Selection Criteria for Smart Mobile Devices in the Workplace[1]

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ABSTRACT
As the importance of smart mobile devices grows, organizations face the challenge of selecting appropriate devices such as smartphones, tablets, or smart glasses. The device selection can prevent physical and psychological risks associated with their subsequent use in the workplace. Organizations can avoid bad investments and proactively minimize risks by conducting a pre-purchase risk assessment. In the *GBU-SmarD* project, an analysis of 253 publications has provided scientific insight into the potential health and safety risks of working with smart mobile devices. In addition, eight focus groups with 20 tablet and 17 smart glasses users complemented the findings with practical experience from the field. This article presents 24 device selection criteria that will form the basis for the future development of a device selection tool for organizational use.

Keywords
Device – selection – tablets – smart glasses – risk assessment – prevention

Acknowledgments

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1 Smart Mobile Devices in the Modern Workplace

The ongoing digitization and interconnectivity driven by information technology will fundamentally reshape the future of work. Smart mobile devices like tablets, smart glasses, and smartwatches are rapidly becoming valuable tools for optimizing workflows across various industries (Dombrowski et al., 2019; Eller et al., 2020). These technologies provide instant access to work-related information and networked databases or machines (Binar et al., 2022; Chi et al., 2013; Lumsden et al., 2015). Studies predict a continuous increase in the use of smart mobile devices in all industries in the coming years (e.g., Capgemini Research Institute, 2018; Jacob, 2023).

While smart mobile devices offer the potential to improve productivity and flexibility, they can also bring increased cybersecurity threats, concerns regarding privacy, and the necessity for ongoing training and support to ensure effective use. In addition, using smart mobile devices can pose increased physical and psychological risks to employees. Physical risks can result from prolonged screen exposure, which can lead to eye strain or headaches (Aggarwal et al., 2022; Herzog & Beharic, 2020; Uttarwar et al., 2020). Additionally, suboptimal ergonomic working conditions can cause musculoskeletal tension and pain (Lee et al., 2020; Odebiyi & Okafor, 2023). Psychological risks can involve work interruptions, blurred work-life boundaries, multitasking requirements, heighted work intensity (Meyer et al, 2021), and impaired social interactions (Mushroor et al., 2020; Orhan et al., 2021). Both physical and psychological risks can impact well-

[1] This article is dedicated to Prof. Dr. Winfried Hacker on his 90th birthday. We express our appreciation for his outstanding scientific contributions and thank him for his tireless support in our academic work.

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being and health, as well as the acceptance of the technology (e.g., El Shunnar et al., 2024; Mushroor et al., 2020).

Employers must assess the physical and psychological risks associated with smart mobile devices through a risk assessment, as mandated by § 5 of the German Occupational Safety and Health Act (Arbeitsschutzgesetz – ArbSchG). Organizations must define appropriate occupational health and safety measures based on the assessments' results. Additionally, the assessment must consider the risks to vulnerable employees, such as older persons and those with reduced performance capacities, according to § 4. Given these regulatory requirements, the successful integration of smart mobile devices in the workplace requires a balanced approach that maximizes benefits while minimizing associated risks. For effective risk management, it is crucial to select appropriate devices that ensure the safety and health of employees.

2 Selecting a Smart Mobile Device

The selection process entails choosing among different devices (e.g., tablet, smart glasses, smartwatch) and among specific models. Once the organization has acquired the equipment and made the financial investment, mitigating or reducing risks becomes significantly more challenging.

Choosing a smart mobile device poses several challenges for organizations. First, there is a considerable diversity of devices, making it challenging to identify the most appropriate technology for a specific organizational context (Issa et al., 2017; Siedler et al., 2019). Furthermore, device features vary from one manufacturer to another (Paramasivam et al., 2011). The classification system for workplace digital assistance systems reflects this variability of devices available (Figure 1).

Figure 1: Classification of digital assistance systems, adapted from Apt et al. (2018) and Mewes et al. (2020).

The classification illustrates the multiple functions of smart mobile devices depending on the type, level, location, and purpose of the support provided. This versatility opens a wide range of technical possibilities and organizational use cases, making the device selection difficult.

The second challenge arises from the lack of a universal „one-size-fits-all“ device selection strategy. Organizations' specific characteristics and requirements, including company size, technologies already in use, task complexity, and data security considerations, play a significant role in determining the most suitable technology (e.g., Hirsch-Kreinsen, 2016). To successfully navigate this complexity, organizations must comprehensively assess their specific needs and the operational context. This assessment necessitates a detailed examination of the existing technological infrastructure, the anticipated use cases, the long-term strategic objectives, and the employee requirements (DGUV, 2022; Gerpott, 2020; Kirchhoff et al.; 2016, Klinker et al., 2021 a; Mewes et al., 2020).

Third, selecting a device requires proactively assessing and anticipating potential physical and psychological risks associated with the chosen product (Parker & Grote, 2020, 2022). Though, prospective assessments can be challenging due to fast-paced technological advancements and limited practical, aggregated information regarding risks linked to smart mobile devices (Alloghani et al., 2020; Fergen, 2017). However, conducting a pre-purchase risk assessment enables organizations to identify and eliminate risks before investing. Also, according to § 3 of the Ordinance on Industrial Safety and Health Protection in the Use of Work Equipment (*Betriebssicherheitsverordnung*-BetrSichV), this risk assessment must start before selecting and procuring work equipment, with a particular focus on the equipment's suitability for its intended use, work processes, and organizational context.

In summary, selecting a smart mobile device is a complex process that requires considering multiple device characteristics and organizational factors influencing potential physical and psychological risks. Experience from the *GBU-SmarD* project shows that organizations need substantial support to choose a smart mobile device that aligns optimally with their specific needs and objectives.

2.1 Criteria for device selection

Various tools and guidelines provide valuable criteria that organizations can use when making this decision. While these criteria are industry-specific and device-specific, they offer insights and guidance for their respective contexts. For instance, Hafner (2022, p. 151) compares three device models – HoloLens 2, Magic

Leap, and the iPhone – in the context of intralogistics planning in the automotive industry. She presents a table illustrating how these devices meet specific functional requirements (e.g., information display, analysis function, documentation) and non-functional requirements (e.g., portability, time expenditure, costs). Similarly, Ziegler (2016) compares the usability of various input devices for industrial maintenance, including keyboards, gesture recognizers, rolling balls, and speech recognizers, for tasks such as pointing, selecting, navigating, dragging, and inputting (p. 117).

Ehmann et al. 2012 (as cited in Hüer et al., 2020, p. 60) refer exclusively to smart glasses. The authors list indicators for and against using smart glasses. Indicators for smart glasses include hands-free operation, an unobstructed field of view, mobility, non-obscuring reality, short secondary task periods, and frequent switching between primary and secondary tasks. The social accident insurance for the woodworking and metalworking industries (*Berufsgenossenschaft Holz und Metall* – BGHM, 2019, p. 2) provides a comparable list of indicators regarding the suitability of smart glasses. Zobel et al. (2016) defined 12 usability criteria for smart glasses by combining literature and the widely used standard DIN EN ISO 9241-11 (Deutsches Institut für Normung, 2018). The criteria proposed allow usability comparisons between models of smart glasses. The usability criteria for smart glasses include performance, perception, preference, user interface, interaction, cognitive effort, suitability, system stability, use context, ergonomics, social experience, and technology. Finally, the German Social Accident Insurance (DGUV, 2021, p. 3) has developed a selection guide for smart glasses to ensure that organizations accurately identify all potential stressors for employees using smart glasses prior to procurement. To accomplish this, organizations should consider four key areas:

1. tasks, including requirements related to processes, technical peripherals, organization, and employees,
2. purpose and function of the smart glasses,
3. hardware and software requirements of the smart glasses,
4. technical specifications and equipment of the smart glasses.

Given the current limitations of available tools and criteria to specific industries or devices, the *GBU-SmarD* project aims to develop a device selection tool for organizations to facilitate decision-making across various industries and device types. In addition to the properties shared by different devices, the tool will consider distinguishing attributes specific to each device. For instance, smart glasses have the unique capability of projections, which significantly differentiates them from display-based devices. Consequently, the selection tool encompasses both cross-device factors and the unique attributes of specific devices like smart glasses.

3 Smart Mobile Devices in the *GBU-SmarD* Project

The *GBU-SmarD* project, funded by the DGUV, was initiated to provide organizations with comprehensive support in assessing and designing work involving smart mobile devices. A particular focus was on potential physical and psychological risks and requirements for older employees and those with reduced performance capacities.

In the project, we selected three device types for more in-depth-investigation because of their versatility and effectiveness for different areas of application and industries: tablets, smart glasses, and smartwatches: *Tablets* are portable computing devices that typically feature a touchscreen interface and are larger than smartphones but smaller than traditional laptops. Initially designed for personal use, they now find increasing application in professional settings like offices and machine control (IFA, 2017). *Smart glasses* are wearable electronic devices with a small display that overlays digital information and instructions in the employee's field of view, allowing them to see and interact with virtual content while being aware of their physical surroundings. Smart glasses offer hands-free access to information and functionalities, making them particularly useful in navigation, remote assistance, and industrial maintenance (Kim & Choi, 2021; Weber & Buchkremer, 2021). *Smartwatches* are wrist-worn computers or sensor systems that allow for responsive interaction with the user (Schellewald et al., 2016). Smartwatches can manage digital communication, including calls and messages, provide immediate notifications for critical incidents such as machine downtimes, and serve as fitness trackers by capturing physiological data to offer health insights. Given the limited prevalence of smartwatches in both the literature and organizational practice (Koutromanos & Kazakou, 2023; Reeder & David, 2016) we considered smartwatches in a subordinate manner in comparison to tablets and smart glasses.

4 Methods

We employed a multi-faceted approach to identify potential risks associated with using smart mobile devices, including a scoping review and focus groups.

4.1 Scoping Review

We conducted a scoping review (Munn et al., 2018; Peters et al., 2015) to summarize the current research activity on the topic of „working with smart mobile devices“. The scoping review explored potential physical and psychological risk factors associated with smart mobile devices across various contexts and industries.

Search Strategy
We conducted a literature search in the PSYNDEX, Web of Science, and EBSCOhost databases, supplemented by an extensive hand search for German- and English-language publications from 2014 to December 2022. Given the topic's relevance to researchers and practitioners, we also included grey literature, project reports and white papers, scientific publications, and standards. In addition to the documents within the specified search period between 2014 and 2022, we have considered regulations and standards published outside the search period. The search term consisted of two primary components, each explored through synonyms in German and English: First, the overarching term „smart mobile devices“, which included specific categories such as „smartphones“, „tablets“, „smartwatches“, and „smart glasses“. Second, the research targeted the „risks“ associated with the use of these devices in the workplace and the corresponding „work design requirements“. Additionally, we conducted a hand search for publications involving older workers and people with reduced performance capacities to gain deeper insights into these employee groups. Figure 2 shows the process of the scoping review.

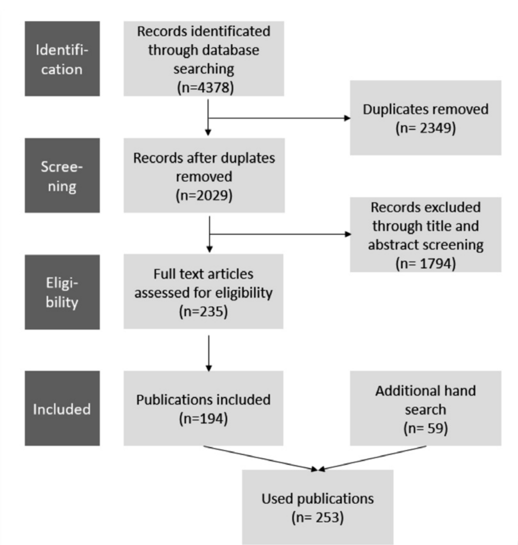

Figure 2: Scoping review process.

We identified 4,378 publications through database searches. Consequently, we excluded 1,794 articles on non-professional use of smart mobile devices or unrelated subjects like artificial intelligence and remote work. After filtering the results based on title and abstract screenings, we conducted a full-text screening of the remaining publications. Including the hand search, our review encompassed a total of 253 publications.

Characteristics of Included Publications
To provide an overview of the included articles, Figure 3 depicts a timeline illustrating the number of publications per year between 2014 and 2022. Regulations and standards published outside the search period are not included in the timeline.

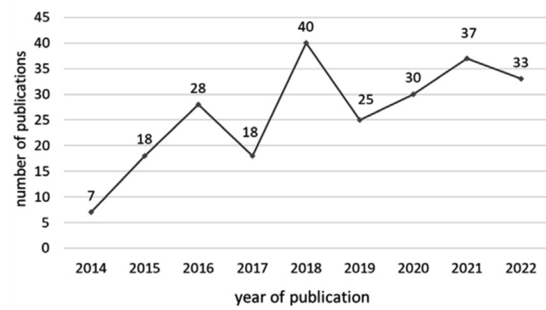

Figure 3: Timeline of publications in the scoping review (n = 236).

From 2014 to 2022, there was an overall increase in annual article publications, with a slight decrease during the pandemic and a modest peak in 2018.

Figure 4 presents the distribution of publication types included in the scoping review.

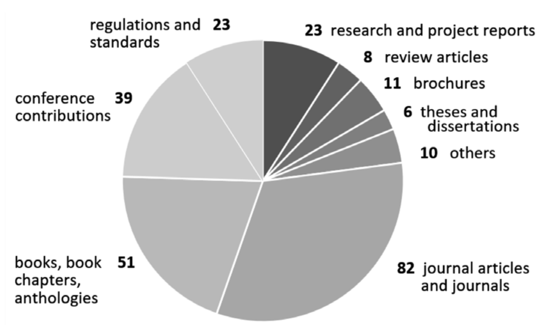

Figure 4: Publication types in the scoping review (n = 253).

The scoping review showed a clear prevalence of journal articles and journals, followed by books, books chapters and anthologies, and conference contributions.

4.2 Focus Groups

Focus groups were employed to validate and enrich the findings of the scoping review by collecting participants' insights and perceptions regarding the use of tablets or smart glasses at work. Given the limited adoption of smartwatches, the focus group sessions only addressed tablets and smart glasses. We conducted eight focus groups from April to December 2023.

Data Collection
The primarily online focus groups lasted between 3 and 3.5 hours. Two moderators facilitated the focus groups using a semi-structured and pre-tested moderation guide. The sessions consisted of four discussion parts, each employing a different method, e.g., a pro-con debate and the headstand technique. Participants provided informed consent to attend the focus group and to have the session recorded electronically. The co-moderator summarized and documented the discussion outcomes using a physical or digital whiteboard. This method of group quality control (Pelz et al., 2004) allowed participants to review the summarized points and enabled immediate feedback. After the workshop, we checked the whiteboard protocol for completeness and accuracy using the electronic recordings.

Participants
We recruited participants through cold calling, referrals, and personal and professional networks. Seven participants were employed in healthcare, six in service, and five in skilled trades. Three participants were respectively from the automotive, public administration, and chemical and pharmaceutical industries. Additionally, we recruited two participants from the following industries: energy, research and development, shipbuilding, and defense. Finally, one participant represented the logistics and food industries, respectively. Participants included 16 organizational hardware and software administrators, seven end users, six hardware or software developers, six external occupational safety experts (e.g., accident insurance representatives), and two augmented reality / smart glasses researchers. Table 1 provides an overview of participant characteristics.

A total of 20 participants took part in the focus groups on the topic of tablets and 17 on the topic of smart glasses. The focus group size varied, with an average of five participants per group. There was a higher representation of males, with thirty males and seven females participating. The ages of the participants ranged from 24 to 67 years, and their work experience ranged from 1 to 42 years.

4.3 Data Analysis and Definition of Selection Criteria

We performed qualitative data analysis using the VERBI Software (2021) MAXQDA Analytics Pro18 Portable for both the scoping review and the focus groups (for further details, see Haase et al., 2023). For consistency in coding, we conducted regular coding training sessions. We categorized physical and psychological risk factors from the literature and workshop protocols into codes corresponding to the work system elements defined by DIN EN ISO 6385 (Deutsches Institut für Normung, 2016). The work system elements encompass *work equipment*, *employees*, *work organization*, *work tasks*, and *workplace and work environment*. Afterward, we translated the risks and design requirements into the selection criteria for smart mobile devices by determining how organizations can avoid these risks when purchasing. We used the Jamovi software, Version 2.3 (2022), to process sociodemographic data.

Table 1: Participant characteristics (n = 37).

Focus group	Content	Participants (m, f)	Age in years (min – max)	Professional age in years (min – max)
1	Tablets	5 (4, 1)	49 (30 – 60)	21 (7 – 37)
2	Tablets	2 (2, 0)	46 (34 – 58)	22 (1 – 42)
3	Tablets	6 (6, 0)	35 (28 – 45)	5 (1 – 10)
4	Tablets	3 (3, 0)	34 (24 – 41)	6 (2 – 12)
5	Tablets	4 (3, 1)	60 (47 – 67)	34 (21 – 41)
6	Smart glasses	4 (2, 2)	49 (34 – 64)	16 (2 – 33)
7	Smart glasses	6 (5, 1)	36 (28 – 46)	9 (1 – 29)
8	Smart glasses	7 (5, 2)	45 (30 – 66)	13 (3 – 39)
		5 (30, 7)	44 (24 – 67)	15 (1 – 42)

Note: m = male, f = female, M = mean, min = minimum, max = maximum.

5 Results

The following section outlines the key selection criteria for smart mobile devices derived from the scoping review and focus groups. We cite selected literature references and participants' statements to support the relevance of the criteria.

5.1 Costs

Device Costs
Given the significant price differences between smart mobile devices such as tablets and smart glasses, initial purchase cost emerges as a critical factor in organizations' selection processes (DGUV, 2022; Klinker et al., 2021 b; Wölfle, 2014). By aligning device selection with their available budget, organizations can ensure adequate funds for providing necessary devices and supporting resources for their employees. The number of devices organizations want to procure is a significant factor in determining overall costs, as are expenses for replacing old or damaged devices.

Additional Costs
Organizations must account for associated expenses like training, technical support, and maintenance. One participant in a focus group highlighted the importance of monitoring ancillary costs with an analogy: „„Buying a Porsche is one thing, but affording the fuel later is another".

5.2 Physical Features

Environmental Resistance
Rugged, industrial-grade equipment is preferable to standard equipment in environments with high dust, humidity, or extreme temperatures (Aromaa et al., 2018; Krzywdzinski et al., 2022; Vorraber et al., 2020). Industrial-grade equipment inspires confidence in workers due to its reliability, as it is less prone to malfunctions or breakdowns, even when exposed to falls. For instance, a focus group participant mentioned, „You do not want to use highly sensitive HoloLens on a construction site where there is dust and dirt around". Another participant pointed out that in a medical context, for example, equipment must be easy to disinfect.

Device Weight and Size
The literature indicates that the device's weight and distribution on the body or head can affect discomfort, muscle tension, and pain (Gabbard et al., 2019; Gross et al., 2018; Hüer et al., 2020; Theis et al., 2016; Zhuang et al., 2019). In the focus groups, participants highlighted the importance of weight and compactness, including the battery, for ergonomics and carrying comfort, especially during extended periods of use. One participant noted that holding a 10-inch tablet becomes difficult after a few minutes. Another participant stated that two hours is „a long period" for smart glasses. It is, therefore, essential to select lighter and more compact models that are comfortable to wear for prolonged use of devices.

Wearability
The term „wearability" describes the comfort and practicality of wearing a device directly on or close to the user's body, implying that the employees can wear the device as an accessory. Wearable technology can enhance the range of motion and prevent interruptions in the workflow (Dennerlein, 2015; Kasselmann & Willeke, 2016; Kietrys et al., 2015). Smartwatches offer long-term wristwear, while smart glasses enable continuous headwear. Some smart glasses models even feature foldable displays for added convenience when not in use. Devices not affixed to the body, such as tablets, require employees to use suitable stands or holders to ensure ergonomic and safe handling.

5.3 Display Features

Display Positioning in or out of the Field of View
In certain situations, e.g., in monitoring operations, employees must keep their eyes on the task. Smart glasses prove to be advantageous in these contexts, as their display is positioned directly in the employee's field of view, thereby eliminating the need for the employee to divert their attention from the task at hand (Krzywdzinski et al., 2022; Sedighi et al., 2018). Nevertheless, in critical or safety-related situations, research indicates that peripheral vision is limited for all devices (Büttner et al., 2016; DGUV, 2015; Theis et al., 2016; von der Horst, 2022). The impairment of situational awareness (Wölfle, 2014) can increase the risk of accidents (Darius et al., 2015; Friemert et al., 2021; Mewes et al., 2020).

Display Size
The amount of information a screen can display, and the reading performance depends on its size (Atilgan et al., 2020; Dennerlein, 2015; Tegtmeier, 2018). Thus, larger screens can display more information. Small screens (e.g., on smartwatches) are suitable for displaying single words or numbers. At the same time, a greater volume of data, such as continuous text or complex images, requires larger screens (e.g., on tablets) (DGUV, 2015; Kirchhoff et al., 2016). As indicated in the focus groups, an insufficient large display can impede readability and usability, for example, when performing tasks requiring 3D visualizations.

Display Readability
The readability of the display is dependent on several factors, e.g., display brightness, ambient light illuminance, and surface reflection (Chen et al., 2017; Mewes et al., 2020). Difficult lighting conditions, such as bright or dark, require displays that maintain readability and avoid eye strain, for example by adjusting the ambient contrast ratio (ACR) or reducing glare and blue light conditions (DGUV, 2021 a; Mewes et al., 2020; Tegtmeier, 2018). The relevance of display legibility increases with age, as so-called „presbyopia" sets in from the age of 40, caused by a decrease in the elasticity of the eye's lens. In addition, older people require a higher level of illumination due to the increasing rigidity of the lens (Association of Metal Trade Associations, *Vereinigung der Metall-Berufsgenossenschaften* – VMBG, 2001). One of the main characteristics of smart mobile devices is their portability. Employees use them in different lighting conditions, e.g., when they move from indoor to outdoor. Therefore, focus groups and literature emphasized the importance of display readability across different environments.

3.4 Input and Output Options

Hands-free Capability
Smart glasses can display information directly in the field of view. This advantage is ideal for tasks that require workers to have both hands free (Kim & Choi, 2021; Weber & Buchkremer, 2021). Alternatively, accessories such as tablet holders can provide hands-free smartphone operation, although information is typically not presented directly in the field of view. The capability for hands-free operation is closely linked to the criterion of wearability.

Device Control Options
Different control options, e.g., touch, gesture, and voice, are appropriate for different tasks and employees. Voice control was the most frequently requested feature in the focus groups for using tablets and smart glasses. Without the need for typing, employees have both hands available for their tasks, potentially enhancing uninterrupted workflow and reducing typing errors (Przybilla et al., 2021; Wölfle, 2014). However, effective voice control requires familiarity with the voice commands and precise pronunciation (Schwantzer, 2018; Wölfle, 2014). Additionally, it is essential to recognize that voice commands may be constrained in the presence of customers, for instance, as this form of input is still less accepted in social interactions compared to touch control (Mack & Schmidt, 2019). In such social situations, in noisy environments, when employees are dealing with complex content or have limited language proficiency, they may benefit from using touch or gesture control (e.g., Huck-Fries et al., 2021; Loske & Kaspar, 2018; Wüller & Behrens, 2021).

Device Output Options
To prevent information overload, the device output (e.g., screen display, audio, vibration) should target different sensory organs different from those already engaged by the work or work environment. For example, voice output is less useful in a noisy environment than an on-screen display or a vibrating alert (e.g., Bitzer et al., 2019; DGUV, 2021b; DIN EN ISO 9241-129 (Deutsches Institut für Normung, 2011).

3.5 Alignment with Employee Needs

Device Familiarity
As stated in one focus group, choosing a class, brand, or operating system that employees are already familiar with can speed up the adoption and learning of new devices (Bitzer et al., 2019; Meske & Junglas, 2021; Mewes et al., 2020). One focus group participant reported, „It can be stressful and overwhelming for employees to learn entirely new systems".

Customization Options
Organizations should prioritize smart mobile devices adaptable to employees' needs and preferences, e.g., offering customization options like display and sound profiles and interaction options such as touchscreen or voice control. Smart glasses can offer customization options for mounting and display positioning for the dominant eye (Thomas et al., 2020). By customization, employees gain autonomy over their user experience, improving usability and hardware adoption (Aringer-Walch et al., 2018; Laun et al., 2022). Moreover, customization can support older employees and those with reduced performance capacities like visual, auditory or cognitive impairments (Apt et al., 2018; Evers et al., 2019; Minow et al., 2021).

3.6 Alignment with External Requirements

Alignment with Customer Requirements
Smart mobile devices should not interfere with interpersonal contact to customers and clients. Resistance or concerns towards smart mobile devices may discourage employees and customers from using them, potentially affecting satisfaction and overall success (Remmers, 2021; Khasawneh, 2018; Rasool et al., 2022). For instance, in a focus group with healthcare professionals, one participant reported that occasionally, patients feel frustrated and neglected when healthcare professionals use a tablet for documentation. Organizations may address these concerns, e.g., by opting for less intrusive technologies like voice con-

trol and voice-to-text. Furthermore, training employees in practical and empathetic handling and involving clients in documentation processes can be beneficial.

Alignment with Legal Requirements
Businesses must comply various regulatory requirements, including data privacy laws, product safety standards, accessibility standards, consumer protection laws, and health and safety regulations (*Bundesanstalt für Arbeitsschutz und Arbeitsmedizin* [BAuA], 2018; DGUV, 2009; BSI-Standard 200-1). Varadinek et al. (2018) summed up legal data protection requirements for adaptive work assistance systems. Furthermore, in the focus groups, participants highlighted the importance of smart mobile devices to follow the General Data Protection Regulation (*Datenschutzgrundverordnung*-DSGVO), especially when collaborating with customers.

3.7 Alignment with Other Work Equipment and Tools

Alignment with Other Devices
When selecting a device, it is crucial to consider its potential for interfacing with other devices and systems. A focus group in emergency services reported that the lack of interfaces between devices, such as tablets, electrocardiograms, card readers, and printers, hinders work processes and user-friendliness (Zakerabasali et al., 2021). Furthermore, organizations need to consider the handling of multiple devices. External devices can provide advantages and enhance ergonomics. For instance, an external keyboard allows for a more ergonomic typing position, resulting in greater efficiency and comfort when typing long texts than an integrated keyboard (Lugay et al., 2022; Emerson et al., 2021). Conversely, participants have reported that supplementary devices and accessories such as protective cases or card readers may impact device handling by adding extra weight or being perceived as cumbersome. Organizations should limit the number of devices employees use in their work, e.g., by selecting integrated systems like a tablet and card reader bundle.

For employees with disabilities, the device should support assistive technologies such as hearing aids or prosthetic limbs and integrate accessibility tools such as screen readers and braille displays (European Parliament, 2018; Krzywdzinski et al., 2022).

Compatibility with Safety Gear
The participants in the focus groups stressed the importance of ensuring that the device does not interfere with the proper use or comfort of safety gear, such as safety glasses, helmets, and gloves (Mewes et al., 2020). For instance, as one participant summarized, „Gloves and touchscreen – that doesn't fit".

3.8 Specifications

Hardware Performance
As found in the focus groups, the hardware should possess adequate performance (e.g., central processing unit-CPU and Random Access Memory-RAM), sufficient storage (e.g., hard disk), and adequate cooling (von der Horst, 2022). Poorly equipped hardware limits work tasks' efficiency, accuracy, and reliability, restraining employees from completing their work without interruptions or delays caused by hardware malfunctions (Carstensen, 2015; Müller-Thur et al., 2018).

Battery Performance
The battery features, such as battery power and charge time, depend on factors like the frequency and duration of daily use and power-hungry applications. Battery life that is too short or charging times that are too long can significantly hinder work processes and thus reduce device adoption (Büttner et al., 2016; DGUV, 2022; Khakurel et al., 2017).

3.9 Services and Support

Device Training led by Providers
Training and learning significantly influence device adoption and usage rates (Meske & Junglas, 2021; Paruzel et al., 2020; Wirth & Wache, 2023), making them pivotal in device selection. The format, frequency, and duration of training offered by the device provider or other sources can vary considerably. As highlighted in the focus groups, training and learning resources provided must be tailored to the organization's needs. Moreover, training opportunities for smart mobile devices must be easily accessible and usable by employees (D21-Digital-Index 2023/24; Merda et al., 2017), to prevent strain such as frustration, resistance to smart mobile devices, and stress experiences (Müller-Thur et al., 2018).

Support Provided for the Device
When selecting a device, it is crucial to ensure that it meets the company's requirements on the type of support needed, especially in the case of malfunctions or failures. Key aspects include the availability of help desk services via phone, email, or remote support and service level agreements, e.g., response time and uptime guarantee (Rösler et al., 2018; van Fossen et al., 2022). One focus group highlighted the importance of ensuring that the support team does not place organizations on hold for an extended period and that adequate language resources are available to the support team.

5.10 Additional Selection Criteria for Smart Glasses

The following section outlines the specific selection criteria for smart glasses, addressing their unique properties. These criteria complement the general selection criteria presented above.

Mounting
There are various ways to wear smart glasses, including head-mounted options, integration into safety helmets, combination with safety glasses, attachment to spectacle frames, and as standalone models. Wearing comfort, related to the fixation of smart glasses on the head, is frequently discussed in the literature (e.g., Rejeb et al., 2021; Wille et al., 2014). Congruent with the research, the focus groups showed how employees wearing smart glasses is an important factor.

Three-dimensional Depth Vision or Two-dimensional Vision
Monocular smart glasses have a display in front of only one eye, typically providing a 2D display, while binocular smart glasses have displays in front of each eye. Binocular smart glasses can enable spatial depth perception (Overmeyer et al., 2019).

Extent of Obscured Field
Organizations must assess the acceptable level of environmental obscurement caused by the smart glasses (DGUV, 2021; Kirchhoff et al., 2016; von der Horst, 2022). The extent of the obscured field depends on the frame type (e.g., full-rimmed frames, semi-rimmed frames), material transparency, and the display positioning (Klinker et al., 2021 b; Mewes et al., 2020; Theis et al., 2016). For instance, when tasks require employees to maintain an unimpeded field of view without obstructing their surroundings, organizations should opt for models with minimal rim or frame obstructions. Research indicates a realistic, acceptable minimum field of view in Augmented Reality Smart Glasses (ARSG) is 30 degrees horizontally (Syberfeldt et al., 2017).

6 Discussion

The objective of this article was to present a set of selection criteria for organizations when choosing a smart mobile device. Table 2 summarizes the criteria.

Table 2: Device selection criteria.

Device attributes	Device selection criteria
Costs	Device costs Additional Costs
Physical features	Environmental resistance Device weight and size Wearability
Display features	Display positioning in or out of the field of view Display Size Display Readability
Input and output options	Hands-free capability Device control options Device output options
Alignment with employee needs	Device familiarity Customization options
Alignment with external requirements	Alignment with customer requirements Alignment with legal requirements
Alignment with other work equipment and tools	Alignment with other devices Compatibility with safety gear
Specifications	Hardware performance Battery performance
Services and support	Device Training led by Providers Support provided for the device
Additional selection criteria for smart glasses	Mounting Three-dimensional depth vision or two-dimensional vision Extent of Obscured Field

The twenty-four criteria identified in the literature and focus groups underline the complexity of the selection decision. We will develop a device selection tool to facilitate the process for organizations.

6.1 Development of the Device Selection Tool

As a part of the *GBU-SmarD* project, we will integrate the selection criteria into a device selection tool. The focus groups highlighted the importance of the tool's practicality and accessibility so that we will organize the selection criteria in a practical format like a table, checklist, or decision tree. Furthermore, the focus groups indicated that the device selection and purchasing process often involves input from various individuals within organizations, including professionals with expertise in occupational health and safety, such as Health-Safety-Environment (HSE) specialists, and individuals without specific expertise in this field, such as ergonomic engineers, user interface experts, quality management professionals, and purchasing personnel. The design of the selection tool will reflect this diversity of users' knowledge and backgrounds.

6.2 Applying the Device Selection Tool in Practice

The tool will assist organizations in navigating the complexities associated with the procurement of smart mobile devices by addressing potential physical and psychological risks before the purchase. Nevertheless, three key considerations remain: First, the pre-purchase assessment does not release companies from needing a subsequent risk assessment. Organizations must still conduct a risk assessment after implementing the devices. However, this retrospective risk assessment will yield more favorable results if the procurement process targets physical and psychological risks in advance. Second, organizations need to prioritize and balance the proposed selection criteria. Some of the criteria are interconnected and may conflict. For example, a device's ruggedness might conflict with its weight, and display size may affect readability. These interconnections complicate selecting the optimal device. A comprehensive analysis of the organization's initial situation and a weighting of the relative importance of the selection criteria is essential to facilitate the best choice. Third, it is crucial that organizations involve future users for acceptance and high usage rates. Kane (2019) asserts that „people are the real key to digital transformation“. Employees can offer valuable insights based on their experiences with work equipment, which organizations should consider when selecting devices.

6.3 Limitations

By integrating research findings from the scoping review with practical insights from the focus groups, we were able to gain a comprehensive understanding of the potential physical and psychological risks associated with the use of smart mobile devices. However, our research also possesses certain limitations. First, we exclusively focused on smart glasses, tablets, and smartwatches without considering other smart mobile devices, e.g., smartphones, smart pens, hand scanners, pagers, or phablets. Second, we did not conduct a focus group with individuals who use smartwatches, as we could not identify suitable volunteer participants. Nonetheless, these limitations will not compromise the efficacy of the selection tool, as our research includes both a projection-based and a display-based device, making the results applicable to a broader range of devices. Third, this paper focuses on device selection, but it is equally important to choose the right software. Consequently, our selection tool will also address relevant software characteristics. Ultimately, our research captures the current state of technology. The rapid progress of digital technologies requires continuous research in this area and continuous adaptation of the device selection tool.

6.4 Conclusion

The device selection tool is a crucial component of the early implementation of workplace health and safety measures, which can help to mitigate risks associated with smart mobile devices. However, for organizations, device selection is only one step in the digitalization process, albeit a crucial one. The successful integration of smart mobile devices requires a change management process that includes a thoughtful digitization strategy and an employee-focused implementation plan. This plan should ensure the effective dissemination of relevant information to employees, provide appropriate training, and involve employee participation.

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