometria olyan tudomány, amely azonosítás céljából méri az emberi jellemzőket. A biometrikus technológia a munkahelyen biometrikus jellemzőket, például ujjlenyomatot, írisz, arcfelismerő rendszereket használ a vállalati létesítmények fizikai eléréséhez, valamint az alkalmazottak késésének és részvételének figyeléséhez. Az egyéb biometrikus jellemzők, mint a magasság, súly, vér és vizelet elsajátítása a biometrikus szűrési események bevezetésével vált uralkodóvá a munkahelyeken. A munkaadók felismerik a munkahelyi biztonsági és egészségvédelmi kezdeményezések fontosságát egy vállalkozáson belül. A cikkünk áttekintést nyújt a biometrikus adatokról, munkahelyi használatáról, a biometrikus szűrési folyamatról, beleértve a tesztek és méréseket. Ezenkívül áttekinti az ipari biztonsági koncepciókat és a biometrikus szűréseket, amelyek a biztonságra, mint ösztönző eszközre és a teljesítményt befolyásoló tényezőkre vonatkoznak.

### Kulcsszavak

Biometria, szűrések, munkavédelem

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## INTRODUCTION

Biometric science is based on the measurement of the body. The collection of biometric traits has been used for identification purposes in different areas, including the workplace. Workers' biometric characteristics can serve as an element in recognition systems and as a tool for improving occupational safety and health. Hence, biometric screenings use body measures to characterize employees' health but can also affect safety.

The following paper provides a broad review of biometrics, its usage in work spaces, biometric screening tests, and processes. Moreover, it overviews industrial safety concepts and analyzes the linkage between biometric screenings and occupational safety as an incentive tool and via performance influencing factors.

## BIOMETRICS

The word "biometric" comprises two Greek words: bio, which means life, and metrics related to measuring [1]. Biometrics is the science that measures and analyzes physical or behavioral traits in humans. Its objective is to determine the identity of a specific individual[2]. Biometric characteristics are defined as the metrics associated with human features or traits. Some examples include fingerprints, face, iris, retina, hand geometry, vein, gait, DNA, and odor. [3][4].

Biometric technology takes advantage of the fact that physical or behavioral features in humans are unique. Thus, identifying a specific person is easier and more effective by analyzing these characteristics[5]. Biometrics identification robustness resides in the concept of who the person is instead of what he or she has. Therefore, biometric systems offer higher security levels than traditional identification methods such as passwords, pins, or identification cards[6]. Additionally, these systems provide accurate verification so that authorized personnel can access secured information or places. The utilization of this technology also provides accountability. Hence, a particular action or event can be easily linked to a person. Duplication, information sharing, and fraud are successfully prevented to enhance safety in an organizational environment[7].

A biometric trait should possess the following characteristics to be suitable for acquisition and analysis[8], [9]:

- Universality, all individuals should have the biometric feature
- Uniqueness, the biometric trait is exclusive to every individual
- Permanence, the biometric identifier cannot vary throughout time
- Collectability, the biometric identifier should be able to be obtained and digitalized using the suitable equipment
- Acceptability, the participants in a biometric system should accept the characteristic for authentication and identification purposes.

Biometric systems use pattern recognition. They comprise of two parts[2][3][10]:

### 1. Enrollment

Biometric traits are collected from the individual; only distinctive features are acquired and stored in the database.

## 2. Recognition

Biometric data is collected from the individual and compared with the information previously stored at the enrollment to recognize and authenticate its identity.

Biometric technology is widely used in different fields, such as forensics, banking, airport control, electronic commerce, and social services [11]. Some examples of where this technology is applied are[2]:

- Commercial uses such as user authentication in online banking, services or in ATMs, credit card usage, mobile phone, distance learning, and access to healthcare systems
- For government identification purposes, including identification card issuance, driver licenses, access to social benefits, and border control.
- In forensics, for body identification, criminal purposes, parenting determination, and in case of missing people.

### **Biometric Uses in the Workplace**

Biometric systems are employed in organizations for numerous purposes, as described below:

- **Background Check**

At the beginning of the hiring process, employers use biometric technology to access candidates' criminal records. In the United States (US), companies screen potential employees seeking a job. In other countries, presenting a criminal record is a requirement at any point in the recruiting process.

Law enforcement agencies such as the FBI in the US retrieve applicants' criminal histories. This information guides the recruiter regarding a hiring decision. FBI uses two fingerprints and two names to run the background check[12].

- **Staff Monitoring**

Fingerprint recognition equipment is predominantly used in companies for registering workers' time and attendance. The software present in these devices can accurately calculate working hours, punctuality, time breaks, sick days, absence, overtime, and payroll elements. Additionally, other devices can deny access to company technology and networks upon completion of the workday.

Biometric-based equipment is faster regarding clocking in and out than other methods, such as tokens or magnetic cards. Fraud and buddy punching are reduced while efficiency and productivity are boosted thanks to this technology[13].

- **Access Control**

Authorized personnel recognition and access granting are performed by authenticating identity using biometric technology such as fingerprint, face recognition, and eye scanning. In terms of safety, biometric identification equipment restricts access to specific areas, such as places containing dangerous, valuable materials and sensitive information.

Moreover, it offers increased security against trespassers by protecting buildings, computers, and networks. Devices that use fingerprint and facial recognition, such as keyless locks, laptops, USBs, and mobile phones, grant access and track workers' activities during equipment usage to improve organizational safety [14][15].

- Tracking company assets

Biometric identification equipment is used to track corporate property, such as vehicles, machinery, and smartphones. Real-time data on speed, location, and delivery time can be easily retrieved. These devices also provide traceability reports during the workday, which can be favorable in the event of accidents and responsibility claims. Additionally, biometric technology can monitor staff in the workplace at any time and promotes safe conduct and safety procedures usage [7].

As explained above, biometric characteristics such as fingerprints, hand geometry, face, iris scanning, and palm recognition are usually used in the workplace for identification purposes. Nowadays, via biometric screening events, organizations acquire other biometric traits such as height, weight, waist, hip circumference, and more to assess the workforce's health conditions and monitor the changes throughout time[16]. These features provide health-based benefits to workers and employers and can contribute to workplace safety.

## **BIOMETRIC SCREENINGS**

### **Measures and Tests**

Below are listed and described several of the measures and tests performed on employees during a biometric screening event[17]:

- Height and Weight

Height and weight measures detect if an individual is healthy, overweight, or underweight by using weight and height ratios and calculating the body mass index (BMI) and the basal metabolic rate (BMR). BMI value is utilized to identify people at risk of hypertension and diabetes, while BMR helps develop personalized dietary regimes.

- Body Fat Percentage

This measure can indicate obesity, which is a risk factor for several chronic diseases such as stroke, diabetes, and heart problems

- Body Measures

Waist circumference, hip, or neck measures are acquired at screening events to detect overweight, obesity, and sleep apnea.

- Blood

A blood sample can deliver different results such as glucose level, triglycerides level, cholesterol, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) cholesterol ratio. Cholesterol and triglyceride levels can detect the development of coronary and heart diseases such as heart attacks. Glucose levels can indicate if a person suffers from hypoglycemia or hyperglycemia. It is a condition that can lead to diabetes if not prevented via health coaching and lifestyle changes.

- Blood Pressure

Systolic and diastolic blood pressures reveal if the heart is working correctly and the risk of heart disease or a stroke.

- **Cotinine Test**

Cotinine is the major metabolite of nicotine. This test establishes whether nicotine is present in the blood, urine, saliva, or hair. It gives a picture of the workforce's smoking habits and can help develop smoking cessation programs and policies within the organization[18].

- **Bone Density Test**

This test is used to identify individuals at risk of developing osteoporosis and provide education and timely treatment to diagnosed workers[19].

- **Vision and Hearing Tests**

These tests can be used for pre and post-occupational screenings. They serve as a baseline tool for detecting the development of a work-related illness throughout the time spent at a company[20].

- **Fitness Tests**

These tests evaluate a worker's endurance and physical capabilities. It is crucial for job positions that require manual work and physical stress[21].

## **The Biometric Screening Process**

The biometric screening process involves different actors, resources, and logistics deployed before, during, and after collecting biometric traits. It is essential to take into consideration some procedures described below to obtain the expected safety and health outcomes:

- **Before the Process**

The preparation of a biometric screening event entails different activities. Logistics and supplies can be easily coordinated by a third-party provider, which can also accommodate the test screenings based on the organization's goals[22]. On the other hand, as implementers, it is necessary to focus on the two elements described below to ensure high participation rates:

### *Communication*

Before starting a biometric process, it is essential to set up goals, describe the different tests that will be administered to the employees, and state the purpose and benefits of these procedures.

Additionally, the biometric screening planning process should follow the principles of purpose and proportionality. These principles imply an analysis of whether biometric data acquisition is necessary or if other less intrusive methods can deliver the same purpose or outcome[23].

The workforce privacy right to protection should be considered starting at the planning phase, given the nature of the data that is going to be collected. Moreover, knowing and complying with the laws concerning biometric data acquisition and usage established in the country or region where the screenings will be held is critical.

In the European Union (EU), the General Data Protection Regulation (GDPR) is the legal framework used to regulate data protection and privacy. It is considered the most stringent data security framework in the world. Companies can face up to €20 million or

4% of the global fee turnover for non-compliance. Biometric data is treated as personal data, which is any physical or behavioral characteristic of a person that proves that individual's unique identification. It consists of seven requirements[24]:

- Consent for data collection and usage should be obtained utilizing simple terms. Likewise, consent withdrawal must be easy to get.
- Data breach notification should be done within 72 hours.
- Right to access: Subjects have the right to be informed about personal data processing, and they can obtain a free electronic copy of the collected data.
- Right to be forgotten: Data must be deleted when it is no longer pertinent to the original purpose.
- Portability: Subjects can get and use their collected personal data within different IT environments.
- Data protection should be instated from the initial state of the process, applying the appropriate measures.
- Public authorities or large organizations should select data protection officers with more than 250 employees to monitor personal data processing.

Consequently, the whole biometric screening process should be carried out, considering privacy by design concept. It means focusing on data security from the beginning of the process and not including this aspect when the event is in progress[25]. Hence, creating and disseminating a data protection plan is vital to avoid privacy breaches and employees' concerns, such as misuse of the collected data, sharing, stealing, and connecting these traits with private information in other databases [26]. Additionally, the plan should specify that the acquired biometric information and results cannot be shared without a written consent that includes who will receive the information and how it will be used[27]. Every employee must sign a consent stating their willingness to participate in the screening event.

The screening program presented as a priority by management is necessary for engaging employee participation. Additionally, it is crucial to seek involvement on every level of the organization to join efforts toward a successful event.

The dissemination of essential information regarding the biometric screening process via flyers, emails, bulletin boards, social networks in the company, and frequently asked questions concerning the procedures should be transmitted regularly [28]. Moreover, these means of communication create awareness about the screening event and clear any doubts the workers may have.

#### *Incentives*

Incentives are a fundamental part of the biometric process. They serve as engaging tools for increasing participation, which is a way of measuring wellness program success. Some examples of incentives include: lowering the contribution for insurance or medical plans, cash, gift cards, and prizes in raffles[29]. A biometric screening without any incentive can reach 30% of participation. In comparison, the usage of cash-related incentives can rise to 50%, and a health-designed incentive plan can increase participation rates to 80% [30].

- **During the Process**

The success in the execution of the screenings depends on different factors such as correct staffing, materials for the tests conducted, equipment, and accurate scheduling. The effective combination of these factors will guarantee a smooth process flow.

Apart from these critical elements, collecting and effectively protecting the information acquired during this process is fundamental. Considering that the organization devoted economic resources and efforts, the workers dedicated their time and provided sensitive data that needed to be securely stored[31]. Hence, data processing, reporting, and safety are central issues to track during this stage. A unique identifier for each employee should be assigned at the moment of the data collection to protect the participant's privacy and report the results. Furthermore, privacy guidelines and laws should be strictly followed, and data security plans regarding clerical, physical, and technical risks should be implemented to prevent breaches[32][23].

- After the Process

Biometric screening results alone cannot accomplish an organization's safety and health outcome. It is vital as screening promoters to go beyond the results and consider the following actions for the employees and the company:

*Personnel*

Review and communication of the test results

It is necessary to appoint meetings with each participant to review and communicate the test results to provide a complete screening solution [33].

Evaluation of the results

The employees must understand the numbers beyond the tests administered to them. This evaluation is the first step for detecting, preventing, treating chronic illnesses, and getting motivated to change behavior towards healthier habits via informed decisions. The results can be evaluated by a physician or a health coach, depending on the severity of the effects [33].

Resource provision

The employees will receive information about their condition, treatment, and medicine management options depending on the results. For prevention purposes, it is suggested to provide education, motivate lifestyle changes, and set personal goals for the participants. Additionally, suggesting and engaging workers in other company wellness initiatives is critical for accomplishing safety and health objectives[34].

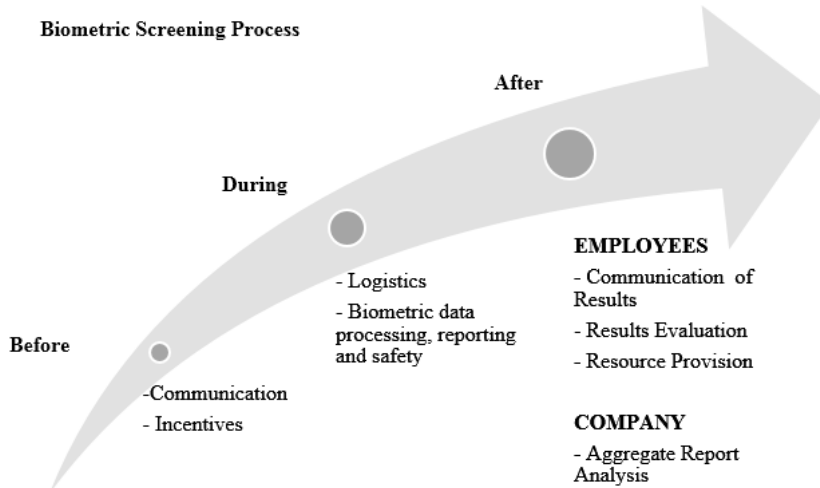
Follow up

This last step is critical for the success of the process and workforce welfare. Keeping track of the disease and medical management programs regarding chronic conditions and reviewing the participants' progress year by year will determine the effectiveness of the biometric screening process[35].

*Company*

It is highly recommended to obtain an aggregate report detailing the information collected and the results of the screenings. This report shows trends regarding the workforce's health status and how the workplace environment affects the employees. It provides feedback on how safety and health initiatives are developing each year. Moreover, the report can serve as an audit of the wellness programs implemented at the company. It is an exceptional opportunity for creating new safety and health policies, stating health priorities, eliminating the ones that are not effective, and integrating other wellness programs[36]

Figure 1 gives a graphic description of the various procedures to be considered before, during, and after a biometric screening process. It highlights the afterward steps which are crucial for getting the expected health and safety outcomes.



*Figure 1: Biometric Screening Process Stages and Procedures*

## INDUSTRIAL SAFETY CONCEPTS AND BIOMETRIC SCREENINGS

Occupational Safety and Health generally directs attention to preventing and finding the root cause of work-related accidents and injuries. Consequently, different theories have been developed to serve this purpose. Some of them are depicted below:

- **Axioms of Industrial Safety**

In the late 1920s, Herbert W. Heinrich formulated the 10 Axioms of industrial safety and the theory of accident causation known as the domino theory. The principles and theory were developed to explain the origin of accidents. Even though his research is outdated and poses various criticisms [37], it is relevant to understand the industrial safety basics.

The ten axioms of industrial safety are [38], [39]:

1. Injuries are the result of a series of factors.
2. Accidents can only occur due to an unsafe act (person) or a physical hazard.
3. Most accidents are the consequence of unsafe behavior.
4. Unsafe acts or hazards do not always result in an accident or injury.
5. Understanding why people commit unsafe actions can help develop guidelines and corrective procedures.
6. The severity of an injury is fortuitous, and the accident that caused it is preventable.
7. The best accident prevention techniques are analogous to the best quality and production techniques.
8. Management should assume responsibility regarding safety to get the best results.
9. The key person for the prevention of industrial accidents is the supervisor
10. Accidents include direct and indirect costs.

Additionally, Heinrich's domino theory is summarized in two statements:



1. The action of the preceding factors causes accidents.
2. The elimination of the main factor (unsafe act/ hazards) nullifies the action of the other factors; thus, accidents and injuries are prevented [39], [40]

- **Human Factors Theory and Accident/ Incident theory**

This theory explains the occurrence of an accident as a chain of events caused by a human error. Human error consists of three factors:

1. Overload, such as noise, distractions, personal problems, stress, and level of risk.
2. Inappropriate response
3. Inappropriate activities

The Accident/ Incident theory expands the human factors theory by adding new factors contributing to human error, such as ergonomic traps, the decision to err, and system failures [39], [41].

- **Epidemiological Theory**

This theory states that the principles used to establish relationships between environmental factors and diseases can also analyze the causes of environmental factors and accidents[39].

- **Systems Theory**

This theory describes an accident as a system consisting of three main elements: a person, a machine, and the environment[42].

- **Combination Theory**

This theory relies on the fact that sometimes, the cause of an accident cannot be adequately explained by using a sole approach. Hence, it is necessary to work with different models to find an accident's origin and prevent it [39].

## **Biometric Screenings as an Incentive tool**

An incentive is defined as a valuable object, action, or desired event that incites an employee to accomplish more of what he/she is asked to do by the employer[43]. Incentive programs can help promote workplace safety[39].

Biometric screenings were usually just a path for obtaining financial incentives, prizes, and discounts in health plan packages or used as incentives to increase participation in these events [44][45]. However, these screenings by themselves can be used as a non-monetary incentive. This type of recognition is often more efficient than monetary prizes because it acknowledges what others have done [46].

Employees recognize the commitment the company is making toward workforce health. As a result, workers get motivated; productivity, loyalty, and safety behaviors are stimulated while reducing risks and health costs[47].

Biometric screening events can be effectively used as incentives given the following guidelines[39]:

1. Objectives and outcomes should be well established
2. Criteria on the quantity and how the reward will be granted should be well defined
3. Establish clear communication between the employees regarding how valuable biometric screenings are, the benefits, and long-term rewards.

4. Employees should be involved in all screening events stages, from planning to evaluation.

### **Biometric Screenings and Performance Influencing Factors**

Performance Influencing Factors (PIF) are different aspects that affect human performance in the workplace. These aspects should be monitored and optimized to enhance safety at work[48]. They can be divided into two groups:

- Internal factors

These factors are related to the employees' inner well-being. Some examples are emotional state, motivation, stress level, physical conditions, morale, and fatigue[49].

- External factors

These factors consider the environment and organization where the employee is working. External factors include communication, inadequate procedures, routine tasks, unclear policies, poor supervision, peer pressure, and poor work conditions [50].

Biometric screenings promote PIFs engagement among employees. Biometric test results combined with health education and interventions after the testing influence internal PIFs, by promoting healthy behaviors, early disease intervention, treatment, reduction of sick leave, absenteeism, and presentism [30].

## **CONCLUSIONS**

This study aimed to explain biometric screenings and analyze the benefits of these tests in occupational safety. Health and safety at the workplace are directly connected since healthy employees are motivated to safety behaviors, which decreases work-related accidents. Furthermore, biometric screening results provide critical health information to prevent and execute timely interventions regarding diseases and unhealthy habits within the workforce. Additionally, the processes that come after the tests, such as education, health providers' appointments, follow-ups, and medical resources, are essential for the success of the screenings. It is necessary to consider that the results obtained through biometric screenings must be interpreted by a medical practitioner and understood by the worker to achieve health and safety outcomes in the workplace.

## **REFERENCES**

- [1] P. Roxburgh, "Biometrics and its introduction into the workplace," National College of Ireland, 2011.
- [2] A. Jain, A. Ross, and K. Nandakumar, *Introduction to Biometrics*. Springer, 2011.
- [3] R. De Luis-García, C. Alberola-López, O. Aghzout, and J. Ruiz-Alzola, "Biometric identification systems," *Signal Processing*, vol. 83, no. 12, pp. 2539–2557, 2003, doi: 10.1016/j.sigpro.2003.08.001.
- [4] E. Kaděna and L. C. Ruiz Salvador, "Adoption of biometrics in mobile devices," in *FIKUSZ 2017- Symposium of Young Researchers*, 2017, pp. 140–148, Accessed: Jan. 11, 2019. [Online]. Available: <http://kgk.uni-obuda.hu/sites/default/files/10-Esmeralda-Kadena.pdf>.
- [5] M. Vrbanec and F. Magušić, "Application of Biometric Systems in Safety," *Saf. Eng.*, vol. 1, no. 1, pp. 35–43, 2012, doi: 10.7562/se2011.1.01.07.

- [6] L. C. Ruiz Salvador, "Biometric Systems and Uncertainty: A General Approach," in *TIEES 2020 Trends and Innovations in E-business, Education and Security Eighth International Scientific Web-conference of Scientists and PhD. students or candidates*, 2020, pp. 115–121.
- [7] L. C. Ruiz Salvador and A. Oszi, "Biometric uses in Occupational Safety and Health," *Hadmérnök*, 2016, Accessed: Jan. 11, 2019. [Online]. Available: [http://hadmernok.hu/164\\_01\\_arnold.pdf](http://hadmernok.hu/164_01_arnold.pdf).
- [8] A. Jain and A. Ross, *Handbook of Biometrics*. 2008.
- [9] S. F. Darwaish, E. Moradian, T. Rahmani, and M. Knauer, "Biometric identification on android smartphones," *Procedia Comput. Sci.*, vol. 35, no. C, pp. 832–841, 2014, doi: 10.1016/j.procs.2014.08.250.
- [10] Huu Phuoc Dai Nguyen, L. C. Ruiz Salvador, and A. Oszi, "Biometrics acquisition in a Hungarian university," *Banki Reports*, pp. 30–33, 2018.
- [11] R. Vargas and L. C. Ruiz Salvador, "Deep Learning : Previous and Present Applications," *J. Aware.*, no. November 2017, 2018.
- [12] M. E. Callahan, "Contact Point Donald Hawkins USCIS Privacy Officer United States Citizenship and Immigration Services 202-272-8000 Reviewing Official," 2010. Accessed: May 16, 2019. [Online]. Available: [www.dhs.gov/privacy](http://www.dhs.gov/privacy).
- [13] S. Nwachokor, "Biometrics: Advantages for Employee Attendance Verification," Michigan. Accessed: May 16, 2019. [Online]. Available: [https://www.academia.edu/35413262/Biometrics\\_Advantages\\_for\\_Employee\\_Atendance\\_Verification](https://www.academia.edu/35413262/Biometrics_Advantages_for_Employee_Atendance_Verification).
- [14] J. M., "10 Ways Biometrics Technology Can Make Your Workplace Safer," *Ezine Articles*, 2009.
- [15] L. C. Ruiz Salvador, "Security systems: The introduction of biometric technology as a smart solution," *SISY 2017 - IEEE 15th Int. Symp. Intell. Syst. Informatics, Proc.*, pp. 347–351, 2017, doi: 10.1109/SISY.2017.8080581.
- [16] CDC, "Workplace Health Glossary," *Center for Disease Control and Prevention: Workplace Health Promotion*, 2018. <https://www.cdc.gov/workplacehealthpromotion/tools-resources/glossary/glossary.html>.
- [17] Health Wellness Professionals, "Biometric Screenings & Their Importance in the Workplace," 2016. <http://solutionsforyourwellness.com/biometric-screenings-their-importance-in-the-workplace/> (accessed May 06, 2018).
- [18] "Nicotine Testing: What to Expect." <https://www.webmd.com/smoking-cessation/taking-nicotine-test#1> (accessed Jun. 04, 2019).
- [19] World Health Organization, "Invest in your bones: Osteoporosis in the Workplace," Nyon, 2002.
- [20] "Hearing (Audiometry) and Vision Screening | MedPro | Onsite Flu Vaccinations, Health Checks and Drug Testing in the Workplace." <http://www.medpro.co.nz/?p=221> (accessed Jun. 04, 2019).
- [21] "Fitness for work assessments | Occupational Health." <https://www.oh.admin.cam.ac.uk/services/fitness-work-assessments> (accessed Jun. 04, 2019).
- [22] A. Kohll, "8 Questions to Ask Your Biometric Screening Company," *Forbes*,

- 2017.
- [23] L. C. Ruiz Salvador and T. Kovacs, "Biometric Information Acquisition, Privacy Issues at the workplace: Monitoring vs Security," 2016, Accessed: Jan. 11, 2019. [Online]. Available: <http://bgk.uni-obuda.hu/iesb/2016/publication/10.pdf>.
- [24] Thales Group, "Biometric data protection (EU, UK and US perspectives)," Dec. 21, 2020. <https://www.thalesgroup.com/en/markets/digital-identity-and-security/government/biometrics/biometric-data> (accessed Dec. 28, 2020).
- [25] R. Minter, "The Informatization of the Body: What biometric technology could reveal to employers about current and potential medical conditions," 2011.
- [26] S. Prabhakar, A. Jain, and A. Ross, "An Introduction to Biometric Recognition," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 14, no. 1, pp. 4–20, 2004, [Online]. Available: <https://researchweb.iit.ac.in/~vandana/PAPERS/BASIC/intro.pdf>.
- [27] L. C. Ruiz Salvador and K. Andras, "Biometric Security Systems Risk Assessment: A general Overview," *Hirvillam*, pp. 13–25, 2017, Accessed: Jan. 11, 2019. [Online]. Available: [http://comconf.hu/kiadvany/hirvillam\\_8evfolyam\\_1szam.pdf](http://comconf.hu/kiadvany/hirvillam_8evfolyam_1szam.pdf).
- [28] R. Rameswarapu, S. Valsangkar, A. Rizvi, and U. Kamineneni, "Trends shaping corporate health in the workplace," *Apollo Med.*, vol. 11, no. 3, pp. 217–221, 2014, doi: 10.1016/j.apme.2014.07.010.
- [29] Willis North America, "The Willis Health and Productivity Survey Report 2014," 2014.
- [30] R. Z. Goetzel and R. J. Ozminkowski, "The Health and Cost Benefits of Work Site Health-Promotion Programs," *Annu. Rev. Public Health*, vol. 29, no. 1, pp. 303–323, 2008, doi: 10.1146/annurev.publhealth.29.020907.090930.
- [31] J. Crews and A. Ebejer, "Security at your fingertips: Biometrics and Workplace Law," *Scientific American*, vol. 290, no. 6, pp. 108–110, 2004.
- [32] B. Squiers, "Data Security and Your Employee Wellness Program," *Employee Wellness Blog*, 2015. <http://info.totalwellnesshealth.com/blog/data-security-and-your-employee-wellness-program> (accessed Apr. 02, 2018).
- [33] American College of Occupational and Environmental Medicine (ACOEM), "Consensus Statement Offers Guidance on the Use of Biometric Screenings as a Workplace Wellness Tool," *Journal of Occupational and Environmental Medicine*, 2013. <http://www.acoem.org/BiometScreen.aspx> (accessed Nov. 03, 2017).
- [34] L. E. Smith, "Participation in Worksite Health Screening Activities, Health Behaviors and Readiness to Change," Minnesota State University Mankato, 2017.
- [35] R. Loeppke, "Biometric Health Screening for Employers: Consensus Statement of the Health Enhancement Research Organization, American College of Occupational and Environmental Medicine, and Care Continuum Alliance," *J. Occup. Environ. Med.*, vol. 55, no. 10, pp. 1244–1251, 2013, doi: 10.1097/JOM.0b013e3182a7e975.
- [36] B. Squiers, "Common Wellness Trends and What They Mean for Your Company," *Employee Wellness Blog*, 2016. <http://info.totalwellnesshealth.com/blog/common-wellness-trends-and-what-they-mean-for-your-company> (accessed Feb. 02, 2018).
- [37] F. A. Manuele, "Dislodging Two Myths From the Practice of Safety," *Professional Safety*, no. October, 2011.

- [38] B. P. Basford, "The Heinrich model: determining contemporary relevance," 2017.
- [39] D. L. Goetsch, *Occupational Safety and Health for Technologist, Engineers, and Managers*, Seventh. 2011.
- [40] "Heinrich's domino model of accident causation," 2017. <https://risk-engineering.org/concept/Heinrich-dominos> (accessed Jun. 18, 2019).
- [41] "Petersen's Accident-Incident Causation Theory | RLS HUMAN CARE." <https://rlshumancare.com/petersens-accident-incident-causation-theory/> (accessed Jun. 18, 2019).
- [42] D. L. Goetsch, *Implementing Total Safety Management*. New Jersey: Prentice Hall, 1998.
- [43] S. M. Heathfield, "What Do Employee Incentives Consist of at Work?," 2019. <https://www.thebalancecareers.com/what-are-incentives-at-work-1917994> (accessed Jul. 09, 2019).
- [44] D. D. Maeng, Z. Geng, W. M. Marshall, A. L. Hess, and J. F. Tomcavage, "An Analysis of a Biometric Screening and Premium Incentive-Based Employee Wellness Program: Enrollment Patterns, Cost, and Outcome," *Popul. Health Manag.*, vol. 21, no. 4, pp. 303–308, 2017, doi: 10.1089/pop.2017.0110.
- [45] P. Montalto and Quest Diagnosis, "The Role of Incentives in Biometric Screening Program Participation THE ART OF DISCOVERING WHAT EMPLOYEES VALUE," *Blueprint for Wellness*, 2010.
- [46] B. Nelson and D. Spitzer, *The 1001 Rewards & Recognition Fieldbook*. New York: Workman Publishing Company, 2003.
- [47] "10 Pros and Cons of Biometric Screening for Corporate Health," 2017. <https://blog.corehealth.global/10-pros-and-cons-of-biometric-screening-for-corporate-health> (accessed Jul. 09, 2019).
- [48] J. W. Kim and W. Jung, "A taxonomy of performance influencing factors for human reliability analysis of emergency tasks," *J. Loss Prev. Process Ind.*, vol. 16, no. 6, pp. 479–495, 2003, doi: 10.1016/S0950-4230(03)00075-5.
- [49] C. Österman, "Performance influencing factors in maritime operations," *Hum. Elem. Contain. Shipp.*, no. March, pp. 87–104, 2012, doi: 10.13140/RG.2.1.5139.9442.
- [50] Health and Safety Executive UK, "Performance Influencing Factors (PIFs)." <http://www.hse.gov.uk/humanfactors/topics/pifs.pdf> (accessed Jan. 12, 2018).