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Preface of the publisher

20. Journal for Facility Management: Science meets Practice

The year 2020 started as usual, and then, mid of March, everything was different. From one moment to the next flying, meeting, seeing friends was almost impossible. A lot of studies envision COVID-19 as a game changer. I consider the pandemic as an accelerator. Existing trends and challenges were speeded up or made visible due to the pandemic.

New ways of working were already a hot topic in the last years. We could see a lot of discussions how the new office should look like. There was already a discussion, if and how to include home office in the new work environment. Due to COVID-19 companies were forced to use home office. Home office was the only way to enable business continuity. But companies also learned that they have to enable their employees to work from home. The first steps were to enable access to documents from everywhere and video conferencing as physical meetings were not possible at all.

Years ago, Diane Coles Levine was already giving a presentation on activity-based working and the enablement of home office at the IFM congress in Vienna. At this time, she was with a large health care insurance provider in the Bay area. She stressed the importance of setting up home office in a right way to secure data security and work life balance. But she also described the limitation of home office. For example, her company limited home office to two days per week to secure social binding, learning and interaction.

COVID-19 made these difficulties more visible than before. Working from home kept the business running, but social binding was lost or not build up. How to gain trust when you do not know people and you have no possibility to meet in person? Onboarding without physical meeting? Teaching on distance? How could a fair deal regarding costs and efforts look like? How to secure work life balance?

Also, digitalization of the core business was speeded up by COVID-19. Offerings had to be made to the clients via the web, as shops were closed down totally. Clients were accepting or better had to accept these new ways of interaction and procurement to fulfil their demands.

A lot of challenges. Therefore, this issue of Journal für Facility Management provides you with insights into the development of the industry and workplace management:

- The Upwards Trend of the Outsourced Facility Service Industry in Germany and Austria
- How do people from different generations approach work? Implications for workspace design

- New World of Work characterized by the digitalization and flexibility. Change Management and Facility Management at the heart of change.
- Implementation of a virtual occupancy sensor for smart building support

The last worldwide economic crisis happened after 2008. The first paper shows that according to EU statistics the FS industry grew faster than the rest of economy in Germany and Austria between 2008 and 2016 in terms of value added and full-time equivalents. In Germany, there were no decreases for any FS activities in terms of profits, value added, personnel costs or wages. This points out that this industry supported the economic recovery after 2009.

The second paper makes a connection between the Sustainable Development Goals (SDG) and the meaning of work for the motivational theory. The authors performed a field study to find solutions for the multi-generational environments fostering skill and experience sharing. The solution takes care on cultural identities and changes in motivational patterns.

The third paper covers the effects of changes of physical workplaces triggered by trends like digitalization and flexibilization. As the world is Volatile, Uncertain, Complex, Ambiguous (VUCA) Facility Managers are to support new way of working, collaborative work and activity-based working (ABW) strategies with real and virtual office concepts understanding psychological and sociological interactions between people and space. Co-operation of FM, HR and IT is necessary to achieve workspaces fostering networking, interconnection and health. Mere cost reduction is not enough anymore.

The last paper provides more insight in predicting occupancy patterns. Having access to either real-time presence data or patterns extracted from historical data is particularly valuable when dealing with facility design. The paper proposes a cost effective and privacy-preserving method to extract the occupancy information. By aggregating semantic knowledge, motion sensor data and data from dwelling entrance doors, a robust virtual occupancy sensor has been developed.

These articles are giving answers to day-to-day problems for the time after COVID-19 that we need to be prepared for. At this point, I want to thank all international researchers who sent us numerous abstracts and papers for the double-blind review. The decline rate was kept high with more than 50%. The high-quality research handed in enabled us to increase the quality of the IFM journal over the last years. Thanks for your help, and we are looking forward for your future support. I also want to thank the members of the editorial and the scientific board for their terrific work. They supported me in reviewing first the abstracts and then the full papers and gave a lot of input to the authors.

The high decline rate, the high reputed members of the editorial and the scientific board and the supporting universities ensure that the articles are not only having a high scientifically quality, but also that practitioners can put them into practice easily.

I also want to thank my team, especially Larissa Locsmandy und Mag. Barbara Gurdet. Without their personal engagement, the journal would not be available in this high quality.

I wish you all the best from Vienna, an enjoyable read, a lot of input for your research and/or for your daily work. I look forward to a lot of new abstracts and papers for the next call for papers for the 14th IFM congress 2021.

Stay healthy,

Alexander Redlein

Head of Editorial Board

To my family: Barbara, Caroline Sidonie und Alexander David

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Vielen Dank an alle KollegInnen des IFM für die Mithilfe bei der Organisation!

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Science meets Practice I:

Strategy and Workplace

New World of Work characterized by the digitalization and flexibility. Change Management and Facility Management at the heart of change.

Mag. Ing. Roland Skreta Akad. FM.

Österreichische Galerie Belvedere

Abstract

This systematic review covers the effects of changes of physical workplaces triggered by trends like technology 4.0, digitalization and flexibilization. The world is going VUCA – Volatil, Uncertain, Complex, Ambiguous – and there have to be found the suitable working spaces. The impact of the COVID-19 pandemic on work life shows us that changes can reach out without premonition. Work isn´t bound to space and time schedules any more, it takes place where and when it best fits – theoretically 24/7.

Facility Managers and Facility Management (FM) departments are challenged to support new way of working (NWW), collaborative work (CW) and activity based working (ABW) strategies with real and virtual office concepts. At the same time FM has to understand and face the psychological and sociological interactions between people and space in the time of transition. Active change management and an open minded communication and feedback culture are key factors to a modern FM and office design strategy. Facility Management in leading position needs to join forces with the internal service departments like HR and IT and external designers to achieve the planning and realization of complex tailor fitted workspaces.

Networking, interconnection of knowledge, promotion of informal communication, design of healthy and motivating workplaces drives mere office cost reduction and space efficiency programs into the background.

Keywords: New Ways of Working, Corporate Culture, flexible Arbeitswelten, Digitalisierung

1. Einleitung

Diese wissenschaftliche Arbeit stellt einen Ausblick auf neue Arbeitsformen und Bürowelten im Zeichen der Digitalisierung und Flexibilisierung vor. Change Management (CM) als Beitrag zur erfolgreichen Bewältigung zum Teil massiver Veränderungen und Facility Management (FM) in seiner Funktion zur Steuerung der sekundären Prozesse stehen im Schnittpunkt des Wandels der Arbeitswelten.

Die aktuelle COVID-19 Pandemie führt uns vor Augen wie rasch sich Arbeitswelten ändern können. Selbst traditionelle, konservative Unternehmen müssen sich dem Thema Homeoffice und neuen den Kommunikationswegen mit Belegschaft und Kunden stellen. Der Autor dieser wissenschaftlichen Arbeit, die vor den dramatischen Auswirkungen der Pandemie verfasst wurde, untersucht das Thema Neue Arbeitswelten, und die Auswirkungen und Veränderungen denen sich das FM innerhalb der Organisationen stellen muss. Dieser Wandel wird durch den Megatrend Digitalisierung und Flexibilisierung der Arbeit getrieben.

Wie wird dieser Wandel in Organisationen begleitet? Werden diese Veränderungen durch CM Programme aktiv unterstützt, oder werden Arbeitsplatzkonzepte ohne gründliche Planung rein technisch umgesetzt?

Themen wie *Flexible Working*, Digitalisierung der Arbeitswelten, Office 4.0, *New Way of Work*, CM gilt es aufzunehmen, zu betrachten und zu verarbeiten. Die Treiber dieser Veränderung der Arbeitsumgebungen sind zu identifizieren und kritisch zu hinterfragen.

Welche Motive treiben Organisationen an, den Schritt in innovative Bürokonzepte zu gehen? Welche Ziele werden verfolgt? Werden diese Ziele erreicht und welche Erfolgsfaktoren sind ausschlaggebend für gelungene Veränderungsprozesse in der Office Welt? Gibt es eine professionelle Begleitung der MitarbeiterInnen auf dem Weg dieser weitreichenden Veränderung der Arbeitsbedingungen und Arbeitsumgebungen? Wie beeinflussen diese Veränderungen das Berufsbild und die künftigen Aufgaben des Facility Managers bzw. die internen FM Abteilungen?

1.1 Ausgangssituation und Problemstellung

Mit der Digitalisierung und den neuen globalen Herausforderungen kommt es zu einer rasanten Veränderung der Arbeitswelten und damit zu einer Neuorientierung hinsichtlich Design, Anforderungen und Arbeitsweisen.

Bei Stellenbeschreibungen (z.B. Leiter/In Facility Management - Amrop Jenewein - 20.11.2018, amropjenewein.at) für die Position Facility Manager werden in den Anforderungsprofilen von Jobinseraten die Kenntnisse von digitalen Arbeitsumgebungen und jene der (die) Überführung aktueller Arbeitsumgebungen in moderne Arbeitswelten erwartet. Office 4.0, Arbeit 4.0, Industrie 4.0 greifen den Megatrend Digitalisierung auf (Bruch et al. 2016). Dieser Megatrend wirkt sich auf die gebaute Umgebung aus.

Unabhängig von der Größe eines Unternehmens wirkt sich die Digitalisierung der Arbeitswelt einerseits auf die Entstehung neuer Geschäftsmodelle und Wettbewerbsstrukturen und andererseits auf Arbeitsinhalte sowie die Organisation von Produktions- und Arbeitsprozessen aus (Klammer et al. 2017). In dieser Arbeit soll der Schwerpunkt der Auswirkungen auf die gebauten und neu geschaffenen Arbeitswelten gelegt werden. Die Anforderungen an unsere Arbeitsräume verändern sich grundlegend, wobei der Mensch trotz Technik und Flexibilität im Mittelpunkt steht (Donhauser et al. 2011) Daher gilt es die Wechselwirkung Arbeitswelt, Mensch und die Begleitung der Veränderung zu untersuchen.

Steffes, Maier und Arnold weisen auf folgende drei Aspekte: Veränderung der Tätigkeiten und Intensivierung der Arbeit sowie flexible Arbeitsformen wie Homeoffice und ständige Erreichbarkeit bzw. Crowdworking und Gig Economy **(**Steffes et al. 2017). Bei diesen Schwerpunkten der Veränderung werden die traditionellen Arbeitswelten keine adäquate Entsprechung sein.

Neben der Digitalisierung gibt es auch andere Treiber für die Neuschaffung von neuen Arbeitswelten. Als Treiber des Wandels führt das Beratungsunternehmen Moocon folgende Beispiele an: auftrittsorientierte Identitätsvermittlung und flexibilitätsorientierte Flächeneffizienz oder eine revolutionäre Gesamtbetrachtung in die der Unternehmenserfolg, die Produktivität der Organisation, die Attraktivität des Arbeitsgebers und die Unternehmenskultur einfließen (Leuchtenmüller, Schlüter 2016). Bischofsberger sieht in ihrer Online Umfrage 2016 zu den Treibern neuer Bürokonzepte die Verbesserung der Kommunikation und Zusammenarbeit sowie der Steigerung der Arbeitsplatz Attraktivität und Qualität gegenüber reinen kostenorientierten Treibern an Bedeutung gewinnen (Konkol et al.

2016, s 50). Als Ergebnis dieser Veränderungen stehen Arbeitswelten, die diesen Anforderungen gerecht werden müssen. Es ist zu erwarten, dass für diese unterschiedlichen Anforderungen auch unterschiedliche Ergebnisse die Folge sein werden. Die Bürolandschaften und Arbeitswelten finden in einer flexiblen Bürogestaltung und Variabilität, um auf diese Veränderungen jederzeit reagieren zu können, ihre Umsetzung (Kohlert, 2016, s 129-139). Anderseits gilt es auch im Hinblick auf Mensch - Maschine - Schnittstellen und Akzeptanzfragen in Hinblick auf Technikrealisierung und damit verbundenen Arbeitsrollen zu diskutieren (Zink 2015). Die aktive Begleitung der Belegschaft bei der Besiedelung und Nutzung der neuen Arbeitswelten und die Anpassung von Einstellungen und Denkweisen der Beschäftigten ist von großer Bedeutung und findet in einem aktiven CM seine Entsprechung (Klaffke, Oppitz 2016).

Der Facility Manager im Schnittpunkt von People - Place - Process kann eine Schlüsselfunktion für die erfolgreiche Anpassung bilden. Diese Schnittstellenfunktion und Kompetenz muss aber auch organisationsintern kommuniziert werden. Abschließend kann zusammengefasst werden, dass die Arbeitswelten auf Grund von Digitalisierung, *Internet of Things* (IoT), Änderung der Arbeitsformen und Steigerung der Flächeneffizienz einem raschen Wandel unterzogen sind. Dieser Wandel betrifft sowohl das Office Design und die physische Gestaltung der Arbeitswelten, als auch die Arbeitsabläufe der MitarbeiterInnen und die Interaktion der handelnden Personen.

1.2 Zielsetzung und forschungsleitende Fragestellung

Ziel der wissenschaftlichen Arbeit ist durch eine systematische Literaturanalyse die Auswirkungen der Digitalisierung, Flexibilisierung und Individualisierung der Arbeitswelten und der dadurch folgenden Herausforderungen an das Facility Management und Change Management zu ergründen.

Zentrale Forschungsfragen

- Welche Beispiele für die Veränderungen der physischen Arbeitswelten durch die Trends der Digitalisierung und Flexibilisierung sind erkennbar?
- Welchen Beitrag kann ein aktives Change Management und Facility Management bei der Veränderung der Arbeitswelten leisten?

2. Veränderungen der physischen Arbeitswelten durch die Trends der Digitalisierung und Flexibilisierung

2.1 Digitalisierung der Arbeitswelt

Wörwag und Cloots sehen die Digitalisierung als Megatrend, der auf das Zusammenwirken von technologischer Entwicklung, wirtschaftlichen Interesses und der gesellschaftlichen Prädisposition mit der Akzeptanz für und dem Wunsch nach der virtuellen Vernetzung zurückzuführen ist, der nicht nur als Ergänzung zu bestehenden Strukturen verstanden werden kann, sondern alle Lebens- und Wirtschaftsbereiche betrifft (Wörwag, Cloots 2018, s 109-110). Gorden und Nelke sehen ebenfalls die Auswirkungen der Digitalisierung auf alle Bereiche und Branchen mit einer sich vergrößernden Schnittmenge der realen und virtuellen Welt (Gordin, Nelke 2017, s 307). Klaffke meint, dass um die Chancen der Digitalisierung auszuschöpfen, das Büro als Katalysator des digitalen Kulturwandels fungieren muss (Khare et al. 2018, s 131). Trotz des Einsatzes von Technologie und digitaler Arbeitsprozesse ist die Verbindung zum physischen Arbeitsplatz von zentraler Bedeutung (Schircks et al. 2017, s 90). Es ist aber ebenfalls von Bedeutung, dass die angebotene Technologie von den MitarbeiterInnen auch verstanden, sie darin geschult werden, da sie sonst mehr behindert als nützt (Schardt 2018, s 75). Um diese technologische Revolution zu beherrschen zitiert Roper eine Studie des National Research Council aus 2011, die fünf persönliche Fähigkeiten zunehmenden Wert zumisst: Anpassungsfähigkeit, die Fähigkeit Komplex zu kommunizieren, Problemlösung abseits von Routinen, Selbstmanagement und systemisches Denken, alles Eigenschaften die mit FM assoziiert werden (Roper 2017, s 236). Die physische Arbeitswelt und deren Ausgestaltung wird auch in Zukunft, trotz Digitalisierung und der Veränderung der menschlichen Arbeit durch Technologien 4.0 von zentraler Bedeutung sein. Die unternehmerische Tätigkeit wird weiterhin durch Menschen geplant und erfüllt.

2.2 Flexibilisierung der Arbeitswelt

Wörwag und Cloots sehen die Flexibilisierung der Arbeitsprozesse und Arbeitswelten referenziert auf betriebsexterne Faktoren und diese müssen auf der innerbetrieblichen Ebene umgesetzt werden, sind jedoch abhängig von der Flexibilisierungsmentalität im Unternehmen. Die Interessen der MitarbeiterInnen an einer zeitlich und räumlich flexiblen und individuellen Arbeitsumgebung stehen der allgemeinen Flexibilisierung auf Unternehmensebene mit ihren Anforderungen an Veränderung gegenüber (Wörwag, Cloots 2018, s 113). Für Klaffke sind traditionelle Kostensenkungsprogramme mit reiner Büroflächenverdichtung ohne Rücksicht

auf die neuen Arbeitsanforderungen, die ein kreativitäts- und wissensaustausch förderndes Teamarbeiten, mit der Wahlfreiheit des Ortes und Zeitpunktes der Arbeitserledigung, die durch die Informatisierung der Arbeit unterstützt werden und außerdem ökologische Nachhaltigkeit – Stichwort *green building* - verlangen, nicht geeignet für die Schaffung künftiger Büromodelle (Klaffke 2014, s 209-212).

Flexible Arbeitswelten bringen nach Grimshaw auf der positiven Seite geringere Fehlzeiten, die Möglichkeit Schlüsselarbeitskräfte anzuziehen, bessere Motivation und Produktivität bei gleichzeitiger Reduktion der CREM Kosten. Ziel ist eine bessere Work Life Balance bei geringeren Flächenkosten. Dabei besteht die Gefahr der Isolation, der Vermengung von Privat- und Arbeitssphäre und die folglich daraus abgeleitete permanente Erreichbarkeit. Auf Seiten des Kerngeschäfts besteht die Sorge die Kontrolle über die Belegschaft zu verlieren. FM kann sich somit nicht mehr auf den physischen Arbeitsplatz der Vergangenheit beziehen. Um die Anforderungen der Organisationen zu erfüllen muss FM multidisziplinär, flexibel, bereit für den Wandel sein und sich vom Konzept des physischen Arbeitsplatzes wegbewegen in Richtung Agilität und der ständigen Veränderung (Grimshaw 2007, s 414-416). Der Fokus von FM auf den physischen Arbeitsplatz wird mit Hilfe von multidisziplinären Ansätzen in Richtung gesamtheitlicher Betrachtung der Arbeitswelten verschoben.

2.3 Räumliche Flexibilisierung der Arbeitswelt

Die räumliche Flexibilisierung der Arbeitswelten stellt das FM vor die gleiche Herausforderung wie in der Vergangenheit: optimale Arbeitsplätze anzubieten.

Die Digitalisierung ermöglicht es den ArbeitnehmerInnen von überall und zu jederzeit unter der Entgrenzung von Privatsphäre und Arbeit am Arbeitsprozess teilzunehmen (Wörwag, Cloots 2018, s 121). Für Coradi und Schweingruber basieren die postmodernen Arbeitsplätze auf einem Design der Begegnung auch im virtuellen Büro und die offenen, aktivitäts-orientierten Räumlichkeiten lösen die Einzelarbeitsplätze ab, mit der möglichen Ergänzung von *third places* wie Cafés, Escape Spaces, Co Working und Homeoffice (Schricks et al. 2017, s 88-94). Für Bauer et al. sind Homeoffice, der Arbeitsplatz am Firmenstandort, Co Working Spaces die Entsprechung der räumlichen und zeitlichen Flexibilisierung (Spath et al. 2012, s 27-28). Grimshaw stellt den Trend der Connectivity der MitarbeiterInnen, weg von der Face to Face Kommunikation hin zu Flexibilität in Raum und Zeit, fest (Grimshaw 2007, s 414). Für Robertson bedeutet die Transformation der Arbeitswelten die Änderung der Arbeitsumgebung in Richtung flexibler, agiler, kommunikativer und qualitativ höherwertiger. FM ist noch immer

in alten Rollen verhaftet. Ziel ist die höhere Flächeneffizienz bei einem Schreibtisch pro MitarbeiterIn. Diese Office Welt wird sich bei steigender Anzahl von Telearbeitern, Personen im Homeoffice und ändernden Arbeitsformen laut Robertson ebenfalls ändern müssen (Robertson 2000, s 378). Skogland und Hansen konstatieren, dass das Bewusstsein das Änderungen der Raumstrategie Veränderungen der Unternehmenskultur herbeiführen können verbreitet ist, es aber oft mit vereinfachten und copy paste Lösungen versucht wird umzusetzen, die daher nicht erfolgreich sind (Skogland, Hansen 2017, s 103-104). Dies mag ein Grund für die ernüchternden Ergebnisse sein, die in der Studie *Arbeitswelt im Umbruch* ermittelt wurden. Bei den 25% der deutschen Unternehmen in denen neue Arbeitsformen und Arbeitswelten bereits implementiert wurden, sind nur 6% erfolgreich umgesetzt (Bruch et al. 2016, s 4). Die Individuen reagieren emotional unterschiedlich auf ihre Arbeitsumgebung und diese beeinflusst wiederum das persönliche Wohlbefinden und die Produktivität der Organisation (Veitch 2018, s 4-5). Tagliario und Ciaramella betonen die Wichtigkeit einer gründlichen Pre-Design Phase, in der die Bedürfnisse des Unternehmens an Hand der Mobilitätsschemata: Geschlechterfragen, Vorlieben, Generationenfragen und die Arbeitsorganisation berücksichtigt werden können (Tagliaro, Ciaramella 2016, s 203-204). Büros müssen flexibel, wie Theaterbühnen sein, damit auf Wechsel der Anforderungen rasch reagiert werden kann. Diese Rekonfiguration muss kostengünstig und rasch umsetzbar sein (Robertson 2000, s 380). Aber es muss bei der Einführung von flexiblen Büros auf die Bedürfnisse nach Privatheit Rücksicht genommen werden, vor allem bei Wissensarbeit (de Been, Beijer 2014, s 153). Die Herausforderung für Unternehmen deren FM Abteilungen/internen Serviceabteilung wird das rasche Bereitstellen von optimal an die Arbeitsanforderungen angepassten Arbeitsbereichen sein, die auf die psychischen und physischen Bedürfnisse der Menschen Rücksicht nehmen und so die Interaktion, Kreativität und Produktivität steigern.

3. Das Zusammenspiel von Change Management und Facility Management im Prozess der Veränderung der Arbeitswelten

FM muss die Veränderungen von People, Place und Process (IFMA Report #1 1984) mit den optimalen Mitteln begleiten und den Fokus auf Lebensqualität und Produktivität des Kerngeschäfts nach ISO 41001 legen.

Inalhan weist auf die drei psychologischen Schlüsselprozesse – Bindung, Familiarität, Identität - die Menschen mit dem Raum verbinden hin und die bei Änderungsprozessen beachtet werden müssen (Inalhan 2009, s 17ff). CM wird multidisziplinär gesehen und in unterschiedlichen Zusammenhängen eingesetzt (Royce 2018).

In der Definition von Kraus, Becker-Kolle, Fischer ist CM die Strategie des geplanten und systematischen Wandels. Es wird dabei die Organisations- und Unternehmenskultur und das individuelle Verhalten beeinflusst. Die Wechselwirkung von Individuen, Gruppen, Technologien, Werten, Zeit und Machtstrukturen finden Berücksichtigung (Kraus et al. 2010, s 15).

Die Ursachen für das Management der Veränderungen können externe oder interne Ursachen sein. Höfler et al. verweisen vor allem auf den Einfluss der Digitalisierung, der die lineare zu einer exponentiellen Wirtschaftsentwicklung gewandelt hat. Die Welt ist VUCA -Volatile, Uncertain, Complex und Ambiguos - geworden. Auf diese Änderungen müssen entsprechende agile Antworten gefunden werden (Höfler et al. 2018, s 16-17). Das Wissen über die Anpassung von Individuen ist zentral im CM Prozess, da gewohnte Umgebungen aufgegeben werden (Inalhan 2009, s 34). Wegen der emotionalen Bindung zum physischen Arbeitsplatz können Änderungen der Arbeitswelt Stress bewirken, die die Gesundheit der MitarbeiterInnen negativ beeinflussen können (Pfannenstiehl, Mehlich 2016, s 35). Klaffke betont, dass die Entwicklung zukunftsweisender Arbeitsszenarien Elemente der Personalstrategie sind und somit nicht alleinige Aufgabe von FM (Khare et al. 2018, s 133). Grimshaw stellt fest, dass das Managen und Unterstützen des Flusses von Personen, Daten und Ressourcen eine Aufgabe von FM ist, die auch die Vernetzung, Kreativität und Flexibilität innerhalb der Organisation fördern muss und daher die Prozesse des Change Management verstehen muss (Grimshaw 2007, s 415). Changemanagement Prozesse sind nicht standardisierbar und müssen im Umsetzungsprozess adaptiert werden (Boch, Konkol 2013, s 37-38). Coradi und Schweingruber sprechen von der Unternehmenskultur, der DNA der Organisation die immer unterschiedlich ist (Schricks et al. 2017, s 90). Robertson spricht vom Silo Modell, in dem People - HR, Space - FM und Technology - IT unabhängig voneinander agieren und somit keine unternehmerischen und strategischen Mehrwert produzieren. Daher spricht sich Robertson für die Integration der drei internen Serviceeinheiten aus (er spricht vom dreibeinigen Stuhl, der beim Fehlen eines Beins instabil wird). Das Outsourcing dieser Kernaufgaben, liefert operationelle Effizienz aber keine strategischen Chancen (Robertson 2000, s 376-377). Schwardt weist darauf hin, dass alle Beteiligten den Änderungsprozess gründlich verstehen müssen und bereit sein zur gemeinsamen Umsetzung, da es auch den eigenen Arbeitsstil ändern wird (Schwardt 2018, s 76). Auch Duffy spricht sich für die Überwindung der Trennung des Architekturprozesses, Office Design und des Designs der IT und HR aus, um bessere Arbeitswelten zu kreieren (Duffy 2000, s 375-379). Tagliaro und Ciaramella sprechen sich ebenfalls für die Zusammenarbeit von CRE, HR, FM, Architekten und Soziologen aus, empfehlen die Steuerung der Veränderung der

internen Abteilungen durch unabhängige von außen kommende Experten (Tagliaro, Ciaramella 2016, s 195). Diese Zusammenarbeit ergänzt durch die Beteiligung des Betriebsrates ist z.B. bei der Entstehung des Erste Campus, dem Headquarter der Erste Group erfolgt, um die Forderungen an People, Place und Technology von Anfang an zu integrieren (Weiss, Gnesda 2017, s 174ff). Im Zusammenhang von NWW führt Lee deren drei Dimensionen Bricks – die physische Dimension, Bytes – die technologische Komponente, und Behavior – die menschliche Dimension der Arbeitswelten ein (Lee 2016, s 24). Es wird deutlich, dass Office Veränderungsprozesse immer einer unternehmerischen Gesamtbetrachtung unterzogen werden müssen, dass sich die einzelnen Bereiche gegenseitig beeinflussen und über den langfristigen Erfolg eines Unternehmens entscheiden. Neu geschaffene Arbeitswelten geben einen flexiblen Rahmen vor, der wiederum evaluiert werden muss und nötigenfalls Anpassungen vorgenommen werden müssen. Bull und Brown empfehlen auf Grund einer Untersuchung, dass für jeden Change Prozess genügend Zeit vorgesehen und eine zentrale Kommunikationsstrategie verfolgt werden sollte. Alle Informationen darüber wieso ein Wandel nötig ist, sollen auf verschiedensten Kommunikationswegen vermittelt werden und Möglichkeiten des MitarbeiterInnen Feedbacks bestehen. Wenn das Change Programm läuft ist es erforderlich MitarbeiterInnen ständig über den Fortschritt zu informieren, mit der Möglichkeit der Interaktion. Nach Abschluss des Change Prozess sind die Ergebnisse zu evaluieren und für das nächste Projekt zu adaptieren. FM Abteilungen müssen Kommunikationsstrategien verfolgen, damit alternative Arbeitswelten erfolgreich und von den MitarbeiterInnen angenommen werden (Bull, Brown 2012, s 147-149). Diese Akzeptanz ist auch bei Coradi und Schweinsgruber zentral, da der Mensch für den Erfolg eines Unternehmens verantwortlich ist und somit psychische und physische Gesundheit ein Rolle spielen (Coradi, Schweinsgruber et al. 2017, s 99). Ohne das Verständnis und aktiver Berücksichtigung der Interessen der Belegschaft und deren alten Bindungen und Verhaltensmuster in der gewohnten Office Umgebung ist mit Frustration und Widerstand gegenüber dem neuen Projekt zu rechnen (Inalhan 2009, s 26). Windlinger et al. identifizieren Transparenz bei den Zielen und Umsetzungsschritten, die Beeinflussbarkeit und die Fairness gegenüber der Belegschaft, die von Veränderungen unterschiedlich betroffen ist, als entscheidend (Pfannenstiel, Mehlich 2016, s 235-236). Bei einer reinen top down Strategie der Veränderung der sozialen Strukturen im Unternehmen besteht laut Skogland und Hansen die Gefahr der Stärkung von Hierarchien, die man eigentlich auflösen möchte (Skogland, Hansen 2017, s 101). Auch Seiferlein und Kohlert empfehlen das CM mit einem umfassenden Kommunikationsprogramm zu begleiten, auch mit anerkannten MitarbeiterInnen, sogenannten Change Agents, um einen hohen Anteil der

Belegschaft zu erreichen (Seiferlein, Kohlert 2018, s 185ff). Konkol verweist in der Studie aus 2010 *Creating New Workplace* ebenfalls auf die Bedeutung der Beteiligung der MitabeiterInnen nach den unterschiedlichen Bedürfnissen in Abhängigkeit von Alter, Geschlecht, Position und Tätigkeitsprofil. Es muss nicht jede MitarbeiterIn eingebunden, aber die Bedeutung der bilateralen Kommunikation beachtet werden (Boch, Konkol 2013, s 34-38). Klaffke betont die Bedeutung der regelmäßigen direkten und persönlichen Kommunikation, die mit dem Kernelement change story den Zukunftsentwurf für die MitarbeiterInnen begreifbar und emotional akzeptabel macht (Klaffke 2014, s 222). Die Ergebnisse der Case Studie von Van Dierman und Beltman stützen diese Einschätzung (van Diermen, Beltman 2016, s 284). Bei dem Office Neugestaltungs-prozess der Kapsch Carrier Com konnten im Planungsprozess mittels gewählter bzw. nominierter Nutzervertreter – *move agents* – Wünsche und Bedürfnisse an das Projektteam übermittelt werden und über das Intranet konnte durch eine Marketingfigur, dem *move man* der aktuelle Baufortschritt verfolgt werden (Bartz et al. 2017, s 280-281). Durchdachte und maßgeschneiderte Kommunikationsstrategien sind für einen erfolgreichen Wandel der Arbeitswelten entscheidend, um Widerständen zu begegnen und Verständnis für den Wandel zu fördern. Kommunikationsstrategien müssen bidirektional aufgebaut sein, um auch das Feedback der Nutzer aufzunehmen und zu berücksichtigen. Duffy konstatiert, dass FM nicht der Treiber der Neugestaltung des neuen Office Designs ist, vor allem da das Ziel, FM in der Geschäftsführung zu verankern, nicht erreicht wurde (Duffy 2000, s 373). Grimshaw sieht die Kritik an der Stellung von FM mit dessen zu großem Fokus auf Kostensenkung begründet. FM gelingt es nicht die Korrelation von physischen Facilities und Produktivität und dem added value darzustellen. (Grimshaw 2007, s 411). Duffy empfiehlt Facility Managern sich als Nutzervertreter zu positionieren und Kostensenkungen versus Effektivitätssteigerung darzustellen (Duffy 2000, s375). Veitch betont, dass vor allem bei Wissens- und Dienstleistungsunternehmen bei einem Verhältnis der Personalkosten \$300/ft^2, Fläche inkl. Möbel \$30/ft^2 und Betriebskosten von \$3/ft^2 die falsche Wahl oder Sparen bei der Gestaltung und Umsetzung von Arbeitswelten fatale Konsequenzen auf die Produktivität des Unternehmens haben kann und umgekehrt gelungenes Office Design den unternehmerischen Outcome positiv beeinflussen kann (Veitch 2018, s2). Die gleiche Erkenntnis liefert Hodulak mit der Einschätzung, dass die potentielle Auswirkung der Arbeitsplatzeffektivität 80% der Unternehmenskosten betrifft, die Kosten für effizientere Arbeitsplätze nur 8% der Kosten beeinflussen können (Hodulak 2017, s15). Kahlen unterstützt diesen Ansatz mit seiner Sichtweise von FM, dass das Ziel die höchste Wertschöpfung durch optimale Arbeitsbedingung und optimale Gebäude für den spezifischen Zweck bereitzustellen ist (Kahlen 2001, s 280).

Diese added value muss in Zukunft konsequenter von den Facility Managern gegenüber der Geschäftsleitung vertreten werden, um offensiv Veränderungen durchführen zu können und um den Wandel entscheidend mitzubestimmen. Ein wichtiges Fazit der Veränderungen der Arbeitswelten ist die notwendige Zusammenarbeit aller zentralen Serviceeinheiten einer Organisation – FM, HR und IT – ergänzt mit externen Fachwissen. Es gibt keine Generallösungen für modernes erfolgreiches Office Design, jede Organisation hat unterschiedliche Ziele, Bedürfnisse an Mensch und Produkt. Büro Design kann strukturelle Veränderungen im Unternehmen unterstützen, zu einer größeren Produktivität beitragen und die Mitarbeitermotivation steigern, aber auch behindern und einschränken. Von zentraler Bedeutung ist eine offene Kommunikation und eine ernstgemeinte Feedbackkultur zwischen Belegschaft und Management und eine stete Bereitschaft Konzepte anzupassen. Diese Mittlerfunktion soll von FM übernommen werden.

4. Zusammenfassung der wichtigen Erkenntnisse und Beantwortung der Forschungsfrage

4.1 Welche Beispiele für die Veränderungen der physischen Arbeitswelten durch die Trends der Digitalisierung und Flexibilisierung sind erkennbar?

Die neuen Arbeitswelten zeichnen sich durch eine Entgrenzung in räumlicher und zeitlicher Hinsicht aus. Die Digitalisierung eröffnet durch die 24/7 Verfügbarkeit von Daten und Arbeitsmittel einerseits multilokal tätig zu werden aber auch den Kunden 24/7 mit Organisationen in Kontakt zu treten. Um sich den rasch ändernden Anforderungen anzupassen, müssen die Arbeitsumgebungen sehr flexibel gestaltbar sein. Darüber hinaus bieten sie die Möglichkeit der Kommunikation im realen und virtuellen Raum und schaffen Begegnungsräume für informelle Gespräche und formelle Meetings. MitarbeiterInnen die von third places wie Cafes, Co Working Offices oder im Extremfall von einem Urlaubsort aus arbeiten, werden in die Office Welt eingebunden. Modernes Office Design begünstigt die hierarchie-unabhängige räumliche Vernetzung der MitarbeiterInnen. Wissen in Form von Zugänglichkeit zu der Welt der Daten – unter Berücksichtigung von Sicherheitsaspekten – wird 24/7 zur Verfügung gestellt. Gleichzeitig werden hohe Anforderungen an die Qualität der Räume und an mögliche Befriedigung individueller Bedürfnisse wie z.B. Licht und Akustik gestellt. Es gilt zu beachten, dass es keine Blaupausen für erfolgreiche flexible Arbeitswelten gibt und jede Organisation einen anderen Mix an aktivitätsorientierten, realen und virtuellen Arbeitsplätzen benötigt, der sich ständig ändert und laufend angepasst werden muss. Für FM bedeutet dieser Wandel den Fokus weg von Flächeneffizienz und Kosteneffizienz hin zu einer

multidisziplinären Gesamtbetrachtung von Arbeitswelten unter Berücksichtigung psychosozialer Auswirkungen des Raumes.

4.2 Welchen Beitrag kann ein aktives Change Management und Facility Management bei der Veränderung der Arbeitswelten leisten?

Auf Grund der raschen Veränderungen der räumlichen und zeitlichen, realen und virtuellen Arbeitswelten, vor allem durch die Möglichkeiten der Digitalisierung, müssen die Arbeitsumgebungen flexibler und aktivitätsbasierter werden.

Facility Management Abteilungen können einen wichtigen Beitrag zur Umsetzung neuer Arbeitsplatzkonzepte leisten, da sich ihre Disziplin seit Beginn mit den Fragestellungen People, Place und Process beschäftigt. Auf Grund der Komplexität der psychologischen und psychosozialen Auswirkungen von Veränderungen der Arbeitsumgebung ist ein multidisziplinärer Ansatz zu verfolgen. Diese *soft skills* sind zu berücksichtigen und externe Experten hinzuzuziehen. Anerkannte oder gewählte MitarbeiterInnen sollten als Botschafter der Ziele des Wandels eingesetzt und die Ängste und Bedenken von Verlierern der Neuerung – es gibt immer Gewinner und Verlierer bei Veränderungen – aktiv begegnet werden. Die Zusammenarbeit der drei internen Serviceeinheiten – HR, IT, FM - in CM - Prozessen ist erforderlich, um gesamtheitlich erfolgreiche Veränderungen der Arbeitsplatzkonzepten umzusetzen, die in einer globalisierten VUCA gewordenen Geschäftswelt funktionieren. Ein mögliches Ziel ist, FM als Nutzervertreter organisationsintern zu positionieren, und das Wissen um gebaute Räume mit dem Feedback der Nutzer in Verbindung zu bringen. Dafür wird es notwendig sein, aktive Kommunikationsstrategien mit einer offen gelebten Feedbackkultur durch FM zu implementieren. Dies kann helfen die in der ISO 41001 geforderte Korrelation der Steigerung der Produktivität des Kerngeschäftes und die Steigerung der Lebensqualität der Menschen zu erreichen.

5. Schlussfolgerungen

Die Facility Manager und die FM Abteilungen müssen bei der Flexibilisierung der Arbeitswelten noch enger mit den Abteilungen HR und IT zusammenarbeiten.

Hier gilt es auch die Eignung für unterschiedliche Generationen, Gender und ökologische Fragen zu bedenken. Es ist unumgänglich in der FM Welt, neben der technischen und prozessualen Sichtweise, auch Verständnis für die psychologische Dimension zu wecken. Daher muss Change Management integraler Bestandteil in FM Strategien sein, um diesen

Wandel erfolgreich zu gestalten. Der Fokus technische Lösungen und auf reine Flächeneffizienz und damit verbunden kurzfristige bzw. kurzsichtige Kostensenkung ist zu wenig. Kommunikation in führender Position als einer der Erfolgsfaktoren muss ins Zentrum rücken.

Dies kann durch internes Marketing, Positionierung als Nutzervertreter oder dem Einsatz von Feedback Tools wie z.B. *my building message* der FH Kufstein erfolgen. Interne Blue Prints können helfen rascher und strukturiert maßgeschneiderte Lösungen zu erhalten. Leitfäden (Planen, Errichten und Betreiben im BIM oder Nachhaltiges Facility Management) der FM Interessensvereinen wie FMA, Gefma und IFMA können die Basis bilden.

Der rasche Wandel, der durch die Digitalisierung oder wie jetzt durch eine Pandemie getriggert ist, wird zu einer Nachfrage an flexiblen realen und virtuellen Raumlösungen führen. Diese können im Unternehmen entstehen, im Homeoffice oder von Anbietern professioneller Co Working Spaces bereitgestellt werden.

FM Abteilungen müssen, unter Change Management Begleitung, an der Planung und Implementierung von neuen Arbeitswelten strategisch führend beteiligt sein, da sie die drei Kunden – customer, client und end user (FM Modell ÖNorm EN 15221) im Zentrum ihres Wirkens haben und den Erfolg von Organisationen maßgeblich mitbestimmen.

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How do people from different generations approach work? Implications for workspace design

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Abstract

Economic performance is a concept that extends beyond the profit figure of a company. The knowledge society needs, not in spite but because of technology, a broader and integrated view of people in an array defined by technology, culture and space.

The present paper makes a connection between the macro level - the Sustainable Development Goals (SDG) defined by the 2030 Agenda for Sustainable Development, officially approved document by the United Nations in 2015 and the micro level – that represents the meaning of work for the motivational theory. The authors performed a field study, "Generations@Work", started in early 2019 until April 2020, intended to find solutions for the multi-generational environments of workers, with focus on the integration of new generations in the workforce, such as the digital natives.

The methodology involved a project in two stages, with 44 participants involved, from different generations and backgrounds. Divided into 7 multi-generational teams at first, they were directed into several common tasks, activities and questionnaires to find solutions for cooperation and identification of motivational differences. In the second stage, two teams elaborated work solutions and spatial strategies for multiple generations before and during the pandemic time. General results emphasized that generational integration is based on the importance of skill and experience sharing and different cultural identities, finally leading us to observe changes in motivational patterns. Based on Generations at Work research conclusions the article has a chapter about a possible sustainable development model.

Keywords: Workplace Management, wellbeing, community, meaning of work, questionaire, workplace design

1. Introduction

During the last decades, the workforce has witnessed changes as never before, regarding the nature of work, work-related behaviors and consequently, the perception of knowledge workers as multi-dimensional entities. The action of work can no longer be separated from the people who perform it, nor from technology, individual and company culture or the workplace. In addition, the meaning of work becomes the real motivator for employees, engaging creativity, commitment and a sense of belonging to a purpose and community.

The paper follows essential guidelines established by the United Nations in 2015, regarding the Sustainable Development Goals (SDG) defined by the 2030 Agenda for Sustainable Development (United Nations, transforming our world: the 2030 Agenda for Sustainable Development), where one can find the principles of "Good Health and Wellbeing" in third position, respectively, “Decent Work and Economic Growth” in the eight position. Wellbeing is the experience of health, happiness, and prosperity, it involves a state of optimal mental health, elevated life satisfaction and a sense of meaning. These aspects are reflected differently along generations in the knowledge society, but considering the diversity of a workplace where different generations cohabitate, wellbeing becomes a complex matter for companies, researchers and designers alike. Studies have shown tendencies in the average digital natives’ generations towards lower levels of work motivation, changes regarding the meaning of work, increased percentage of single-person households, lower level of happiness, although younger people benefit from higher psychological and physical comfort than older generations (Lan, 2019). These contemporary symptoms have recently been accentuated by the Coronavirus sanitary, economic and social crisis, as alienation has forced rapid shifts in everyday life, with obvious psychological implications world-wide. The meaning of work becomes questionable, following the economic and social lockdown in the context of individual and planetary health, as the already sensitive limit between personal and professional life has faded.

Companies are currently in an urgency to seek resiliency in order to mitigate the impact on business and people. As stated in the recent report undergone by the strategy firm “Board of innovation”, a so-called “low touch economy” (De Ridder and De Mey, 2020) is a possible solution for crossing this period of uncertainty, involving substantial investment in research and innovation.

Artificial Intelligence (AI) is among the key elements of this strategy, whose accelerated development will replace routine jobs, as well as some direct interaction jobs in light of the coronavirus pandemic, the above-stated situation will worsen if new strategies of work adaptation are not taken into account. Traditional jobs were not sufficiently fulfilling to the knowledge society, but in this new context, knowledge fields seem to thrive due to the constant need for resilience and innovation, thus, organizations are to develop meaningful ways to retain valuable employees, foster a sense of belonging to a community and a greater purpose, eloquent to the individual and the group.

2. Towards a new model of sustainable development

2.1.The pandemic, lockdown effects and sustainable development

The global economic setback is an obvious vicious cycle: customers stop buying, companies reduce selling, producers stop production, workers are left jobless and with limited funds. The negative effects are witnessed at all levels except for several fields such as medical or information technology. Among the positive effects that have become obvious for companies around the world during the lockdown are those related to pollution and cost reduction due to an abrupt interruption of air and personal automobile transportation. Companies show a tendency to reduce rented office surfaces together with infrastructure costs, while hiring remote workers when possible. This allows an important virtual expansion of the workforce worldwide.

Even more obvious and decisive are the effects on employees who have gone from office to home office in a matter of weeks: the absence of long commutes, apparently more personal time, no disturbance from colleagues, deceptive freedom without administrative control (although activity tracking systems were put in place in applications like Zoom. WebEx).

Negative effects are also to be highlighted, for, in the long term, the burnout effect is inevitable since the limit between personal and professional life fades, due to the overlap of work and relaxation periods (Giurge and Bohns, 2020). Household distractions such as children, pets, other activities have proven to reduce productivity and focus massively. Remote work involves greater responsibility from employees, especially from younger generations that do not yet own enough practice in work management and need the guidance of their older peers. While office spaces invest massively on technological infrastructure for impeccable connections throughout the headquarters, suddenly this had to be replicated at smaller scales in many homes, whether the space and setting allowed it or not.

2.2. The future of work and sustainable development

Looking at the United Nations Sustainable Goals, the pandemic crisis considered the potential COVID-19 health threat as a primary concern, focusing all global actions towards a solution. Several immediate consequences were detrimental to the first sustainable goals (No Poverty and Zero Hunger), as these social categories are struggling to survive economically during the restrictions. Wellbeing, a criteria of equal importance to health, has been affected in the short and medium interval of time. Goals as Climate Actions, Life on Land and Bellow Water are better recovering following the pandemic global lockdown measures.

In the first stage, the middle class was protected through a debatable experiment, but in a short time, the solution might be the Guaranteed Minimum Income (GMI). Many authors consider that GMI is a suitable tool to reduce the global negative impact of humans, with a more Responsible Production and Consumption process. This might lead to a positive effect on certain social and professional categories, as they might find another meaning of life that was lost in the turmoil of a busy lifestyle. Unfortunately, this will not be a solution on a large scale, as, many people will need a sufficiently paid job, that is appreciated and rewarded by the community.

The pandemic situation led to an acceleration of technological progress of Artificial Intelligence (AI) and with a lot of debates about the “Future of Work” as a consequence. Juval Harari has argued even before the pandemic that "the technological revolution could soon take billions out of the labour market and create a new and huge useless class, generating social and political transformations that no existing ideology knows how to manage"(Harari, 2018). History shows that past industrial or technological revolutions have always seemed to threaten certain occupations, but never as pronounced as the present situation, when AI is a powerful competitor against human cognitive potential. "People have two types of abilities - physical and cognitive. In the past, machines competed with people only in terms of physical abilities, while people kept an enormous advantage over machines - knowledge.” (Harari, 2018) But Artificial Intelligence has now the potential to surpass man in terms of cognitive abilities, so the possibility of completely replacing man in many fields is situated on a horizon of only a few decades. "We do not know of a third field of activity - beyond the physical and the cognitive - in which people will always keep a secure advantage."(Harari, 2018)

The COVID-19 lockdown has brought sudden transformations that were expected in the far future. One can say that human nature is extremely well rooted in a clear set of coordinates that

allows a natural sense of resilience, although we are currently witnessing major changes on individual and collective levels. Community involvement will be a solution to what many motivational authors already call "living / working" for a purpose higher/beyond oneself. The cultural identity within the office has given shape to a common purpose and voice to protect peoples` interests. Moreover, human beings are social by nature, as history shows that communities have gathered for the human kind to thrive for millennia.

The authors` opinion leans towards a potential sustainable model that involves GMI plus a revalue of Sports Competitions, Arts and Cultural Programs, Social - Community Programs, Environment and Biodiversity actions, Gardening and other activities, combined with a social recognition plan. Employment might drastically shift towards a decreased working schedule per week and per year, allowing the mix of activities rather than a single occupational lifestyle.

Regarding the described perspective, new native digital generations are more prepared, showing relaxed approach towards traditional work models. They have already established personal and common work strategies while using many digital tools along the way. They are already used to switching between remote offices and regular workplaces, so the transition is easier, as they prefer independence and development of personal schedules. An important challenge in the future is a balance between Reduced Inequality and shared prosperity.

2.3. New ways of work. The viability of the “Screen New Deal”

The trends that are currently imposed are not new; the novelty is actually the speed, depth and impact these have on economy, culture and society. The global crisis of COVID-19 has suddenly transformed the way tens of millions of people work, forcing them to work from home.

A Gallup study (Brenan, 2020) conducted in early April 2020 shows a strong tendency toward expanding remote work, with 62% of American employees declaring they worked from home during the period March 30 – April 2, up from 31% between March 13-15. Domains that preferred remote work are technology, insurance, media and professional services, while at the opposite pole are education and retail.

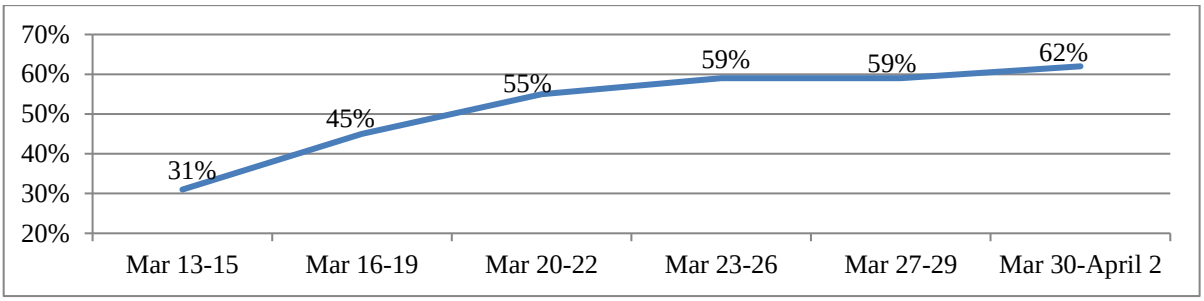

Fig. 1: Percentage of US workers who have worked remotely

Of the respondents, 59% would prefer to continue working remotely after the end of the restrictions, while 41% would prefer to return to the office in pre-crisis conditions. However, an interesting phenomenon is worth mentioning: the percentage of those who would prefer to continue working from home has dropped after almost a month of experimentation. Thus, after reaching 62% at the end of March, it decreased after only 3 weeks to just over 50% (Harter, 2020).

In a study undergone in 2018 in a Romanian branch of an Austrian Insurance Company with the results presented during of 2018 IFM Vienna Congress, we observed that from 35 interviews with middle management people from different departments, 24 considered 2 days / week work from home as a positive measure and 3 of them 1 day / week as a positive measure. All respondents have considered that only remote work is not suitable, affirming that the majority had personal experiences with working from home (Capotescu, 2018). At the same IFM Congress the results of "Office Flexibility" have been presented, based on a survey of 94 interviews with office workers from different companies. Results were in the same direction, 95% considering that working from home part time is possible, but working exclusively from home was considered suitable only by 17%, while 45% considered it entirely unsuitable (Capotescu, 2018)

The comparative analysis of office work versus remote work shows that each of the two options has advantages and disadvantages. However, the situation in the business environment shows that employees have a preference for remote work. A study conducted in 2017 tried to quantify this preference and concluded that on average an employee is willing to accept a salary 8% lower for the opportunity to work from home (Mas and Pallais, 2017).

There are already many presumptions regarding "the end" of office work. Office work will transform - as duration, continuity, flexibility - being defined by a combination of physical and virtual meetings, but direct human contact will remain. Man has, as an individual, clear

psychological needs for communication, relationships and belonging to the community, a fact recognized by most theories of motivation. Organizations are, in turn, defined by their organizational culture. Peter Thiel, founder of PayPal, writes in the book *Zero to one*, "no company has a culture; every company is a culture" (Thiel, 2014). It cannot survive only by remote electronic interaction. Direct interaction is indispensable. Technology will help regain the workplace. On one side, the use of digital and collaborative tools allows business continuity. On the other side, the use of contactless devices such as electronic access, automatic door opening or infrared sensor gel dispenser, provides security in the work environment. Reduction of the occupancy capacity of workplaces to guarantee employees distance, coworking spaces or flex offices are going to play an essential role in delocalization of employees as one of the benefits they offer is short commuting from workers home to the office.

Work styles will be in many cases the choice of the employer rather than the employee, establishing unique strategies for entire teams or companies (Choudhury et.al., 2019). Based on company dynamics, economical and infrastructure capacities, remuneration will be configured depending on more factors than before: individual or group strategies of home office, on site or mixed, depending on a general strategy with some degree of controlled flexibility. Too much freedom leads to lack of coordination between team members, especially in the case of younger generations who are in need of a structured schedule at the beginning of their careers.

3. "Generations at Work" research

3.1 The purpose

The research was developed between February 2019 - April 2020 and was structured in two sections, firstly focusing on soft tools identification for a better intergenerational cooperation and secondly with focus on suitable workspace definition for a better collaboration between generations.

The aim of the "Generations at Work" research stands in the identification of challenges and solutions for multi-generational work environments, focusing on the digital natives` integration, even more eloquent in the light of current changes that were also reflected in participants` collaboration patterns, as the results will show. The ultimate goal was to figure out ways to use the insights from technology, culture and space to improve both efficiency and the meaning of work. "Generations at Work" is an initiative, managed by the Ergonomics and Workplace Management (ErgoWork) Society from Romania, a multigenerational and multidisciplinary

platform, focused on finding relevant meaning for humans, in general, aiming to develop better workplace concepts, in particular.

3.2. First stage: soft tools

3.2.1 Methodology

The first stage of the research (Capotescu et.al, 2019), took place between 22nd February- 28th June 2019 and aimed to identify work (or learning) motivation and group dynamics during the research process. There were 7 multi-generational teams of 6-7 members who were to engage in interviews with people outside the research using a set of surveys. A final number of 111 participants answered the research with the following levels of experience: 20 high school students, 44 university students, 9 employees with up to 3 years of professional experience, 15 employees with 3-15 years professional experience and 23 employees with over 15 years of professional experience.

During the evaluation and team building process, we used three soft tools:

• First, there was a Self-Reflection Questionnaire, based on the subject's thinking about different aspects from their own life. It was not used for statistical analysis.

• The second one was a questionnaire used to make a quantitative analysis of the different motivators and also a tool to build a personality map, or group map function by task: https://forms.gle/gwWSnh7vhDEzvYdC8 . With this tool, the communication was guided in one direction and the introspective and extrospective behavior in another direction according to the answers gathered from the questionnaire. This tool was used to build both a personal behavioral map and a team behavioral map.

• The last tool used, was the "5 Whys Analysis", applied for two topics: Why we should work and Why we shouldn't work. The 5 Whys technique involves reflecting on essential causes of problems, by asking "Why?" five times in order to find potential solutions. That tool was also applied individually and as a debate topic for the team.

3.2.2 Research results and discussions

After the statistical data processing, the results were structured by criteria to highlight work motivation (Table 1).

Tab 1: Motivation Topics General Top 10 Hierarchy and Each Working Experience Hierarchy (HS. – high school group, US. – university student group, EL3 – employees less of 3 years group, E3-15 – employees 3-15 years' experience group, EM15.V. – employees more of 15 years' experience group)

			General Hierarchy	Each Category Hierarchy			
No	**Code**	**Topic description**	**HS**	**US**	**EL3**	**E3-15**	**EM15**
1	M10	To live by practicing personal passions	2	1	5	3	8
2	M3	The opportunity to be among people with whom I feel good, have fun, that are my friends	1	2	9	4	5
3	M16	An organization and / or workplace position in which I feel I can reach my professional vocation and which makes me feel useful.	4	8	1	5	2
4	M4	The opportunity to be among people from whom I can broaden my horizon of knowledge, skills, and abilities.	5	3	6	1	1
5	M1	Reward money or school grades	3	4	4	7	4
6	M2	Comfort and physical work environment (the building and spaces of the company / faculty / school with the facilities that include cleanliness, security, food facilities, socializing and relaxing spaces, fitness, gaming, ergonomics workstations, training spaces, interior design, natural and artificial lighting, green spaces, etc.).	6	5	10	8	3
7	M15	An organization, workplace that gives me the opportunity to learn and do diverse things that I feel are allowing me to grow.	8	11	2	2	11
8	M13	A psychosocial work / study environment that facilitates and encourages the fulfillment of my personal work / learning tasks.	14	18	3	6	12
9	M18	An organization / school where to have a life balance between personal time and work time.	12	6	8	9	15
10	M8	Opportunity to be in a team / organization where I feel appreciated and feel that my worth and contributions are recognized	9	12	7	11	6

Looking in both top 5 and top 10 general hierarchies and each category hierarchy, we have surprisingly found more similarities than differences. However, in a more detailed analysis we can identify several differences. For High School (HS) and University Students (US), the main priorities involve diversity and flexibility, such as M9 and M12 topics, and also a relaxed behavior, as M5 topic shows. For experienced employees, the organization and team capacity become important, as it helps them to implement their ideas / projects – the M7 item, and also a job that avoids a sedentary life – the M11 topic. A remarkable issue is the topic M1 – "Reward money or school grades" that is seen only in 5th position (general hierarchy), a rather unexpected result coming from all age groups.

The general behavior map for the entire respondents group is presented in Figure 2 as a comparison, with a reference system based on equal values between "tasks behavior orientation" and "relaxed behavior orientation" on one side, and equal values between introverted behavior and extroverted behavior on the other side.

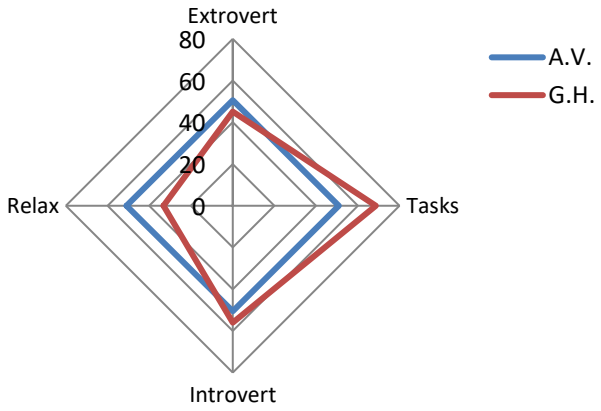

Fig. 2: General Map Behavior of the Respondents Group (A.V. - average values, equals values between tasks and relax behavior and between introvert and extrovert values; G.H. –general values obtained for the entire group of respondents)

The predominance of task behavior orientation is a result of two major influence factors: all survey participants have high work performance behavior, regardless of work experience, while people with less work orientation found it difficult to remain engaged in the research process. Due to this argument, we assume the "money or school grades reward" becomes less important than freedom and meaning of work. „The social desirability bias" is mostly associated with answers regarding task orientation and personal development, than with answers regarding relaxed orientation and „socio-economical recognition". Predominance of introverted behavior is associated with task completion and increased focus. A higher tendency towards relaxation was observed in the younger age groups like high school (107%) and University Students

(124%), similar to extroverted behavior for High School Students (107%) and University Students (101%).[1]

The first stage of the project "Generations at Work" shows that work motivators are not very different across generations but some empirical observations revealed higher orientation for a relaxed behavior in the students groups. At the same time, the research proves the possibility of gathering multiple generations to pursue a certain goal, even without a material reward motivation.

3.3. Second stage: Multigenerational workspace definition and the working process

3.3.1 Methodology

The aim for the second stage of the "Generations at Work" research consisted in a practical exercise of designing an Innovation Hub for 49 researchers (7 teams of 7 members), as an alibi for monitoring the entire design process, interaction between team members and the end results. The second stage of the research was conducted between November 17, 2019 - April 02, 2020. Two multi-generational teams of 5 and 7 members composed of at least one student, one person with less than 15 years of work experience, and one person with higher experience. Each team included at least one architect or interior designer. An additional topic was to analyze the internal dynamic of the group and to identify future soft solutions for a better intergenerational cooperation.

The design process consisted in a number of meetings (8) - online and offline – at a distance in time of 1 to 2 weeks and independent work of each member between them. The most interesting insights came from the design exercises done for different types of office spaces by the sub-teams with homogeneous age category. The differences were quite striking. The final say on the design decision was made by consensus trying to include elements that were required by both "Young age group" and "Experienced employees". Regarding age group preferences in workspace design, the team made a qualitative criteria analysis on three aspects: (1) a general overview of the space design, (2) accent/focus (given by area size and positioning) and (3) organizational culture (reflected/ induced).

[1]The percentages reflect the ratio between the value for the age group and the average for the total number of respondents (n.a.)

3.3.2 Research results and discussions

There were significant differences in the two teams` approach towards the theme, in terms of time management, interaction, task distribution, even though the end results (actual projects) didn`t show many differences in general, but rather at smaller scales. These differences and similarities will be further described for each team.

First team (AHMRA)

The first team was characterized by an average age of 33 years, with more members representing the Generation Z and without Baby Boomer Generation. The team participated at 9 meetings, of which 5 face-to-face and 4 online, that led to a strong connection between the members in a short period of time. A common language, regarding basic design concepts, was defined at first, an important step due to significant differences in age and experience in the field of office design.

For each space design proposal by the team members, 3 elements were described/analyzed: overview, accent (given by area size and positioning) and organizational culture (reflected/ induced), as seen in Table 2.

Tab 2: Criteria analysis regarding age group preferences in the design of the workspace

	Young age group	**Experienced employees**
Overview	– space is less structured – there are 2 important areas: work area and informal/ relaxation/ social area – the work area is located in the center of the space and it is multifunctional (it allows both individual and team work)	– space is more structured – there are 4 areas: individual work area, team work area, informal/ social area, dedicated team coordinator area – there is no main work area, but an even distribution throughout the space – individual work space and the teamwork space are distinct
Accent (given by area size and positioning):	– on teamwork: the common space is located in the center – on relaxation / socialization / informal work (large size of this space) – on personal needs (there is a relatively large space for assigned storage for documents and belongings)	– on the classic workspaces (individual offices for concentrated work and "meetings" table for presentations / training and teamwork) – reduced on socialization / informal work (small size of this space, was finally introduced in a hurry) – there is no significant differentiation between the types of workspaces (they are positioned on the sides of the space) – reduced on personal needs (small space for the cabinet for personal documents/ things) – on the coordinator - the coordinator space is generous (as size and endowments)

Organizational Culture (reflected/ induced)	– egalitarian - equality between all the team members (there is no special sitting place different from the others) – relationship oriented – simplicity and flexibility (in arrangement) – more informal atmosphere/ work	– hierarchy - there is a special area dedicated to the team coordinator (there is an inclination towards the hierarchy) – task oriented – organization and efficiency (in arrangement) – more formal atmosphere / work

Among the applied methodologies inside the team was that each person defined his or her own specific space preferences, allowing a clear analysis of age group differences and similarities. We could thus identify some age-related predilections, many being practical confirmations of the theoretical study results. As seen in Figure 3 (right image), a teamwork studio has resulted differently when designed by students (upper room), compared to a solution designed by experienced employees (lower room). The integration of exercises for each type of workspace conducted finally to the entire space design plan (Figure 3).

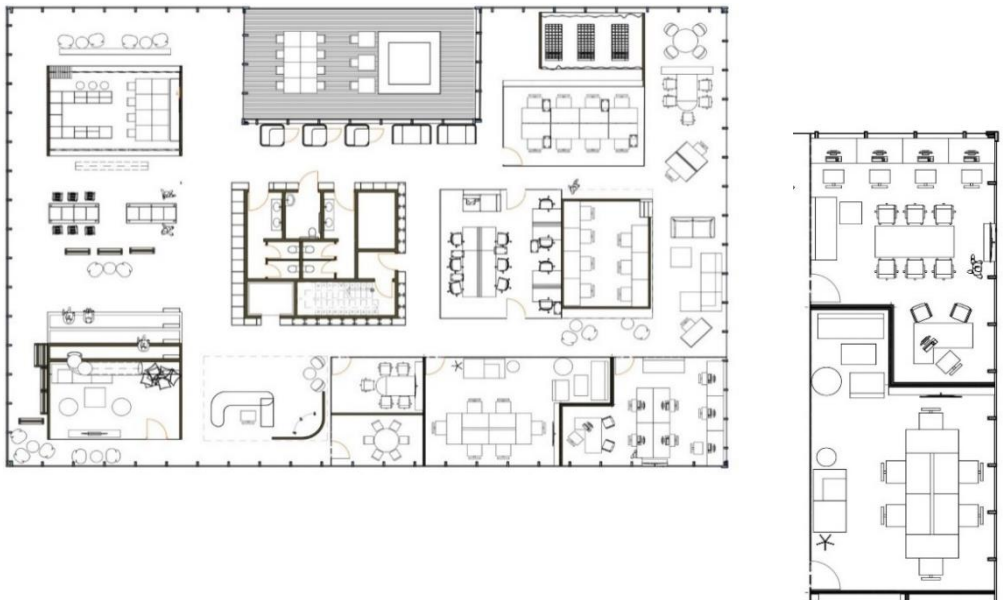

Fig. 3. Left: final design imagined by the team; Right: studio dedicated to a team – upper space (designed by young age group), lower space (designed by older age groups)

Second team (VIFARI)

The second team was characterized by an average age of approximately 38 years, with more members representing the Millennial Generation and Baby Boomer Generation. Consequently, the group structure led to different decisions in collaborations strategies and methodologies

comparing to the first team. A strong participation was noticed from the 20-30 years old age group, as they were more numerous and are clearly influenced by contemporary design trends. The team meetings were dynamic and creative, based on spontaneous decisions and activities. Thus, a step-by-step way of thinking and collaboration was adopted, in order to firstly define what the team needs in terms of functionality and potential activities. Each team member expressed his/her opinions and desires regarding the project, in brainstorming type meetings that were concluded with valuable information, further transposed into sketches and the final floorplan (Figure 4).

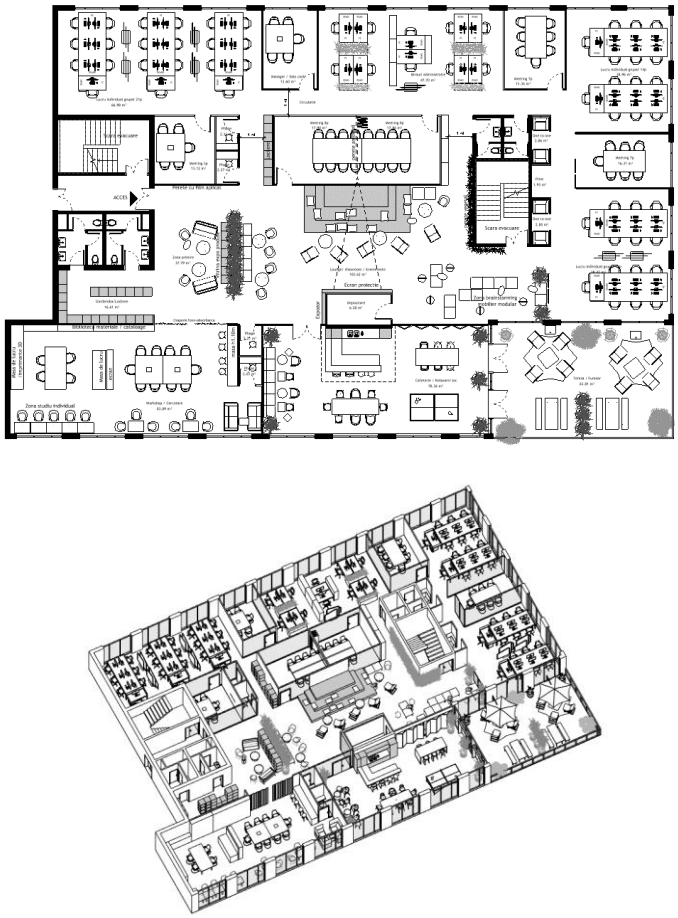

Fig. 4. Final design imagined by the team: plan and axonometry

The design strategy defined as “from inside to outside” allows a simple and exact way of defining well-proportioned surfaces, without expanding or downsizing any space. The functional scheme permitted multiple modifications and alterations, in a dynamic manner, before establishing a final blueprint of the proposed floor plan.

Comparing to the first sketches to the end result, the team members opted for more interleaved closed spaces such as meeting areas of various capacities and also the enclosure of the kitchen/common area, that was an important aspect from acoustical and olfactory reasons. The core of the layout is the presentation and showroom space, in the scope of creating an attractive point to gather all occupants. Individual and administrative desks are organized on the perimeter, far from the noisy activities and close to natural light. The teams are separated by enclosed meeting rooms and phone booths, allowing quick gatherings, project work and discussions without altering the general concentration atmosphere.

The second team showed a greater inclination towards design tendencies such as biophilia, greenery and comfort, due to the presence of the Millennial generation in a higher proportion. Flexibility was promoted and agreed upon by all team members and certain technical details (furniture, economical strategies and acoustics) were expressed by the more experienced members.

3.4. Third stage: Survey on intergenerational cooperation during the "Generations at work" research

3.4.1 Methodology

Apart from the actual projects, the authors conducted an online questionnaire to understand the teamwork in an intergenerational context during the development of the projects. Although the survey does not hold statistical relevance, being answered only by the two teams-members, it offers important qualitative insights into the work process from an intergenerational point of view. Each respondent could choose more than on response (usually 3 or 4) and each response counted as unit in the graphic. The questions were elaborated during the space design period, as an ongoing process based on the behavioral observation regarding differences in the communication and work approach.

The information collected and analyzed included:

- favorite remote communication channels;
- differences in task approaching and completion;
- methods of activity planning and organizing;
- positive and negative aspects identified in the collaboration with other generations;
- proposals to improve future intergenerational cooperations;
- suggestions of spatial design that resulted from intergenerational collaboration.

3.4.2 Research results and discussions

The results, that are mainly qualitative are presented as follows. As seen in Figure 4, the survey shows that there are significant differences in the means of remote communication: young people use mainly WhatsApp and Hangouts, employees with less than 15 years of working experience use e-mail, WhatsApp and Google drive, and employees over 15 years of working experience use e-mail and Skype.

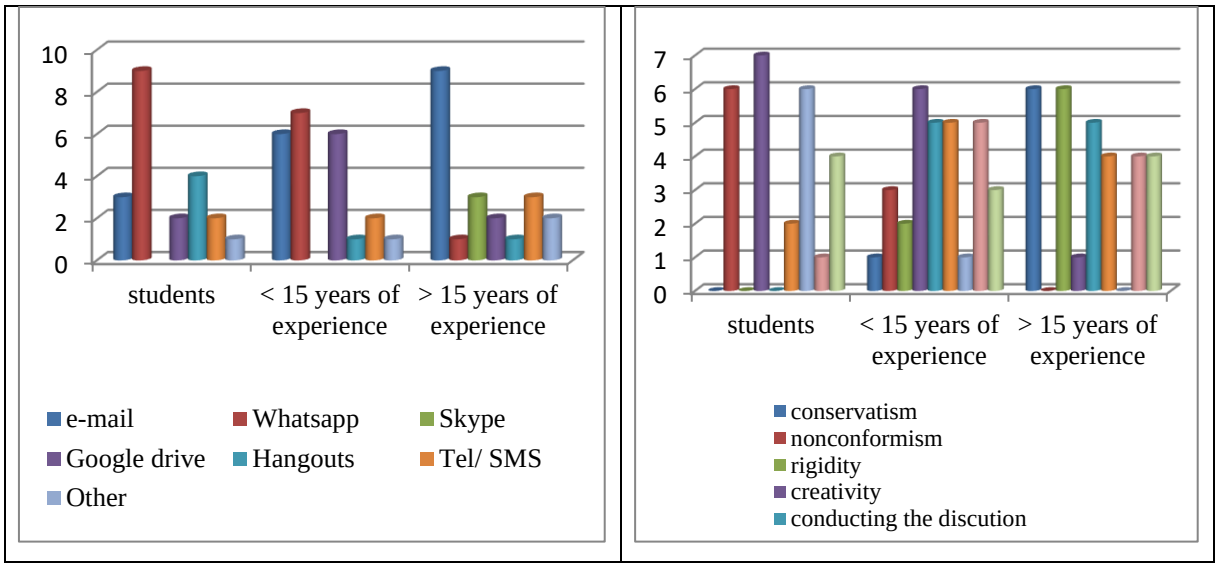

Fig. 5: The favorite means of remote communication | The style of tasks approach

Several differences have been observed concerning task fulfillment (Figure 5): students' style is characterized by nonconformism, creativity and fun, employees with less than 15 years of experience are seen as creative, flexible but with a tendency to conduct the discussion and impose their own point of view, and employees with over 15 years of experience are seen as conservative, rigid and also with a tendency to conduct the discussion.

The analysis shows consistent differences between the way people from different generations plan and organize their activities. Thus, the young generation (students) is characterized by relaxation and unstructured thinking, while employees with less than 15 years of experience and over 15 years of experience are seen to plan and organize in a responsible, consistent and focused way.

Work in intergenerational teams was also investigated in this survey, regarding the perceived positive and negative aspects of such collaboration typologies both before and during the lockdown. Broader work experience has helped implement certain behavioral habits such as structured schedules, motivation and involvement.

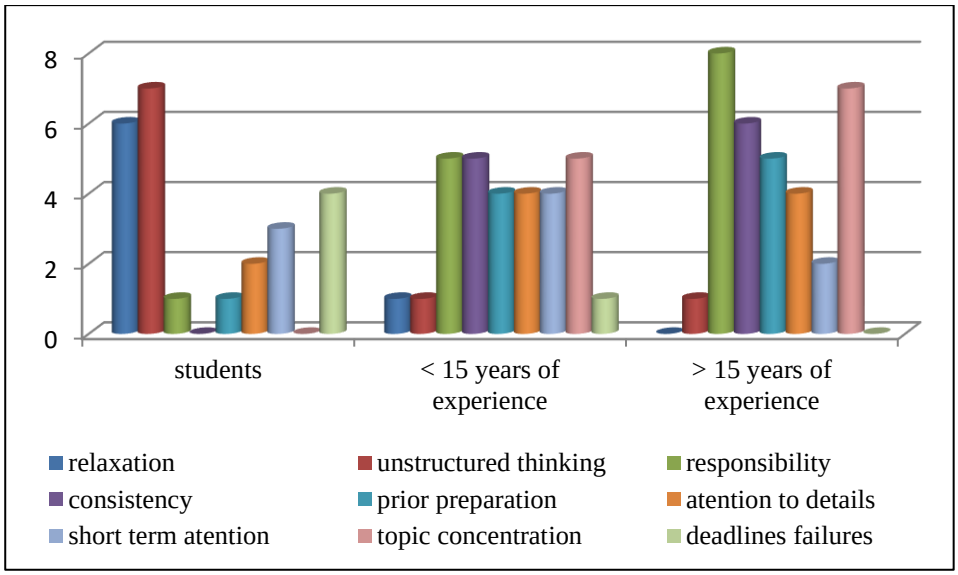

Fig. 6: The modalities of planning and organizing the activities/ tasks

Focused work and concentration on longer tasks are important assets of these generations, comparing to younger ones that tend to get distracted easily. Experienced workers are used to clear spatial and temporal differentiations between home and work and are not as well acclimatized to fast technological changes. Decisions regarding work-life balance, establishing a new work routine and keeping connections alive by online methods were aspects that took longer to implement in older generations than other active generations, but were mandatory for belonging to a community. Thus, they were able to discover new, more simple means and tools of communication while exchanging with other generations.

As far as the Millennial generation, they have already established personal and common work strategies while using many digital tools along the way. They were already used to switching between home office and regular workplace, so the transition was easier, as they prefer independence and development of personal hobbies. The high advantage of Generation Z an Y is the good manipulation and quick adaptation to technological changes, but intergenerational collaboration is key for all generations to thrive, exchanging skills and habits.

Digital Natives needed a more structured schedule, as they come from the academic environment with strict predefined schedules and do not yet have the discipline to focus and engage in activities on their own. They seemed to lack short-term attention and were last to take the initiative or commit to certain ideas. Although they are not as attached to habits and space, sudden freedom and uncertainty of the pandemic context, were felt as negatives in younger generations, although remote work seems modern and interesting at first.

Resulting from the research, there are several directions to be considered for intergenerational collaboration improvement: fostering collaboration relationships helps exercising communication skills, both online and face-to-face, well-scheduled meetings are important for the success of any project, task assignment planned by members of more than one generation is relevant for diversity and strengthens the collaboration. Taking time to clarify misunderstandings and different points of view is inherent in any cooperation, especially intergenerational where there are differences that need to be considered. Encouraging and supporting young people to take initiative can lead to interesting results, but in the same time the presence of one or more people to assign clear tasks, motivate and organize is important. Flexibility is oftentimes beneficial to creativity, an asset that older generations can experiment.

3.5. Generations at Work research and the COVID-19 pandemic

An important part of the second stage of Generations at Work research was developed during the pandemic lockdown. The positive outcome of the research resides in its initiation during normal conditions of face-to-face collaboration, thus leaving the final part of the project, presentations, evaluations and awards to take place in a virtual context. Collaboration strategies shifted from face-to-face interaction to digital means of communication, showing clear differences of adaptation depending on generation. This meant use of technology to get the work done, but in conditions of common knowledge developed before, during face-to-face meetings, when the research participants shared time, explored their habits together, emotions and thoughts creating thus a common thinking framework.

Regarding the first stage results of the Generations at Work research, we observed that almost all the important work motivations are social, as people need a sense of belonging to the group to share feelings and recognize a personal and group evolution when being part of the team. An important factor to build this culture and social life is the physical space and direct human interaction. All those aspects are also reflected on the workspaces proposals from the second stage of Generations at Work research.

4. Conclusions

The socio-economic environment is rapidly changing and so is the way people relate to work. Nature of work changes so economic and management theories need to adapt towards the worker. As we enter more into the knowledge society the worker needs to be seen as a multi-dimensional entity, understanding his level of technology mastering, his cultural and educational background, the space where he works and last but not least what the meaning of

work represents to him. Work cannot be viewed as separated from the people who perform it, for, nowadays, attitudes as initiative, creativity and engagement demand more than a pay check, as the meaning of work becomes the main and real motivator.

The development of Facility Management in the direction of the workplace management is a consequence of the organizations needs to develop all necessary tools, as "New Ways of Working" and the entire support facilities, to enhance the organization's sense of community and culture, but also to increase innovation, creativity and initiative.
On the other hand, for human beings, having a meaning of life and work is also essential. In the context of AI development this question is a central philosophic question, but also a key question in the "Future of Work" field of thinking. What seems a certainty in the future is that, for the humankind, the need of the community feeling and meaning of life will be found on the long term in the professional work organizations.

The intergenerational cooperation and work will increase in importance and an appropriate approach is indispensable. Our findings suggest that there are significant differences on the design people with different age and work experience prefer.
Thus, young people proposed a more unstructured/ informal/ egalitarian space, teamwork/ relaxation/ socialization oriented, defined by simplicity and flexibility while experienced employees proposed a more structured/ formal/ hierarchical space, oriented toward individual work/ organized teamwork, defined by organization and efficiency.

These qualitative findings were reinforced by the responses of the team members to the questionnaire. Thus, it is obvious, regarding the means of remote communication, the increasing use of email and a decreasing use of WhatsApp the older the respondents and a tendency toward conservatism, rigidity and the desire to conduct the discussion of the older comparing to nonconformism, creativity and fun of the younger (students). About the modalities of planning and organizing the activities/ tasks we conclude that young people are relaxed, unstructured, and often fail to meet a deadline while the experienced employees are more responsible, consistent and topic focused.
The main idea of the conclusion is not to put the generations on opposite positions but to try to benefit from the strengths of each generation by allocating tasks and structure the work process, and as a consequence the office design, in a way that facilitate an effective interaction and cooperation between them.

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Science meets Practice II:

Technology and Operation

Implementation of a virtual occupancy sensor for smart building support

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Abstract

Advancements and wide availability of cheap sensors are fuelling the development of Internet of Things (IoT) applications. More sensors mean more data, and more relationships between data points need to be tracked in order to effectively understand, manage and control systems. Having access to either real-time presence data or patterns extracted from historical data is particularly valuable when dealing with facility design and management due to their direct correlation with energy consumption and indoor comfort. We propose a straightforward, cost effective and privacy-preserving method to extract the occupancy information. By aggregating semantic knowledge, motion sensor data and data from dwelling entrance doors, a robust virtual occupancy sensor has been developed; it is underpinned by an ontology that was developed on top of the set of standard ontologies like Building topology ontology (BOT) and Smart appliance reference ontology (Saref) that allowed describing all relevant datapoint and demo site metadata and enabled automated processing of collected data. The method is replicable to all built environment described in a similar way where motion information is collected and where there are clear boundaries of monitored space, and the occupancy information can be useful in different application cases. While predictive occupancy models or expensive sensing alternatives have been already exploited for similar purposes, our solution is simple, inexpensive, replicable and easy to implement in existing buildings.

Keywords: facility management, smart building, semantic web, occupancy, residential, accommodation

1. Introduction

The building sector and activities of people in buildings are responsible for approximately 31% of global energy demand (Ürge-Vorsatz et al., 2012). Thermal comfort services (heating, cooling, ventilation) account for 36% of operational energy demand in buildings. Depending on the region and building sector, these loads are usually controlled either manually or using predefined schedules. While predefined schedules are effective in reducing unnecessary energy usage, once they are commissioned, they are usually not adapted to changing conditions. Operation of thermal comfort services based on occupancy has been proposed before and has been shown to offer significant savings compared to fixed schedules and manual control.

Occupancy detection is typically implemented by using infrared motion detectors that signal the change of temperature. Mathematically it is a nonlinear integration over the temperature in the field of sight. These sensors are affordable and are therefore widely deployed in buildings, typically in combination with a timer that deactivates after a configurable time period. The shortcomings of these sensors are twofold: first, they are not presence detectors i.e. a person that does not move, is not detected; second, persons are only visible if they have a temperature difference to the environment, thus the accuracy decreases in hot environment or when people are fully covered in clothing (e.g. outside in winter season). Still, this type of sensor is the most common solution for applications like automatic hallway lighting, sanitary facilities and generally rooms where people are moving in and out.

Optical sensing methods improve the quality of presence detection but have the problem of compromising privacy; feasible solution is an edge device that pre-process the data and reduce information to anonymous data like a person count. Such devices are available on the market but serve a higher price segment than is commonly feasible for residential or office building applications.

The authors in (Zucker et al., 2017) followed another approach that does not employ any additional sensors: by using the available sensory equipment in the ventilation system, it is possible to make a good estimate of the number of people in a room. The method requires to configure the volume of the room and an estimation of the average CO_2 production of a person. It then calculates the occupancy by using the CO_2 sensor in the ventilation system

together with the supply and exhaust air flow. Such approaches are used for advanced heating, ventilation and air conditioning (HVAC) control algorithms like the dynamic reset of volume flow (Lin and Lau, 2014). A similar approach was done in (Mir 2018) where the CO_2 level was fed into a proportional-integral-derivative (PID) controller that minimized the estimation error of occupancy dynamically. Authors in (Yang et al., 2013) compared performance of different machine learning techniques for binary and multi-class occupancy estimations using varying combinations of commonly used indoor sensors, and concluded that CO_2 sensors, door status and light sensors contributed the most to the accuracy of occupancy detection.

In the present work, a simple, cost-effective and privacy-preserving methodology for occupancy estimation has been developed. Making use of a semantic knowledge base which contains all the relevant information about an apartment building topology and device location, linked with a database of timeseries data from the appliances, we have generated a rule-based algorithm which infers occupancy state and uses it as a feature for consumption prediction models.

Concerning the semantic knowledge base, resource description framework (RDF) is a widely used standard for information exchange between different sources (*RDF - Semantic Web Standards*, n.d.). Atom of information in RDF is a triple consisting of **subject**, **predicate** and an **object** (Fig. **1**). This simple structure allows one to express relationships (predicate) that two concepts (subject and object) are in.

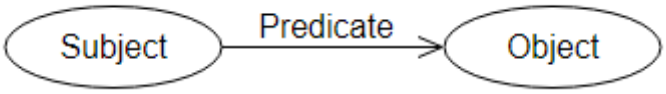

Fig. 1: Graphical representation of a triple

A collection of triples described using RDF forms a directed labelled graph. This enables creating complex network of relationships among concepts. Resulting graph can be explored (traversed) by each application needing the data contained therein, as long as different applications have a common understanding what nodes and relationships in the graph mean. Ontologies are used to define standard concepts and relationships that should be used by all complying application in order to have the same understanding of concepts used in the information exchange. In addition to data representation, it is also possible to deduce and infer the information that is not explicitly stored in the knowledge base.

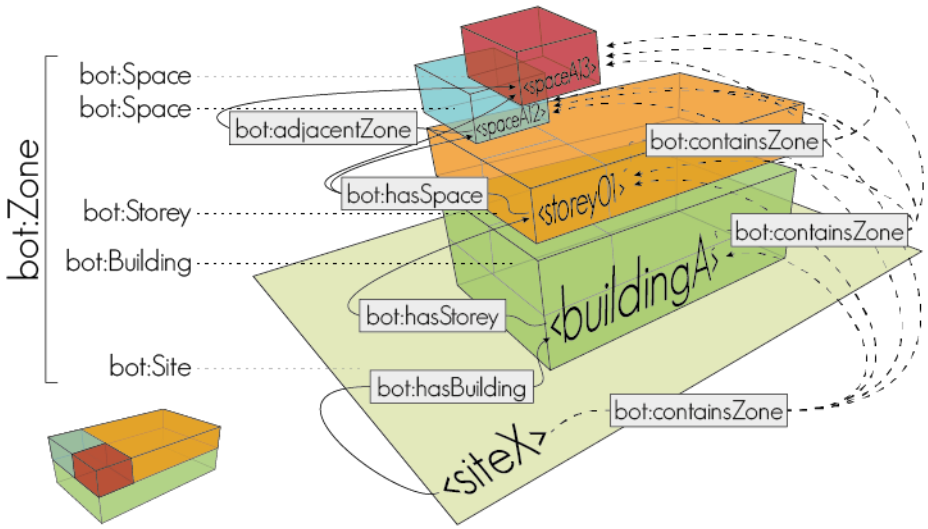

Fig. 2: Representation of spaces and their relationships in a building defined in bot ontology (Rasmussen, Pauwels, Lefrançois, et al, 2017)

In architecture, engineering and construction (AEC) industry several well-known ontologies, such as ifcOWL (Beetz et al., 2009) and Building Topology Ontology (BOT) (Rasmussen et al., 2017), are used to represent the architectural, structural and topological information about the building. ifcOWL can directly represent the information contained in an Industry Foundation Classes (IFC) files as an RDF graph. IFC (*Industry Foundation Classes (IFC)*, 2020) is the standard developed by buildingSMART International and BOT is an ontology focusing entirely on representing topological information about building spaces and elements and is aimed at being a building block for implementation of domain specific extensions on top of it. Fig. 2 shows how concepts defined in a bot ontology are used to represent spaces and their relationships in a building. Similarly, for describing building equipment, several ontologies have been proposed that are in active development. These include Smart appliances reference ontology (SAREF) (Daniele et al., 2015), and its extensions, among which the most relevant is SAREF4BLDG (Poveda-Villalón and García-Castro, 2018) targeting specifically building devices, and Brick ontology (Balaji et al., 2016). For specific use cases described in this work we used a custom ontology (Šipetić et al., 2020) built on top of BOT, SAREF and SAREF4BLDG ontologies.

2. Data

Most relevant information for the developed method for presence detection are detected motion, door opening and closing, and topology of monitored spaces and placement of corresponding sensors therein. As data sources, an InfluxDB database for collecting all the data recorded by

the sensors installed in several apartments of a residential building and, the ontology describing the topology of this specific site are available.

2.1. Sensor timeseries

Real time sensor data from a group of apartments are collected in the database. Data collected includes measurements of indoor conditions (temperature, motion, humidity), power consumption and door/window opening information. Each measurement is recorded in the database on-change with a different change threshold for each measurement type, which is advantageous for battery life and storage savings, but may lead to ambiguous information due to the uncertainty, whether the sensor is operational or not when no measurements are recorded for an extended period. To deal with this issue, we have taken advantage of the multi-sensing feature of the devices. Each physical sensor device measures several properties; for example, motion sensors also provide temperature and illuminance measurements, as well as the strength level of the sensors' signal to the gateway. This way, each time the sensor records one of its measurements, it is marked as operational. Missing data can be partially filled using this methodology. For still remaining gaps, different thresholds have been defined for each type of the measurement, which limit the maximum time a sensor can be inactive. After the measurement dataset gaps are filled, resampling is performed on a 15-minute interval to align all time series to the uniform time grid. The method of aggregating the values when resampling depends on the sensors' measurement type:

- Continuous variables – temperature, illuminance, humidity, … – are forward-filled
- Binary variables – motion, door/window opening, … – are summed up

2.2. Semantic knowledge base

In addition to raw time series data from sensors, an essential part of the approach is utilization of semantic information about the location of sensors and the topology of spaces. The demonstration site is completely semantically described, and this description is available in machine-readable form. In this section we present more details about the structure of static information.

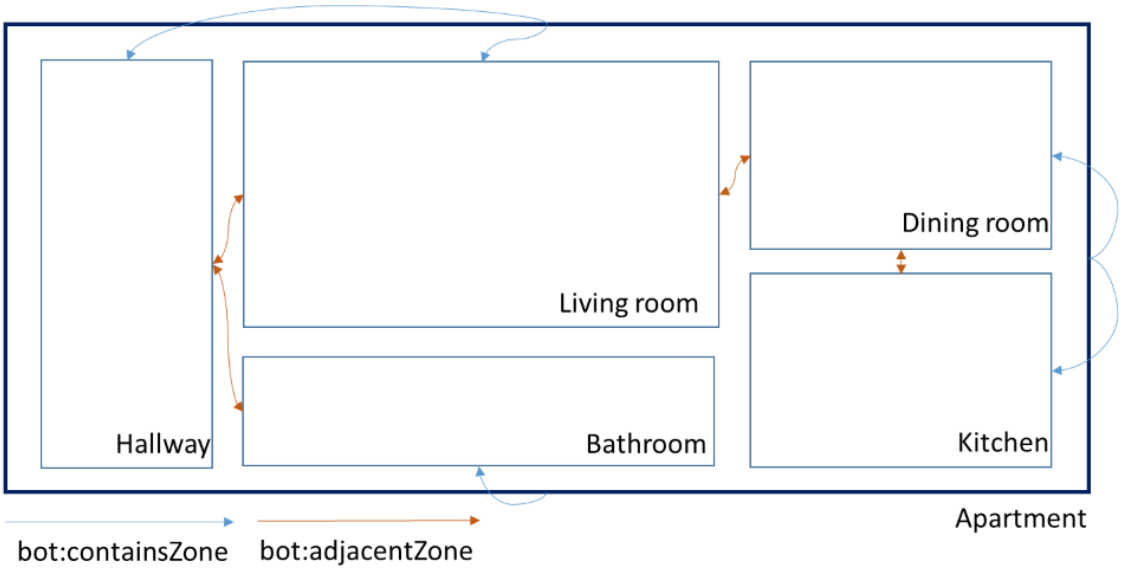

Fig. 3: Topology of an apartment with different spaces and relationships between them following BOT syntax

In Fig. 3 an example of a topology of an apartment is shown with bold largest box being an apartment, and smaller boxes inside representing spaces in the apartment. An apartment is defined as containing a number of different spaces using the **bot:containsZone** relationship (spaces are named zones in BOT ontology). As data is stored in a knowledge base that has a reasoning capability, each apartment space also has an implicit **bot:containedInZone** relationship in the direction of the apartment. That allows one to use either relationship for data querying depending on the convenience and the use case. Axioms defined in the BOT ontology state a number of such inverse relationships. Similarly, rooms have defined adjacencies between them, and adjacency in this context means the ability to move from one room to the other. In this case all the adjacency relationships (**bot:adjacentZone**) are reflexive, meaning when one is defined between two spaces, there is also an implicit relationship in the opposite direction. That allows one to freely form queries that would match entities from either direction.

Each room has a motion sensor placed in it, and that entrance door of the apartment is monitored by a door opening sensor. Door opening sensors, Fig. 4, are physical devices consisting of two parts which are mounted on the door and door frame, opposite of one another when door is closed. When door is opened, movement of the part mounted on the door causes induction in the stationary part, which is transformed into an “Opened” signal, that is sent to the automation system. Once the door closes again, the opposite “Closed” signal is sent.

Fig. 4: Develco door/window sensor

Fig. 5 shows how relationship between an apartment and its entrance are established. An internal wall is instantiated, which is shared by all apartments having entrance door that is part of the same wall. Internal wall is set to be adjacent to a specific space inside an apartment, so that it is clear in which space person enters first through said door.

The internal wall is linked to the door using the **bot:hostsElement** relationships, and door is linked to the sensor device using the same relationship. Another way of placing sensors is shown in the same figure with the example of second sensor that is linked to a containing room using the **bot:containsElement** relationship. Additionally, each of the physical sensor types installed on the site is modelled as a collection of sensors measuring specific physical properties. Possible properties of interest include, but are not limited to pressure, temperature, humidity, open/close state, flow, speed, etc. Each of the door/window sensors described here - apart from sensors for open/close state of the monitored doors - also contain temperature and humidity sensors. Fig. 5 (right) shows how the sensor device is composed of different sensing units. For example, the door sensor that is hosted by a door in Fig. 5 (left) consists of temperature sensing unit and door state sensing unit.

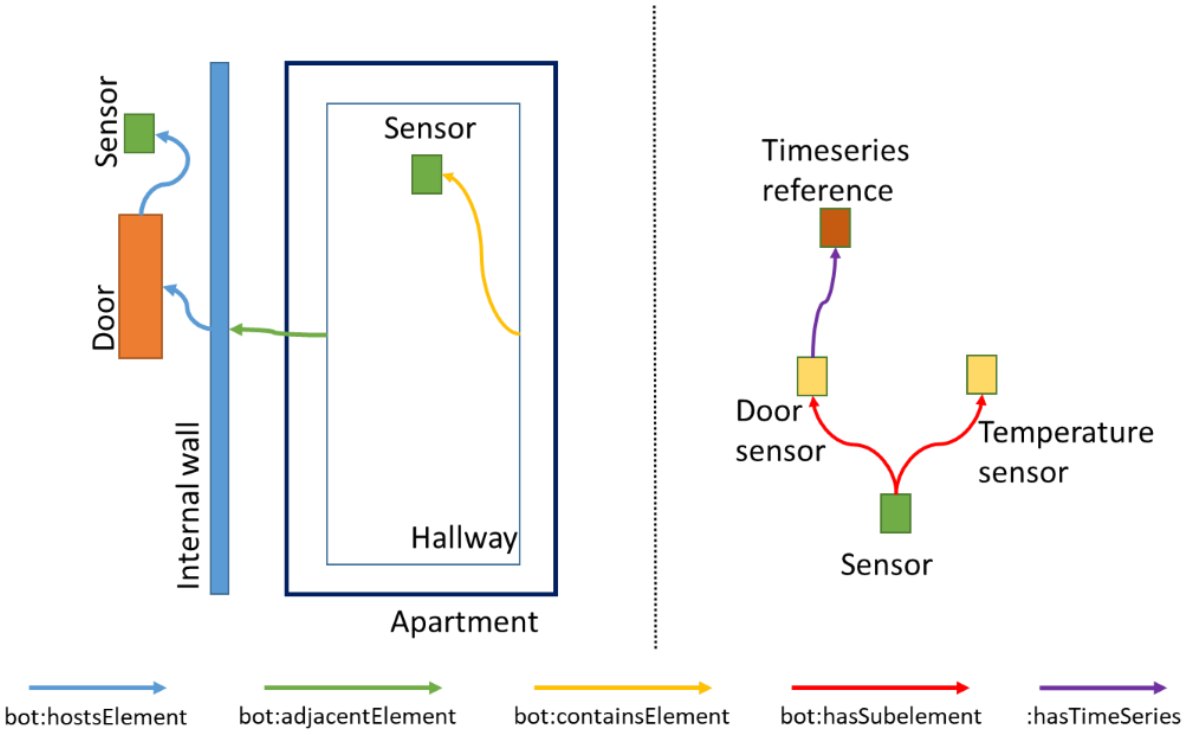

Fig. 5: Relationships established between sensors and building and space elements

Both of these send and store signals in separate time series on the data platform, and reference to these time series is stored in the separate timeseries reference entity that is associated with each sensing unit using the **:hasTimeSeries** relationship. Time series reference contains information such as **database name**, **table name** and **sensor id** when data is stored in the SQL database, or **measurement id** and **field name** when data is stored in time series database such as InfluxDB. Each TimeSeries entity is associated (**:storedInDatabase**) with the containing database as shown in Fig. 6. Database entity describes the specifics (host, ports, …) of each database instance used.

Knowledge bases also allow direct recording of time series into the data model, which allows some interesting use-cases where reasoning is possible over the values of data recorded for each time series. However, for production scenarios, this is usually avoided due to performance reasons, as large amounts of data such as data in IoT scenarios, in combination with reasoning usually cause performance issues.

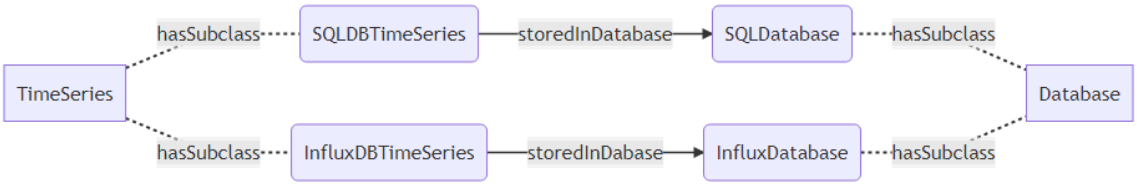

Fig. 6: Metadata structure linking database and time series concepts

3. Methodology

While CO_2 sensor information improves the accuracy of occupancy detection, CO_2 sensors were not available in our demonstration sites. Their high cost prohibits widespread use, especially in residential scenarios. On the other hand, door status and motion data were readily available in project demonstration sites. In addition to that, the space hierarchy, along with sensor and appliance locations and connection information has been collected previously in a separate effort, so all the semantic information was also available. While usage of additional sensors such as temperature, humidity, pressure, smart plugs and similar, could have been possible in some apartments, only the motion sensors were consistently available in all the spaces of the demonstration site, and door status sensors were installed on entrance doors of all the apartments. Limiting the requirements of the technique to just two measurement types simplifies replication. The required sensors are often present in existing smart home installations, and if they are not, retrofit action to add those is simple and inexpensive.

While more detailed space hierarchy, and sensor and device location information are useful in some other scenarios, for the proposed technique we use only the combined information about all the sensors contained in the monitored space, and door status of entrance to the monitored space. If more detailed information is available, it can be easily reduced to this data set, and if the solution is installed from the ground up in the monitored space, the limited data needs reduce complexity of describing the site.

Based on the above, we developed a technique for inferring occupancy using only two measurements: motion recorded within the apartment and entrance door openings. The key for extracting and combining relevant measurements easily from the entire dataset of the building is the knowledge base based on the previously described ontology, which returns the relevant ids of the devices to query from the timeseries database.

To cover different scenarios, two approaches for inferring occupancy will be presented: occupancy feature generation from historic data and real-time occupancy inference.

3.1. Using historic data

This approach is interesting for applications where occupancy information is needed as a historic feature or where the sampling frequency of the dataset is not precise enough, e.g. our use case, where data points are represented in a 15-minute interval.

The initial step is to extract the ids of the apartment's motion and door sensors and filter out all the doors and windows which are not connecting the common areas of the building with the apartment (i.e. all non-entrance door sensors). Window sensors have been filtered out to prevent interpreting state change of an e.g. open window on a windy day as an occupant interacting with the window. The necessary information can be directly queried from the database and processing started. Afterwards, the methodology is straightforward: the data available for inferring historic occupancy is divided into intervals between two door openings-closings and if there is any motion in between, the occupancy state is activated (in binary, 1); in the opposite case, the state is labelled as unoccupied. For the beginning and ending part of the dataset, the state can just be decided if there is any motion and if this information does not exist due to motion sensors not working, the state would be unknown until the next door-motion begins.

3.2. Real-time occupancy inference

For some applications occupancy state information based on real-time processing of data could be useful. In case of streaming operation, it is not possible to process intervals between door openings and closings as they are not available in real time. Instead the methodology is the following: after somebody enters the apartment, there is motion to be expected within the first minutes while the person or people entering the house settle down. Therefore, if the next few timestamps record any movement, the occupancy state will be activated and left unchanged until the next door-opening is recorded. The number of timestamps after door-opening to consider, which corresponds to the timeout of the virtual sensor, is a parameter that needs to be calibrated. The specific value to be used depends on the parameters of physical sensors used on the site. An example of a relevant sensor parameter is motion sensor hold (i.e. how long after the last detected motion will the sensor keep the motion flag set). Different statistical insights can be built to decide it wisely.

Fig. **7** 7 shows the proposed state change diagram for the virtual real-time sensor.

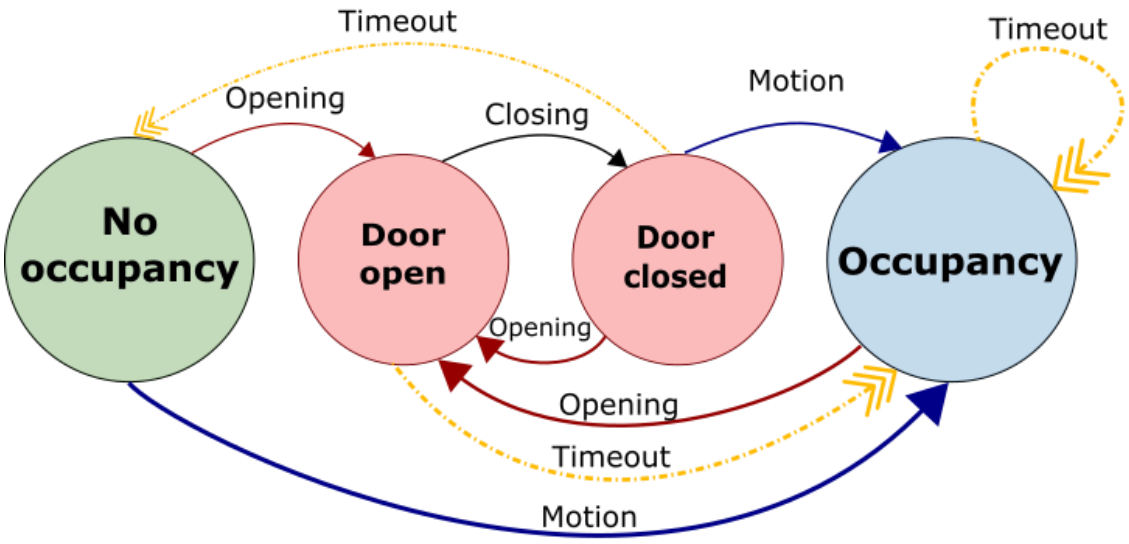

Fig. 7: State change diagram for occupancy inference

3.3. Validation and analysis

For validating our virtual occupancy sensor, as real occupancy information was not available as part of the dataset, visual inspection and statistical insights have been used for verification. First, a random apartment and a 2-day interval have been chosen to see how the aggregated motion of an apartment – aggregated by taking the mean value of all the sensors in the apartment into a single variable – door openings and inferred occupancy state look like when represented together. This can be seen in Fig. 8.

As is noticeable, the virtual occupancy sensor works as expected, the state does not change until the door openings happen and it is activated even when motion is not recorded. On the other side, even if the data used for the generation of this plot is resampled in 15-minute interval, i.e. coarser time resolution, at the timestamp after the door opening there is always motion recordings. This also shows how the online occupancy inference technique could be useful in the case of a coarser historic dataset.

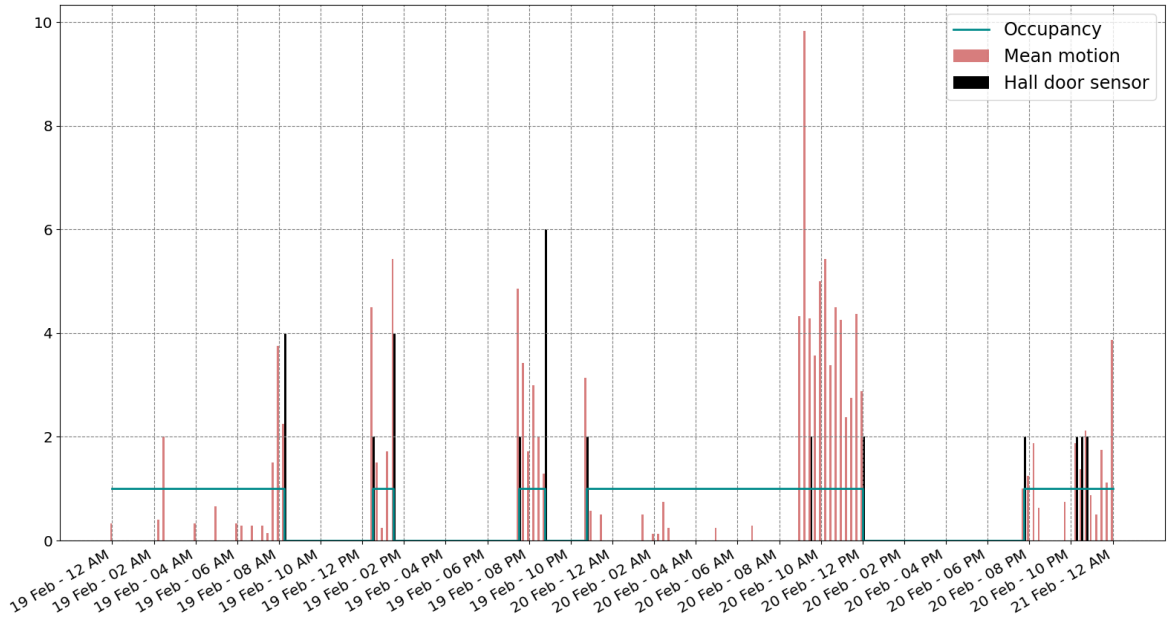

Fig. 8: Visual representation of the inferred occupancy info from mean motion and entrance door opening data

For getting a better insight how the online occupancy inference would work, it has been simulated with the current dataset. We have done this by calculating the ratio between the number of door openings which are followed by a non-zero motion in the next two timestamps and the total number of occupied states which follow a door opening. Therefore, a value of 1 would mean that the online methodology works as well as the historic data processing method and 0 would mean the opposite. Tab. 1 shows for 10 randomly selected apartments how these ratios are in general very close to 1, which means that online methodology is almost as accurate as the historic data processing method even when the resampling interval is very high for such an assumption to work.

Tab. 1: Ratios calculated dividing the number of door openings which are followed by motion in the next timestamp by the total door openings which are followed by occupied state

Apartment	**636**	**421**	**214**	**783**	**318**	**117**	**633**	**136**	**255**	**250**
Ratio	0.93	0.90	0.98	0.86	0.97	0.98	0.97	0.99	0.92	0.97

3.4. Possible drawbacks

Even if the methodology has worked for the use case we worked on, there are some general problems that could interfere with the inference. First, in our case no threshold has been imposed to consider a group of motion recordings as movements being made by a human occupant. Therefore, if there is a pet in the household, the motion sensor is placed in a way that

could detect its movement and the occupancy detection does not want to consider pets as occupants, the result would be incorrect. Some motion sensors have an option to calibrate the sensitivity, so that they do not detect motion of smaller objects.

Other common problems include hardware issues, where e.g. door recordings cannot be sent to the database due to a failure of the sensor or a loss of connectivity. In this case, both methodologies would have similar problems assigning correct occupancy states in time intervals when hardware issues occurred. As previously mentioned, several methods for identifying data gaps have been developed that can detect such issues. One of the ways of dealing with them is to assign an "undecided" state for those periods, so that possible automations that depend on correctly detected occupancy information are not activated erroneously.

4. Relevance for Facility Management

Occupancy information can provide facility managers insights about the people flow dynamics and recurring patterns within a building. The methodology can be extrapolated to all kinds of buildings for which there is populated semantic knowledge base as well as all the necessary sensors.

For office buildings, the historical data of room occupancy can be compared with the expected or reserved room capacity, for example by analysing if room bookings are actually used or if there are vacancies in the reserved rooms, allowing for a reduction of rented office space. Depending on the location of the motion sensors, motionless workers cannot be detected using just motion sensors - our methodology proposes a solution to this shortcoming of commonly used motion sensors. In the case of hotels, this privacy-preserving and cost-effective occupancy inference methodology could be useful for monitoring rooms to know whether to dispatch cleaning staff without the need for customers to put "do not disturb" signs. It could also be used in automation scenarios to safely turn off heating or cooling equipment turned on by the occupant that has left the room. Finally, in residential buildings several safety-related scenarios are imaginable where non-occupancy in connection with activated high-energy devices such as heating bodies or stoves and ovens could be cross checked to detect dangerous situations and cut power or alarm the designated persons.

5. Conclusion and future work

Further integration of available sensor information with topology semantic knowledge will continue to improve the operation quality for technical facility management. Research continues in the direction of sensor fusion, by putting together virtual sensors that use different data source like temperature, CO_2, door contacts, illuminance and other existing sensors. Merging this information can improve indoor air quality, comfort, energy efficiency, and especially operation costs. Occupancy state is relevant for different industries in the building and should therefore be a central data source for HVAC systems, room management and security applications. We see a potential for usage of detected occupancy in several areas. Occupancy state can be used as a more accurate input for building more accurate machine learning occupancy models. More accurate occupancy models can be further leveraged for HVAC system operation optimization scenarios, such as preheating. Furthermore, detected occupancy state could be directly used for automatic turn off on no occupancy. Our simple method, connecting semantic knowledge with sensor data, provides a robust occupancy state detection which can be used in historic or streaming data processing scenarios. When required time series are already available, replication of the method is cheap and simple, and required manual work is limited to describing the related spaces, locations of sensors and links to collected time series using a predefined ontology. As future work, the idea is to use this feature to improve energy consumption prediction models using different aggregated and processed forms of it, as cumulative presence or via a pattern analysis.

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The Upwards Trend of the Outsourced Facility Service Industry in Germany and Austria

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Abstract

The Facility Service (FS) industry is a growing industry. A study (Redlein and Stopajnik 2019) showed that the FS industry grew faster than the rest of economy in Germany and Austria between 2008 and 2016 in terms of value added and employees. To get a better understanding of this development further analysis are necessary: The influence of part time workers is not yet clear and it is not yet clear if the development of value added is driven by personnel costs or profits. Furthermore, it is necessary to investigate which specific FS activities led to that increase.

To answer these questions EU statistics and European norms are used: The European standard EN 15221-4 lists all services that can be considered FS. Eurostat lists economic activities on a detailed level. Those activities are matched with the activities of the EN 15221-4. The selected items of statistics from Eurostat are used to determine the FS industry. As measures full-time equivalents, wages and salaries, personnel costs and profits are selected next to valued added at factor cost and the number of employees. Based on this approach, the development of the FS industry is analysed. To make a comparison possible the FS industry is set into relation to the whole business economy for each measure.

Results show that in Austria and Germany high increases can be registered in the FS activities cleaning, janitoring, building installations and security. Results show that the FS industry grew faster than business economy in terms of full-time equivalents. In Germany, there were no decreases for any FS activities in terms of profits, value added, personnel costs or wages and salaries. In Austria some FS activities such as steam and air conditioning supply, water treatment and supply showed slight decreases.

Keywords: Facility Services, industry growth, employment, value added

1. Introduction

The Facility Service (FS) industry grew faster than the rest of economy in Germany and Austria between 2008 and 2016 according to a study (Redlein and Stopajnik 2019). The selected measures for the time series were value added and the number of employees. In order to get a better understanding of this development further analysis of measures and their relations are necessary: The influence of part time workers is not yet clear and it is not yet clear to which extent the development of value added is made up by personnel costs and profits. Furthermore, it is necessary to investigate which specific FS activities led to that increase. Therefore, the research questions are:

- Which specific FS activities cause the upwards trend of the outsourced FS industry between 2008 and 2016 in Germany and Austria?
- What influence do the measures full-time equivalents, wages and salaries, personnel costs and profits have on the development of the outsourced FS industry?

2. Background

There is a lack of reports and analysis of the FS industry. This is mainly due to the fact that the FS industry as a whole is not represented in the Statistical Classification of Economic Activities in the European Community, called NACE. (European Commission 2008) NACE is the official classification system of industries in the EU and all EU member states. Most official reports about industries are based on this statistical classification. As the FS industry as a whole is not listed in the classification, it is also not listed in the reports and therefore lacks recognition.

Furthermore, there are different understandings of Facility Management (FM) and FS in different countries and organisations. Around 2006 FM still has been a developing business area. To create a common understanding and approach of FM and FS the European norm EN 15221 was created. This was also necessary to increase transparency. (British Standards 2007, EuroFM 2011). In this norm FS is defined as “support provision to the primary activities of an organisation, delivered by an internal or external provider”. (British Standards 2007) In 2012 the norm was extended and a list of activities that can be considered FS was added and published in the fourth part of the norm: EN 15221-4 (British Standards 2012). For this analysis the list published by the EN is used.

The NACE structure is also used by Eurostat, the data base of the European Commission. Eurostat provides a huge open-access data base for governments, businesses, the public and anyone else interested. (European Commission 2019a) Part of the database are also Structural Business Statistics (SBS). The data displayed in SBS is collected by the national statistical offices of the EU member countries and annually transmitted to Eurostat. National statistical offices collect the data from other administrative sources, business registers or with the help of surveys. SBS include annual enterprise statistics in which data about the number of enterprises, turnover, production value, value added, employment, etc. is provided. This data is available on the most detailed level of the NACE structure, so data for several hundred economic sectors is there. SBS include all sectors of business economy except for agriculture and personal services. (European Commission 2019b)

In the previous study the measures number of employees and value added at factor cost were selected. (Redlein and Stopajnik 2019) The number of employees includes part time and fulltime employees. As the proportion of part time workers can vary between industries this has to be taken into account. The second measure gross value added at factor cost "can be calculated from the gross operating surplus by adding personnel costs". (European Commission 2013) As it mainly consists of personnel costs in most industries it's also an indicator for income. Therefore, it would be crucial for the analysis of the industry to find out if profits rose and if employees profited from the increase. As income is spent by the people that earn it, it is given to other people and creates further value this way.

3. Methodology

To answer the research questions the data from Eurostat and the EN 15221-4 were used: The list of services that are FS from the EN 15221-4 was compared to the NACE structure on the most detailed level. So, the relevant industries for FS were identified. They were grouped into the two groups "Typical Facility Services" and "General Facility Services". Typical FS for the operation of business and residential buildings cover activities such as cleaning, maintenance, janitorial services and security services. General FS include services such as water supply, sewerage, waste management, office and administrative support services.

Then the data base of Eurostat was analysed. First the relevant measures to answer the research question were chosen. Next to value added at factor cost and employees the following measures were selected: Personnel costs, gross operating surplus, wages and salaries and employees in full time equivalent units.

The data for those measures for Austria and Germany were selected for 2008 until 2016 from Eurostat and checked for their plausibility and reliability. First the data sets were checked for missing values. For the determination of the FS industry only years are shown when the data sets were complete or if missing subindustries were less than 0,75% of Total FS in the other years. Secondly the continuity over time was checked. Thirdly, ratios such as value added per factor cost were calculated as a plausibility check. Fourthly outliers and their causes were investigated. The checks showed that all data could be used for the calculation, only data for the financial sector had to be excluded. The financial sector is only recorded from 2013 onwards and there is too much missing data, so that this sector would provoke extreme dips due to that. As a relation total-nonfinancial business economy was determined, to make a comparison between measures possible. The data is presented in percentage of total non-financial business economy and in absolute numbers.

4. Results

Employment

The first analysis concentrates on the question why the FS industry shows such a great increase in employees. As the previous analysis didn't differentiate between part- and fulltime workers, the graphic shows the number of fulltime-equivalents (FTE) working in FS in Austria and Germany from 2008 to 2016. The graphic shows that in Germany the number of FTE in FS and in total-nonfinancial business economy increased constantly. This also happened in Austria in FS but compared to Germany the increases were smaller so that it is not visible in the graph. In Austria from 2008 to 2016 the FS sector gained about 20.000 FTE. Also, total nonfinancial business economy increased constantly in Austria, only in 2009 and 2010 after the economic crisis it decreased. This shows that the FS industry is quite robust during and after recession. As the previous study already stated, there are certain FS activities such as maintenance, janitorial services, services connected to water supply and waste management that are very important. Even during a crisis, they cannot just be cut. (Redlein und Stopajnik 2019)

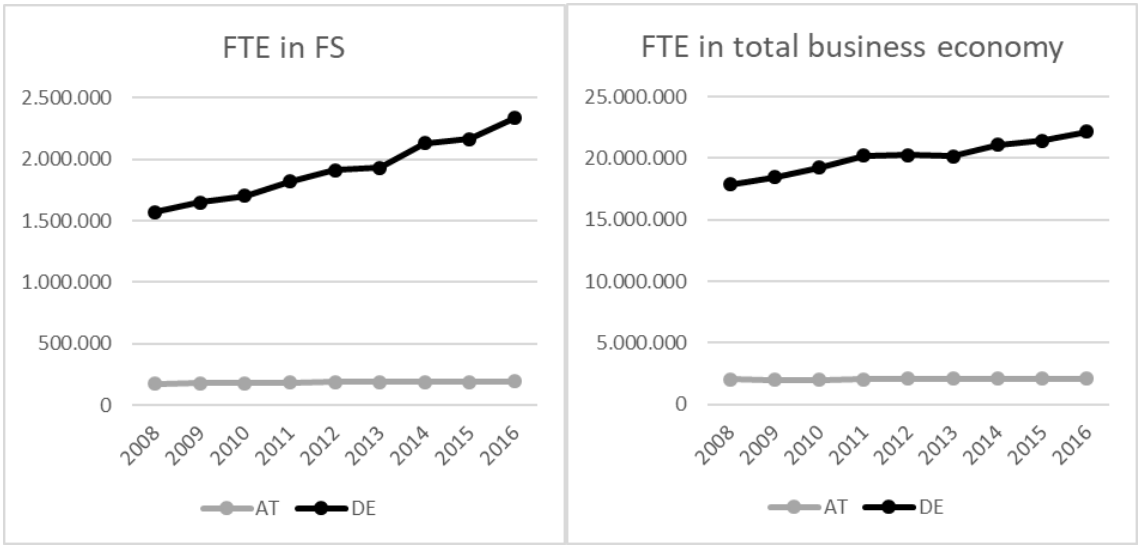

Fig. 1. Left: FTE in total FS, right: FTE in total non-financial business economy, own calculation on the base of annual detailed enterprise statistics (European Commission, last modified 2019)

Fig. 2 shows the proportion of FS-employees in total non-financial business economy in FTE and number of employees separately for the two countries. In Austria there is almost no difference between the proportion of FTE and the proportion of the number of employees. This means that in the FS industry employees have almost the same average working hours as in total non-financial business economy. However, there is also a slight upwards trend visible. This means that actually the FS industry grew a little bit faster than total economy.

In Germany, there is a huge difference concerning the proportions of the FTE and the numbers of employees. Both follow the same trend but the proportion of the number of employees in percentage of total number of employees in non-financial business economy is much higher. This can be explained by fewer average working hours in FS than in the rest of business economy. Based on the assumption that a FTE works 40h per week, employees in FS in Germany work on average around 25 to 26 hours per week, while employees in business economy rather work 30 to 31 hours per week. In Austria the average working hours for employees in FS and in business economy are about 30 to 32 hours. (Own calculation based on the SBS from Eurostat (European Commission, last modified 2019))

However, the over-proportional increase of FS employees in Germany cannot be explained by that because also FTE increase over-proportionally compared to total FTE in business economy. So, a deeper analysis including other industries and the subindustries of FS is necessary.

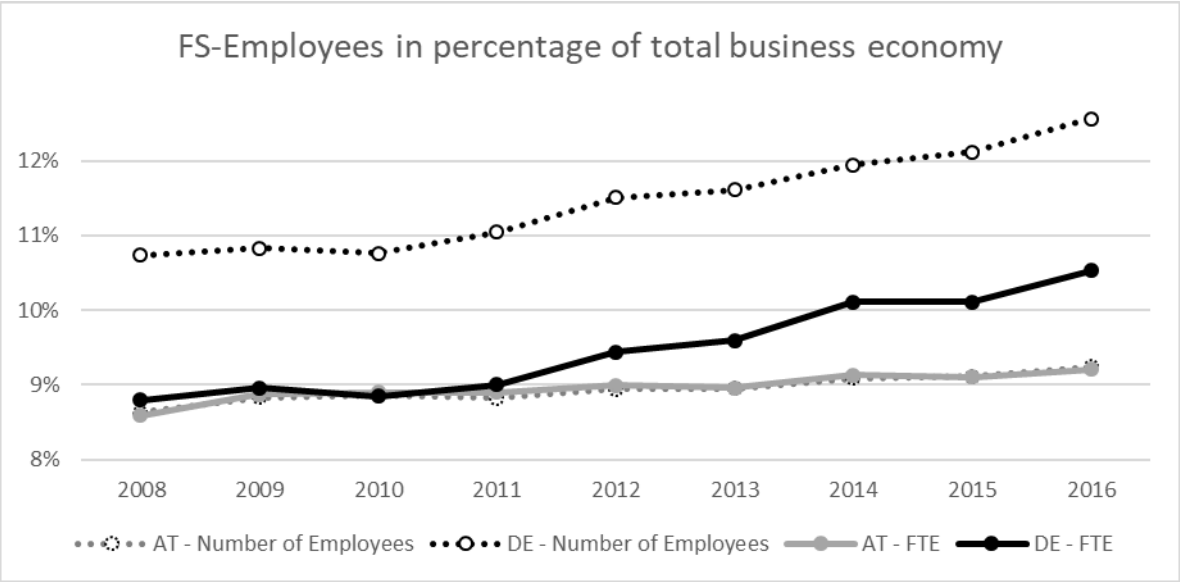

Fig. 2: Number of employees as a percentage of number of employees in non-financial business economy and FTE as a percentage of FTE in non-financial business economy, own calculation on the base of annual detailed enterprise statistics (European Commission, last modified 2019)

Analysis of subindustries and other aggregated industries

A deeper analysis in Austria shows that the increases in the FS industry were mainly due to three subindustries: The subindustry general cleaning of buildings gained almost 9000 FTE, janitorial services gained approx. 4100 FTE and building installations gained almost 5000 FTE from 2008 to 2016. Considering a total increase of about 20000 employees in FS this shows that the increase is made up by typical FS. The other subindustries showed slight positive or negative changes.

A comparison of the FS industry and the other aggregated industries shows that the transportation and storage sector, the manufacturing sector, mining and quarrying and electricity, gas, steam and air conditioning supply show decreases. That could be the reason why the FS industry increased over-proportionally to total business economy.

An analysis of the FS industry in Germany shows immense increases in certain subindustries from 2008 to 2016: In building installations there is an increase of more than 200000 FTE, general and specialized cleaning of buildings gained 140000 FTE, catering increased by around 100000 FTE, security services by approx. 70000 and janitorial services by 40000 FTE. This is already more than half a million FTE.

On the other hand, other aggregated industries showed a decrease like the mining and quarrying sector or only very slow growth like gas and electricity supply. So, in terms of employees it

must be stated that it is correct that the FS industry grew faster than total non-financial business economy. In Germany it is partly due to a lower number of working hours in FS.

Other measures

Due to missing values in Germany an analysis for the measures value added, profits, personnel costs and wages and salaries are only possible from 2011 onwards.

In Germany there were no decreases for any FS activities in terms of profits, value added, personnel costs, wages and salaries between 2011 and 2016. Only a small decrease in wages and salaries per full-time equivalent for move management and specialized cleaning of buildings is visible. The over-proportional increase rather results from decreases in other industries of business economy such as mining and quarrying (for all variables) and electricity and gas sector (value added and profits) and transportation and information and communication (only profits).

In Austria the same decreases can also be seen in the sectors of mining and quarrying and electricity and gas. However, in Austria the situation of the FS industry is a bit different: While the FS industry as a whole increased over-proportionally to business economy some FS activities also show slight decreases. Namely steam and air conditioning supply, water treatment and supply and combined office administrative service activities decreased in terms of full-time equivalents, personnel costs and wages in total and wages per full-time equivalents. The reason for this decrease may be that offices were still rented but the use decreased. Therefor these operating costs depending on the current usage decreased.

Losses in profits were registered for catering activities, steam and air conditioning supply and the management of real estate. All in all, it can be stated that the need for very typical FS activities has been increasing in the past years.

Value added, personnel costs and profits

Fig. 3 shows gross value added at factor cost and its components profits (gross operating surplus) and personnel costs in million euro for the FS industry and total non-financial business economy for both countries separately. It is visible that the personnel costs are increasing constantly – this is going hand in hand with the development of the FTE. The graph also shows that the variations in value added are the same as in profits. Not surprisingly this shows again that employment is much more stable than profits. A crisis first affects profits. This has different reasons, one might be that the firing and recruiting processes take some time and there are legal obstacles to lay off too many employees without previous notice.

Profits in Germany and Austria in the FS industry are between 32% and 38% of value added, in Germany they are a bit higher.

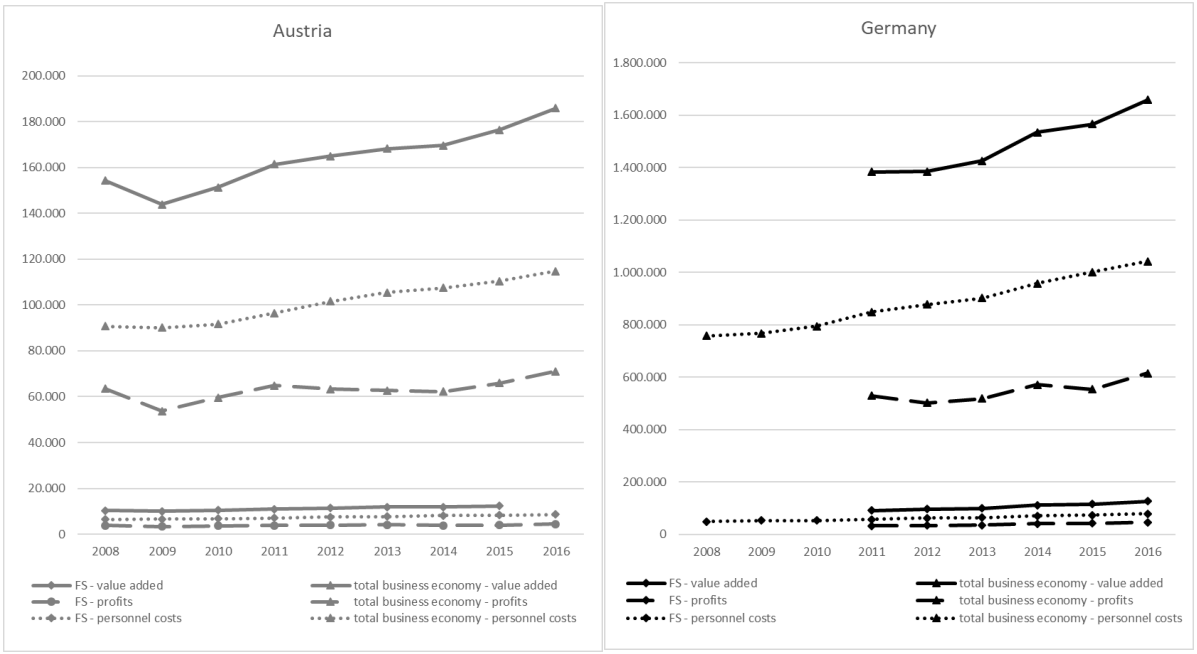

Fig. 3.: Value added at factor cost, profits and personnel costs in million euro in the FS sector and total non-financial business economy, left: Austria, right: Germany, own calculation on the base of annual detailed enterprise statistics (European Commission/Eurostat, last modified 2019)

5. Conclusion

Results show that in Austria and Germany enormous increases can be registered in the FS activities cleaning, janitoring, building installations and security. Results show that the FS industry didn't only grow faster than business economy as a whole in terms of employees but also in terms of full-time equivalents. The main reason for that is that other industries increased less or decreased. However, in Germany the lower number of working hours in FS might partly be influencing this trend also.

In Germany, there were no decreases for any FS activities in terms of profits, value added, personnel costs or wages and salaries. The over-proportional increase rather results from decreases in other industries of business economy such as mining and quarrying, electricity and gas sector, transportation and information and communication. In Austria the same decreases can also be seen in the sectors of mining and quarrying and electricity and gas. However, in Austria the situation of the FS industry is a bit different: While the FS industry as a whole increased over-proportionally to business economy some FS activities also show slight decreases. Namely steam and air conditioning supply, water treatment and supply and combined

office administrative service activities decreased in terms of full-time equivalents, personnel costs and wages in total and per full-time equivalents. Losses in profits were registered for catering activities, steam and air conditioning supply and the management of real estate. All in all, it can be stated that the need for very typical FS activities has been increasing in the past years. The analysis of value added, personnel costs and profits show that employment is much more stable than profits. This is helpful during a recession because people longer receive an income which is spent again and so creates income for other people.

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