Automation, Collaboration, & E-Services

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Human-Automation Interaction

Manufacturing, Services and User Experience

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The Automation, Collaboration, & E-Services series (ACES) publishes new developments and advances in the fields of Automation, collaboration and e-services; rapidly and informally but with a high quality. It captures the scientific and engineering theories and techniques addressing challenges of the megatrends of automation, and collaboration. These trends, defining the scope of the ACES Series, are evident with wireless communication, Internetworking, multi-agent systems, sensor networks, cyber-physical collaborative systems, interactive-collaborative devices, and social robotics – all enabled by collaborative e-Services. Within the scope of the series are monographs, lecture notes, selected contributions from specialized conferences and workshops.

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Series Editor's Foreword

Our Springer ACES Series is delighted to welcome the unique three-book excellent collection of editors, chapter co-authors and contributors on Human-Automation Interaction. This collection includes:

- Human-Automation Interaction: Mobile Computing
- Human-Automation Interaction: Transportation
- Human-Automation Interaction: Manufacturing, Services and UX

When we consider COLLABORATION today, during the age of cyber-collaborative world and society, we cannot limit it any longer to human–human collaboration, the foundation and future of any human civilization. At the same time, we cannot ignore the fact that automation, while invented and implemented by humans, is made solely for the sake of humans. Hence, our essential need is to understand and explore the science, engineering and management of HAI, Human-Automation Interaction. After all, the purpose of interaction is collaboration. That is the theme defined by the committee for the Gavriel Salvendy International Symposium for Emerging Frontiers in Industrial Engineering. (The committee includes Robert W. Proctor, Chair; Vincent Duffy, Shimon Nof and Yuehwern Yih.) While during the pandemic years it could not be held in person, it was possible to engage many colleagues worldwide, who are the participants in this three-book important, collaborative endeavor.

Thanks again to all the participants and contributors, all of us who for many years have been inspired and learned from the leadership of Prof. Gavriel Salvendy. Thanks also to the Springer team, who supported the publication of these books. And welcome to all the many readers we invite to enjoy this exciting reading and exploration of HAI.

West Lafayette, IN, USA
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Shimon Y. Nof
Editor, Springer ACES Series

Preface

Human-Automation Interaction (HAI) has become present, and design considerations are now important in so many aspects of our lives. The themes of the three books are Transportation, Mobile Computing and Manufacturing, Services and User Experience (UX). This initiative is intended as a look toward the future and a tribute to our esteemed colleague, Gavriel Salvendy, who contributed to research literature and the infrastructure development in engineering, human factors and ergonomics over the past six decades.

We celebrate Prof. Salvendy's birthday this year with a compilation of articles in three main themes of *Human-Automation Interaction.* He reviewed and expressed interest in very many of the articles contributed this year. Over the past forty years, he has been the editor of handbooks and journals in areas of overlapping research interest with most of our contributing authors. Dr. Salvendy is the founding chair of Human-Computer Interaction International (HCII) and Applied Human Factors and Ergonomics International (AHFE) conferences.

As co-editors, we invited and appreciated the opportunity to interact with the authors that contributed chapters within the HAI theme of their interest. We look forward to sharing these articles with a general audience that has interest in human factors and ergonomics. We greatly appreciated the opportunity to celebrate international collaborations and contributors through this initiative. We are grateful to those who contributed to this special compilation of articles.

Papers from these volumes were included for publication after a minimum of one single-blind review from among the co-editors within the thematic areas. I would again like to thank the co-editors for their contributions, cooperation, support and efforts throughout. 109 contributing authors from 15 countries contributed 35 articles to the book. The authors and editors in this book are representing Australia, China, Egypt, Germany, Greece, Ireland, Italy, Japan, Malaysia, Nigeria, Norway, Portugal, South Africa, Switzerland and the USA.

The co-editors are Mark Lehto, Yuehwern Yih and Robert W. Proctor. The main parts for the HAI Manufacturing, Services and User Experience book are shown below:

Part One: Advanced Production Management and Production Control
Part Two: Healthcare Automation
Part Three: Measuring and Modeling Human Performance
Part Four: Usability and User Experience
Part Five: Safety Management and Occupational Ergonomics
Part Six: Manufacturing and Services
Part Seven: Data and Probabilistic Information
Part Eight: Training and Collaboration Technologies

On behalf of the co-editors

West Lafayette, IN, USA Vincent G. Duffy

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Advanced Production Management and Production Control

Future of Work and Work Systems: Machine Learning and Artificial Intelligence for Designing Smart, Safe, Healthy and Ethical Work in Financial Services

Joan Cahill, Vivienne Howard, Yufei Huang, Junchi Ye, Stephen Ralph, and Aidan Dillon

Abstract New technologies are being introduced to support the future of work in Financial Services (FS). This paper reports on human factors action research pertaining to the specification of a 'proof of concept' for a future 'Intelligent Work' (IW) system—predicated on advances in business process automation, artificial intelligence, and machine learning. It is argued that IW technologies should enable work that is smart, healthy, safe, and ethical. The implementation of IW technologies will be underpinned by positive change in relation to supporting wellbeing culture in financial services, and the integration of previously diverse processes and functions pertaining to business process management, customer services, human resources, occupational health and safety/health protection and health promotion.

Keywords Human factors · Ethics · Emerging methods · The future of work · Intelligent work · Healthy work · Triple bottom line · Operations management · Wellbeing culture

1 Introduction

Financial institutions are utilizing new automation-based technologies to improve business processes management, work and workforce management, and customer relationships. This includes Robotic Process Automation (RPA) technologies, Business process management (BPM) technologies, Digital Process Automation (DPA) technologies and Dynamic case management (DCM) technologies. These systems take a work/task focused perspective. Accordingly, the focus is on ensuring work

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items are delivered on schedule, and on optimizing productivity/efficiency. Overall, automation has been added without looking at the human role in the system, and in particular, issues pertaining to worker health and workplace wellbeing.

Advances in artificial intelligence (AI) and machine learning (ML) present new opportunities in terms of further enhancing business intelligence and resource management. However, such intelligence needs to be predicated on a rich understanding of the work, the business process, and the person (and/or team) delivering the work. In addition, many workers have concerns about how these new and future intelligent technologies will transform their role and the lived experience of their job. The recent experience of remote work arising from the COVID 19 pandemic has underscored the human and ethical issues surrounding work management, workforce surveillance and managing both formal and informal teamwork and communication.

New human centered business practices/operations practices are now being introduced. Such practices focus on fostering and maintaining a healthy workforce. Underpinning these approaches is the recognition that work is part of our wellbeing and a key driver of health. Following from this, the 'Intelligent Work' project seeks to investigates how automation and artificial intelligence technologies and workers can collaborate in a more efficient, intelligent, and humane way—to improve worker wellbeing and productivity, and by implication improve the company's revenue. This research is part of an academic and industry collaboration between researchers at Trinity College Dublin Ireland and Zarion Ltd. The research is funded by Enterprise Ireland (Irish government agency), as part of the Innovation Partnership Program (IPP).

This paper reports on the requirements for future work and associated 'Intelligent Work' technologies. First a background to the relevant literature is provided. The study objectives and methodology are then explained. Research findings are presented. The findings are grouped in terms of a series of themes spanning different evidence sources and associated phases of research. The emerging intelligent work concept and allied technology requirements are then presented and discussed. Lastly, some conclusions are drawn.

2 Financial Services, Operations Management and New Technologies

2.1 Work, Benefit Areas and Beneficiaries

Operational efficiencies (i.e., time and cost of work/human effort) are a key performance indicator (KPI) in Financial Services. However, as proposed in the 'Triple bottom line' accounting framework, other benefit areas must also be considered [1]. Critically, human activity (including work) should optimize benefits across the economic, environmental, and social pillars [1]. Further, business as responsibility to three stakeholder groups; employers, employees, and society [2].

2.2 Financial Services and Operations Management

Financial services refer to the economic services provided by the finance industry to manage money. This encompasses a broad range of businesses—for example, banks, insurance companies, stock brokerages, and investment funds. Work tasks are classified into two types—transactional work and knowledge work. Transactional work involves the processing of information related to a business transaction (or work item associated with a business transaction). Knowledge work denotes any kind of work that involves handling or producing information, as opposed to producing products or services [3]. It is associated with professions that involve producing unique knowledge such as decisions, analysis, problem solving, theory, strategy, planning, and design [3]. In principle, knowledge work is mostly undertaken by people, with some assistance from technical agents. Transactional work is undertaken by a person and/or a machine or robotic agent.

Operational management refers to the busines practices used by an organization to manage the production of good and services [4]. Typically, operations management focuses on ensuring that business operations are efficient (only using the resources needed) and effective (meeting customer needs) [4]. Although people management is part of managing resources and customer relations, human factors is not typically integrated in operations management strategies. In Financial Services, service delivery is structured in terms of a pre-defined set of business processes that deliver specific business and customer outcomes, and allied business value. Work is allocated to finite teams, to meet targets defined in an operations plan and client service level agreement (SLA). Each work item has a time allocation and due date. Supervisor's and operations manager's report on whether targets are met (linking to SLA's) and team productivity/efficiency and effectiveness metrics. Typically, worker health and performance shaping factors at individual and team levels are not considered both from a work allocation and work monitoring perspective.

2.3 Collaboration and Workplace Collaboration Technologies

Human behaviors associated with collaboration include communication, sharing information, and coordination. Worker collaboration behaviors occur both in real time and asynchronously. With the introduction of technical assistants and robotic agents, collaboration includes both human/human interaction and human/machine interaction.

The field of group supported co-operative work and collaboration technologies concerns the 'support requirements of cooperative work arrangements' [5]. Specifically, it looks at how technology can be used to support and enhance collaborative behavior.

2.4 New Technologies in Financial Services

Financial institutions are utilizing new technologies (including machine learning and artificial intelligence) which enables them to manage their business processes, their workforce, and customer relationships. The technologies can be classified into four overall types—Robotic Process Automation (RPA) technologies, Business process management (BPM) technologies, Digital Process Automation (DPA) technologies and Dynamic case management (DCM) technologies.

RPA technologies use artificial intelligence to handle repetitive, rules-based, back-office tasks. Simple work items are managed by RPA agents or 'bots' providing full automation for repetitive tasks [6]. In some cases, RPA agents act as 'task assistants' providing feedback to business process operations managers and team supervisors as to the status of work, and what tasks to prioritise [6]. Business process management (BPM) technologies are systems which monitor and control the development, progress, and conclusion of processes [7]. Digital process automation (DPA) is a method of automation that uses software to perform processes and automate tasks with the goal of completing and optimizing a workflow [8]. DPA focuses on automating, or partially automating, tasks involved in a variety of business practices that typically need some form of human interaction [8]. DPA is considered an evolution of business process management (BPM). Dynamic case management (DCM) is the handling of case-related work using technologies that automate and streamline aspects of each case [9]. Many argue that DCM is like business process management (BPM) insofar as it works to improve task management and workflow [9].

3 Wellbeing and Managing the Person in the Workplace

3.1 Wellbeing, Mental Wellbeing at Work, Quality of Life and Work-Related Stress (WRS)

As proposed in Engel's 'biopsychosocial' model of health and wellbeing, a combination of physical, psychological, and social factors (including working conditions) contribute to a person's health and wellbeing [10].

The concept of 'quality of life' (QOL) is related to wellbeing. Multiple factors play a role in QOL. QOL indicators include wealth/financial security, employment, recreation and leisure time, education, family life, physical and mental health, safety, security, and freedom [11, 12]. The 'Better Life Index (2021) defines QOL in relation to 11 factors including work life balance [13].

Mental wellbeing at work is determined by the interaction between the working environment, the nature of the work and the individual [14]. Work has an important role in promoting psychological wellbeing. However, it can also have negative effects on mental wellbeing, leading to stress.

Work Related Stress (WRS) is the negative response people have to excessive pressures or other types of demands placed on them at work. As argued by Cox and Griffiths (2005), to understand WRS we must consider both (1) context to work factors and (2) context of work factors [15]. Context to work refers to potentially hazardous conditions (i.e., organisational culture, role in organisation, career development, decision latitude and control, interpersonal relations at work, home/work interface) [15]. Context of work concerns potentially hazardous demands (i.e., work environment and equipment, task design, workload/pace of work, work schedule) [15].

A 2014 National Institute for Occupational Safety and Health (NIOSH) report revealed that 40% of Americans say their job is "very or extremely stressful," and 29% are "quite a bit or extremely stressed at work," and 75% believe that workers today have more on-the-job stress than people did a generation ago [16].

Workers are not immune from common mental health problems such as anxiety and depression. At any given time, one in six working-age adults have symptoms associated with mental ill health [17].

3.2 Managing the Person in the Workplace: Organizational Functions

In an occupational setting, workers need to be fit for work and capable of performing the tasks assigned to them. Equally, the workplace needs to be a healthy and safe environment for workers. Workforce management spans several processes and functions such as Human Resources, Occupational Health and Safety and Health Promotion.

Human Resources (HR) concerns the management of the employee lifecycle in the organization. This relates to recruitment, training, performance management, promotion, and career development, maintaining employee records, managing disputes and discipline issues, managing benefits, and managing payroll.

Occupational health and safety address the principles of assessment and management of hazards and risks, at the workplace level. The International Labour Organization (ILO) and the World Health Organization (WHO) define occupational health in relation to three objectives. "These are (1) the maintenance and promotion of workers' health and working capacity; (2) the improvement of working environment and work to become conducive to safety and health and (3) development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings" [18]. Further, the ILO and WHO define working culture as "a reflection of the essential value systems adopted by the undertaking concerned [18]. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking" [18].

The Centre for Disease Protection and Control (CDC) locate the workplace as a key site for health promotion [19]. In explaining this, WHO propose the concept of a Healthy Workplace (HW) [20], and a 'Health Promoting Workplace' [21]. WHO define a 'healthy workplace' as one in which both physical and psychosocial risks are managed [20]. Psychosocial risks include excessive workload, lack of role clarity and poor communication with managers (EU-OSHA) [22]. A 'health promoting workplace' (HPW) "ensures a flexible and dynamic balance between customer expectations and organizational targets on the one hand, and employee skills and health needs on the other, which can assist companies and work organizations to compete in the marketplace" [21]. The management of psycho-social risk is also emphasized in the new international standards on psychological health in work [23] and safe work during the COVID 19 Pandemic [24].

Many organizations have developed workplace wellness programs to improve employee wellness. According to Goetzel and Ozminkowski workplace wellness is any workplace health promotion activity or organizational policy designed to support healthy behavior in the workplace and to improve health outcomes [25].

As noted by Hymel et al. [26], health protection and health promotion functions within an organization often act in silos [26]. Hymel et al. [26] propose a new concept, "Workplace Health Protection and Promotion,". This concept seeks to integrate these two previously separate functions [26]. So defined, "health promotion interventions contribute dynamically to improved personal safety in addition to enhancing personal health, while occupational safety interventions contribute dynamically to improved personal health in addition to enhancing personal safety" [26].

3.3 Teamwork, Engagement, Job Control and Flow

The concepts of teamwork, engagement, job control, and flow provide insights into certain core dimensions of worker wellbeing, and how it links to human performance in the workplace, along with the business case for wellbeing.

Teamwork involves the collaborative effort of a group of individuals in relation to achieving a common goal. McGrath [27] defines three high level team functions. These are production, wellbeing, and support [27].

Employee engagement is considered a psychological state (or state of mind) experienced by employees, evidenced by three core behaviors. These include vigor, dedication, and absorption [28]. Employee engagement is an important predictor of organizational performance [29, 30]. According to Gallup, more than 60% of the workforce is "not engaged" [30]. Such workers are doing their job, but not giving anything extra. According to Gallup, another 24% are "actively disengaged" [30]. This is described as 'wandering around in a fog', or 'actively undermining coworkers' [30]. Gallup estimates, for example, that for the U.S., active disengagement costs US$450 billion to $550 billion per year [30].

The level of control that an individual has over their work is a key factor for psychological health. As proposed in the 'Job Design Model' (JCM) job features such as skill

variety, task identity, task significance, feedback, and task autonomy are enriching and thereby motivating, characteristics of work [31]. The theory hypothesizes that job enrichment produces a range of positive employee and organizational outcomes. These include high-internal work motivation, higher quality work, increased job satisfaction, reduced absenteeism, and lower staff turnover.

As defined by Csíkszentmihályi [32], flow state is the mental state in which a person performing an activity is fully immersed in the activity [32]. A flow state can be entered while performing any activity including work. When there is little communication of feedback, an employee may not be assigned tasks that challenge them or seem important, which could potentially prevent an opportunity for flow [32, 33].

3.4 Business Case for Wellbeing

The business case for investing in employee wellbeing is well established. The direct cost of poor health is estimated at about 15% of payroll [34]. But the cost of presenteeism—being physically on the job but not performing due to poor well-being, costs organizations even more than absenteeism [34]. Taken together, direct healthcare and the cost of productivity lost to presenteeism can total between 25 and 35% of wages [35].

4 Human Factors, Ethically Responsible Technologies and Stakeholder Evaluation Methods

4.1 Human Factors

As defined in ISO 6385 [36], the discipline of human factors (HF) and ergonomics refers to 'the practice of designing products, systems, or processes to take proper account of the interaction between them and the people who use them' (2016). Human factors approach follows a 'socio-technical systems design' perspective. Central to this is the recognition of the interaction between people/behavior, technology/tools, work processes, workplace environments and work culture [37].

4.2 Ethics, Digital Ethics and Ethically Responsible Technologies

Roboethics concerns the moral behavior of humans as they design, construct, use and treat artificially intelligent beings [38]. Digital ethics or information ethics deals

with the impact of digital Information and Communication Technologies (ICT) on our societies and the environment at large [39]. As argued by the IEEE Standards Association, new technologies should improve the human condition and prioritizes wellbeing [40]. Further, the IEEE Global Initiative argue that 'the world's top metric of value (Gross Domestic Product) must move beyond GDP, to holistically measure how intelligent and autonomous systems can hinder or improve human well-being' [40].

4.3 Stakeholder Evaluation and Human Factors Methods

'Stakeholder evaluation' is the gold standard for human factors action research pertaining to new technology development. The objective is to elicit the perspectives of those who have a "stake" in implementation/change. Stakeholder evaluation methods seek to involve the participation of both internal and external stakeholders. Internal stakeholders (IS) include the project team. As outlined by Cousins [41] and Wenger [42] the 'Community of Practice' is the shared space in which both IS and ES come together to ideate, define, develop and evaluation the proposed solution. Human Factors action research methods are commonly used to support this process.

New technologies have the potential to deliver benefits. However, such technologies are inherently uncertain. As part of new product development, researchers must consider and evaluate the human and ethical implications of things which may not yet exist and/or things have potential impacts which may be hard to predict [43]. Cahill [43] argues that human factors and ethical issues must be explored in an integrated way [43]. The 'Human Factors & Ethics Canvas' introduced by Cahill combines ethics and HF methods, particularly around the collection of evidence using stakeholder evaluation methods [43].

5 Research Project and Methodology

5.1 Introduction and Objective

The objective of this project is to advance a 'proof of concept' for a future work management system. The human factors approach has involved building an evidence map [44] in relation to requirements for the proposed technologies, the human factors and ethical issues pertaining to the introduction of these technologies, and the business case for these technologies. To date, this research involved has concept ideation and validation with conceptual prototypes. Actual technologies have not been advanced.

As indicated in Table 1, a combination of human factors action research methods and business analysis methods have been used. This includes interviews [45], survey

Table 1 Overview of research methods used

#	Method	Details
1	Interviews	Product team interviews/IS (N = 2) Interviews with Zarion staff/IS (N = 6) Interview with ends users/ES (N = 3)
2	Workshops	Product demonstration and review workshop (workshop 1/IS, N = 4) Modelling the proposed IW concept workshop (workshop 2/IS, N = 7) Evaluating the proposed IW concept workshop (workshop 3/IS, N = 7) Using Data workshop (workshop 4/IS, N = 10) Business Case workshop (workshop 5/IS (N = 10) Implementation, Ethics and Acceptability workshop (workshop 6/IS, N = 10) Final Specification and Implementation workshop (workshop 7/IS, N = 10)
3	Survey	Survey with end users (N = 50)
4	Data analysis	Data analysis (deidentified data)
5	Combined interview/Codesign and evaluation	Co-design/evaluation/ES (N = 15)

research, participatory co-design evaluation [46], stakeholder workshops (mix of evaluation and participatory foresight activities) and data assessment (i.e., analysis of company performance data). Table 1 provides an overview of these methods. Specific methods were applied over eight phases of research activity and involved the participation of both internal stakeholders (IS) and external stakeholders (ES), who participated in a 'community of practice'. As the research progressed, the findings of each phase were triangulated, to further develop and validate the evidence map.

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the School of Psychology, Trinity College Dublin. All field research conducted online in accordance with COVID 19 health and safety guidelines—as defined by the Health and Safety Authority, Ireland), and the definition of safe data collection, as defined by the School of Psychology, Trinity College Dublin.

5.2 Overview of Research Phases

Stage 1

The first stage of research involved a review of the existing product. This comprised two stages: (1) a product demonstration and human factors review with the product manager at Zarion (IS, N = 2), and (2) a follow up review of the product and specific

work monitoring and allocation processes with key technical staff at Zarion (IS, N = 4). This review was used to identify potential human factors gaps with the existing technology, to define the problem statement, and to define the target personae and scenarios for the emerging proof of concept. This approach combined the scenario-based design approach used by Carroll [47], with personae-based design approaches as defined by Pruitt [48]. Appendix 1.1 provides an example of the preliminary scenarios.

Stage 2

Stage 2 involved the preliminary human factors and ethics assessment, linking to the first three stages of the 'Human Factors & Ethics Canvas' [43]. As part of this, expected benefits, consequences (positive and negative) and overall impact in relation to three core benefit areas (i.e., triple bottom line—people, profit, and planet) for key stakeholders was defined. This was undertaken with the Product Manager.

Stage 3

The third stage of research involved analysis only. A preliminary analysis and specification of the IW concept and high-level system requirements was produced. Further, key states to be achieved, mitigated/managed and avoided for relevant personae were defined. In addition, key process states, organizational states and customer states were defined. For an example of team member and supervisor states, please see Appendix 1.2 and 1.3.

Stage 4

Stage 4 involved mapping the problem space and further specification/validation of the emerging IW concept and and associated system requirements. Six interviews were undertaken with IS (i.e., employees of Zarion). Interviews reflected a range of skillsets and knowledge of the existing product and customer requirements. This spanned roles such as sales, solutions consultant, technical architect, customer service and product manager. In addition, three interviews were conducted ES. This included two operations managers and one team supervisor.

The combined interview results were analysed. Following from this, the IW system requirements were refined and further specified. In parallel, low fidelity prototypes for two proposed tool concepts were advanced. This included (1) My work (task assistance/performance tool for team members) and (2) Allocate (automated work allocation tool, and task support for team supervisors and operations managers). The high-level requirements for (3) a reporting/analytics tool were also defined. However, a prototype for this tool was not advanced. The prototypes were developed to instantiate the high-level requirements and to support further user product ideation, requirements specification and validation activities.

A follow up workshop (workshop 2/IS, N = 7) was then conducted with the project team and IS (i.e., those who participated in the interviews), to examine the combined analysis of the findings of interviews with both IS and ES and the emerging system specification. The researcher performed a walk-through of the prototypes for the two tool concepts, and participants feedback was elicited. This feedback was then used

to further define the IW concept and associated prototypes. Certain aspects of the workflow were elaborated and modified, and additional functionality was added.

Lastly, an anonymous online survey was developed in Qualtrics. The survey posed questions in relation to existing use of automation/task support tools in work, sources of WRS, the future of work, the requirements for improved tools to support the future of work, and the experience of remote work during the COVID 19 pandemic. Further, it posed specific questions regarding the use and acceptability of specific functions associated with the (1) My Work and (2) Smart Allocation tools. This survey was shared with Zarion customers. The survey was completed 50 participants, and the preliminary feedback was analysed.

Stage 5

Stage five involved further product ideation, prototype development and evaluation. The prototype was further refined and developed, following an analysis of survey feedback. A third workshop was undertaken with the product team and those IS who had participated in the stage 3 interviews (workshop 3/IS, N = 7). As part of the workshop, the latest iteration of the IW concept was presented to participants and feedback obtained. Further, participants reviewed the product prototypes. Again, participant feedback was used to further refine the IW concept and allied system concepts, functions, and user interface/design requirements.

Following this fifteen combined interviews and participatory co-design sessions were undertaken ES. 14 of the 15 participants were existing users of the existing Zarion work management platform. In advance of the workshops, participants were sent a briefing about the IW concept along with screenshots for the two prototypes and a summary description of functionality. During the session, participants were first asked about the overall role, requirements for intelligent work tools and how future work tools might support healthy work. Following this, the researcher presented the prototypes for the two tools. Participants were then asked to provide feedback around specific product features and functions, including issues pertaining to acceptability and ethics. This feedback was used to further refine the product concepts.

Stage 6

An anonymous data set (total of 117,452 records) reflecting operations at an insurance company over a specific time-period was interrogated to understand and identify strategies for better work allocation and management and associated requirements for the proposed IW system. The data was analyzed at three levels—(1) activity/claims level, (2) individual level, and (3) team level. In relation to (1), the relationship between activity complexity and claims productivity (no of claims processed) was explored. In relation to (2) the relationship between activity complexity and workload, work diversity, and teamwork rate was investigated. Lastly, in relation to (3), the relationship between productivity and individual/team location, team size, days worked, and work diversity was examined. Following the data analysis, a report was produced to documenting the data analysis findings, along with implications of this analysis in terms of potential smart allocation product features.

Stage 7

Stage 7 addressed three overall areas, (1) technology roadmap and implementation, (2) business case, and (3) final ethics assessment. Four workshops were undertaken with IS only. The first investigated the use of data to enable smart allocation (workshop 4/IS, N = 10). The second examined the business case for the proposed software platform (workshop 5/IS (N = 10). The last two workshops addressed implementation, ethics and acceptability (workshop 6/IS, N = 10, workshop 7/IS, N = 10).

In relation to the implementation workshops, storytelling and narrative techniques were used to capture the future 'implementation story' for the proposed intelligent work platform. The future 'implementation story' had a high-level tagline, a plot, a context/setting, key characters, and an ending. Participants were invited to define a series of stories reflecting the goals the of the IW tools, and how they might be implemented in the short term, to address specific stakeholder needs. As part of this, participants were invited to consider two taglines and associated plots. These reflected a summary of the research findings. These were: (1) "Move from task to people centric", and (2) "The organization gets the right balance, the customer get the right balance and the people get the right balance". The combined stories were documented, for the purpose of recording a potential future implementation strategy—to be validated with ES/future users of the technology.

Stage 8

The last stage of research involved a thematic analysis of the findings of the interview and combined interview/co-design data, with both IS and ES. This spanned specific interviews in research phases 4 and 5. Two phases of analysis were undertaken. First, response data were aggregated and reviewed to identity the level of consensus across internal (IS) and external stakeholders (ES) as regards specific themes which arose in this research. As part of this, a data frame was developed to reflect the core project themes along with emergent themes. In the second phase, word frequency calculations were carried out on the dataset in relation to these same themes. Words with greater than 5 characters were tallied. This resulted in a specification of a set of overarching themes, relevant to the technology specification. Following this, a final specification of requirements for the Zarion intelligent work platform was produced.

6 Results

6.1 Introduction

This section presents the combined findings from the different research phases and sources of evidence. The results are presented in terms of a series of themes, as defined in Table 2.

Table 2 Themes and evidence

#	Themes	Evidence					
		Initial interviews (IS) (N = 8)	Initial interviews (IS) (N = 3)	Survey (ES, N = 47)	Data analytics (N/A)	Co-design/interviews (ES, N = 15)	Final workshops (IS, N = 40)
1	Job satisfaction and WRS	Y		Y		Y	
2	Types of work and reporting	Y	Y			Y	Y
3	Healthy work	Y	Y			Y	Y
4	Roles and key requirements	Y	Y			Y	Y
5	Performance management, monitoring and Measurement	Y	Y			Y	Y
6	Productivity, workload, task diversity and task complexity				Y		
7	Future of work	Y	Y	Y		Y	Y
8	IW concept	Y	Y	Y		Y	Y
9	Addressing wellbeing in the design of future systems	Y	Y	Y	Y	Y	Y

(continued)

Table 2 (continued)

#	Themes	Evidence					
		Initial interviews (IS) (N = 8)	Initial interviews (IS) (N = 3)	Survey (ES, N = 47)	Data analytics (N/A)	Co-design/interviews (ES, N = 15)	Final workshops (IS, N = 40)
10	Positive and negative impacts, unintended consequences and unknowns	Y	Y			Y	Y
11	Implementation	Y	Y			Y	Y

6.2 Job Satisfaction and WRS

Of those survey, 66% stated that they were satisfied with their job. 45.45% find their job stressful now and again. Respondents reported the greatest challenge to be unclear process (11.65%). This was followed by long working hours (9.71%). Three different sources of stress were ranked joint third. This are: pressure to meet deadlines, repetitive work, and the commute to work (all 7.77%). Interviews with ES (Operations Managers and Team Supervisors) indicates that managing people continues to be a significant challenge. Further, the management of front office staff can be more challenging. Such staff interact with customers. At times, the working day can involve interaction with several demanding customers and/or customers with complaints. This can be a source of considerable stress for staff and impact on morale and wellbeing. Further, it was noted that since the onset of COVID, front office staff are interacting with customers from home. Managing the home/work interface, and specifically an unhappy customer can be more challenging, when staff are also juggling responsibilities at home (for example, minding young children).

All employees are subject to WRS and challenges in term of their working conditions and environment. If team supervisors and operations managers are not supported by management, in relation to managing capacity, workload/resource and training issues, this can make their job very stressful.

6.3 Type of Work and Performance Picture

Currently, allocation systems tend to focus on transactional work. The combined feedback from user interview (IS + ES), and the interview/co-design sessions indicates that all work (i.e., both transactional and knowledge work) involves a range of work types including (1) information review (e.g., emails and documents), (2) customer interaction, (3) work team interaction (i.e., attending meetings, problem solving, knowledge sharing, coordinating work), (4) job mentoring and (5) providing formal and informal assistance to team members. Time estimates for work item allocations need to reflect the scope of work. In relation to knowledge work, this there needs to be particular attention to (3) and (5). Organizations need to find an appropriate way to measure the impact of knowledge work. This might include metrics in relation to influence over customer retention, minimizing exposure to risk, and improving knowledge and/or process design at an organization. Such measurement and tracking might be undertaken by future AI technologies.

6.4 Healthy Work

Interviews with ES indicated a lack of clarity as to the meaning of 'healthy work', as compared with IS. Overall, it seems that 'healthy work' is a relatively new term within Financial Services. Both IS and ES approached a definition of healthy work, in relation to the management and avoidance of work-related stress and promoting positive wellbeing in work (including psychological/emotional wellbeing in work). Many provided examples of sources of stress (for example, poor communication with managers, unrealistic deadlines, excessive workloads, and unclear processes) and unhealthy behaviors (for example, working additional hours, not taking breaks, and not looking for help) which make both work and the work environment unhealthy. There was a general awareness of practices to support healthy work—for example, corporate wellness programs and employee assistance programs. In many cases there was considerable cynicism towards company wellness programs. Many participants reported that while providing access to healthy food, opportunities for exercise or attractive social spaces for colleagues to congregate is nice, it does not tackle endemic workplace health issues such as imbalanced and unrealistic workloads or unhealthy team communications. Overall, participants responded very positively towards the possibility of regulating sources of WRS associated with work allocation (for example, imbalanced workloads and unrealistic deadlines) via new IW technologies.

6.5 Roles and Key Technology Functions/Requirements

In relation to Team Members, the key requirements include to (1) provide easy access to all information relevant to a work item, (2) to provide proactive notifications around work items that are due (i.e., intelligent work item queue), (3) to provide visibility on high priority work items, (4) to support teamwork and communication with other team members and team supervisors, (5) to provide visibility on team allocations/assignments and (6) to support work coordination.

In relation to Team Supervisors and Operations Manager, the systems should (1) enhance work allocation/matching so that workload is balanced and there is sufficient variety in work, (2) support coaching of Team Members—in relation to managing workload, managing challenges and or complexity linked to the completion of a work item/transaction, health in work and career advancement, (3) provide feedback on how Team Members are managing the job and any challenges experienced, (4) provide oversight on work allocation and matching to team member abilities/competency, experience, and preferences, (5) provide real time visibility on the volume and status of work, (6) support capacity forecasting, (7) support training needs analysis and (8) provide data which can be used to support rewards/recognition, career coaching and career progression.

6.6 Performance Management, Monitoring and Measurement

All participants noted that although most people do not like monitoring, it is necessary from the perspective of managing delivery of service. Further, monitoring practices when used correctly should highlight the positive contribution of employees and ensure fairness in work (i.e., in relation to workload, task complexity and task variety).

In relation to work monitoring, it is important that that monitoring activities focus on the right data points. There is a tendency to use standard measures such as number of completions (i.e., finished work items) and productivity. These measures do not inform Supervisors and Operations Managers about the quality of work and can be misleading. Further, in most cases, metrics related to team interactions, the quality of teamwork and formal/informal mentoring are not captured. Teamwork and mentoring have an important role both in relation to work quality and worker morale and needs to be factored into performance evaluations.

On site and strict monitoring does not equal higher productivity. Workers can self-manage themselves remotely with support from their supervisors and automation. Further, productive teamwork is enabled by team members and supervisors having visibility on what work different team members are working on, and any challenges they are experiencing. In this way, performance monitoring and feedback processes, should enable both individuals and teams to do their best work, and obtain task assistance where required.

However, participants reported that being more independent requires greater levels of honesty (how managing workload), proactivity (frequently updating managers about work challenges, what is coming down the line etc.), better interpersonal skills and a greater degree of empathy to compensate for the dearth of physical proximity.

6.7 Productivity, Workload, Task Diversity and Task Complexity

As indicated in the analysis of the insurance dataset, there is a relationship between workload and productivity. Busy people (i.e., those with a higher workload) get more work done (are more productive). Further, there is a relationship between productivity and task diversity. Workers with high productivity rates were found to be involved in tasks with higher diversity levels (i.e., variety in work) and more complex tasks. This creates a brief for smart allocation technologies—allocation rules should be premised on a model of the 'sweet-spot' for workload, task complexity and task variety. Further, the system should continuously monitor this at an individual level, to ensure the allocations reflect what is known about the person (i.e., tweak the allocation to reflect the sweet-spot' for that person).