European Commission

R&I for a Fair Digital Transition

Project review and policy analysis

European Alliance for Social Sciences and Humanities
Study finalised in 2022 and published in January 2024

EASSH
European Alliance for Social Sciences and Humanities

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Directorate-General for Employment, Social Affairs and Inclusion
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The views expressed in this paper are the views of the authors and may not, under any circumstances, be interpreted as stating an official position of the European Commission.

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List of abbreviations

AI: Artificial Intelligence

DESI: 2021 Digital Economy and Society Index

LDA: Latent Dirichlet Allocation

MCA: Multiple Correspondence Analysis

SDG: Sustainable Development Goals

SSH: Social Sciences and Humanities

RRF: Recovery and Resilience Facility

R&I: Research and Innovation

VET: Vocational education and training (VET)

WoS: Web of Science

Executive summary

Over the last 20 years, digital technology has significantly shaped all aspects of our social, professional and personal life. This rapid change is driven by the innovations and the entrepreneurial outlook of science and business: whether to create problem-solving products or to open up new opportunities that were not previously imagined.

It might appear that policy is following the technology. Policy makers are aware that the new technologies will continue to have tremendous influence across the widest landscape, without always knowing precisely where policy interventions will be needed. The challenge for policy making is to ensure that there is a balance between encouraging innovation and managing and mitigating the differential effects of the introduction of new technologies in business sectors, or in other spheres.

The EU 2030 policy programme 'The Path to the Digital Decade' aims to ensure that the EU achieves its objectives and targets towards a digital transformation of our society and economy in line with the EU's values, reinforcing its digital leadership and promoting human-centred, inclusive and sustainable digital policies empowering citizens and businesses. Although the broad objectives are clear and defined, to achieve European competitiveness, the greater challenge is to ensure that the transition is fair and equal across all dimensions of European society. The faster the opportunities created by new technologies arrive, the more important it becomes to ensure that the pace of change allows time for adaptation of society. The European digital transition has huge implications for our lives: from the economic effects on business and employment, to our own health care, and how we access public services. The implications go far beyond simply the use of new technology, encompassing also how this has the potential to disrupt social interactions and affect human wellbeing.

This report presents the results of a study on the existing research in the human and social sciences (SSH) which is relevant to the questions that need to be addressed to ensure well informed and evidence-based science policy investment to guide Europe's digital transition.

The study

The study looked at three different sources of information to understand the potential research resource that is available to inform policy making: 1) SSH research funded by the EU during Horizon 2020 (2013-20); 2) general SSH academic literature, and 3) by convening an expert panel of current researchers to highlight future research on issues or from perspectives not already covered in the previous two categories.

Horizon 2020 (H2020) is the pan-European research programme, which supports fundamental research, through the European Research Council (ERC), and research which is directed at priority challenges identified by the European Commission in the cooperation programme. More than 4,000 Horizon 2020 research projects were identified in this study which have a strong SSH research component. The analysis used statistical methods to identify, from the text of the project objectives, the most frequently occurring themes and topics across all 4,000 projects. The themes and topics were plotted on a 'landscape' providing an overview of the relationships between those topics. The projects which were most relevant to the question of how the digital transition is impacting labour markets in the EU were then identified. Plotting the projects on the topics landscape shows where the concentration of projects lies and the spaces where little or no research has been conducted.

A similar approach was used to analyse existing research in the publications record by constructing a search of the Web of Science (WoS) database. Several key topics from the text of digital transition policy documents were extracted and those which appeared most frequently were used as the basis for the searches. An additional criterion, that publications also considered digital transition policy in the context of the effect on the labour market, was included. The search focused on the publication abstracts. This search yielded a dataset of publications which are most relevant to policy issues relating to the digital transition and their differential effects on the labour market.

Outline of results

The analysis of H2020 research projects clearly shows that a strong feature in the objectives of the funded research was focussed on developing specific tools, products or policy interventions. H2020 specifically focused on encouraging business digital competitiveness and integrating the discussion about the market purely from an economic and utilitarian perspective, including research on the labour market.

Conversely, the analysis of the research contained in publications suggests that the challenge for policy makers will be to prepare the economy and labour markets to resist and recover from the shocks that will arise as the result of the introduction of new digital technologies. These technologies have the potential to influence every aspect of the economy and society, in unpredictable ways. Much of the research therefore identifies what is needed to prepare labour markets to be resilient, adaptable, and quick to recover. The real issue for a fast-changing society has been the lack of expertise, knowledge and infrastructures, all of which affect a society's capacity to be competitive and drive the emerging digital world. Much of the research highlights the importance of modernising the education, skills and training sector across countries and the EU. The European digital strategy, including key policies such as the Digital Services Act, Digital Markets Act, European Digital Identity, European Data strategy, the European declaration on digital rights and principles, the proposed AI act, and the 'Path to the Digital Decade', address the importance of a fair transformation and a human-centric approach to achieve the European digital society.

The first two parts of this report highlight the predominance of research, which is drawn from a narrow part of the SSH landscape. Much of the research identified has a strong economics component, not surprising given the connection made to labour market research. The research also appears to be largely based on a more quantitative set of methodologies. There is an absence of research which is sensitive to the cultural impacts of the digital transition, or the longer-term effects on identity for individuals or communities. In the third part of the study the panel of experts highlights that future research must pay particular attention to a wider range of cultural and historical studies to ensure that it is possible to implement an open and inclusive job market, employment flexibility, and cross border provisions in social policy in harmony with a diverse Europe.

It is important to bear in mind that, although new to the European funding landscape, issues of fairness must be addressed through a deep understanding of our diverse society. At a high level, resources must be made available for studies that can offer a wider comprehension of legal, historical and identity issues, as well as socio-political dynamics which work in synergy and not in silos (as the analysis of the H2020 projects has shown). Furthermore, there is a need for a commitment towards education research to understand how to address European issues of skills and capabilities, but which also addresses innovation, inclusivity and diversity.

Last but not least, a profound understanding of the roots of inequality, poverty and social discrimination are key to pave the way towards a more just society, which can widely

support the technology jump for digital competitiveness. Targeting the digital transformation in employment, our experts have teased out examples of the broader research contributions that should be considered to support future policy making. The expert panel highlight the need to give due attention to open and flexible work platforms, the place of labour/social movements, changes in the cultural sector and the importance of self-education for developing a knowledge society, together with the university third mission and lifelong learning provisions. Attention must be paid to research on welfare and wellbeing, work safety-driven or impacted by digital tools - mental health support and assistance, social provisions policies to engage with a highly mobile, flexible, cross border labour force facilitated by a European digital labour market. It is important to identify patterns of changes between employment and self-employment which have impacted both professional and more mundane jobs.

The final recommendations of the report build on the evidence of the study that until now the focus of relevant research has been drawn from a particular perspective in SSH research and that greater care needs to be given in the design of future programmes and calls to engage a wider set of perspectives to ensure there is a ‘human-centric’ or ‘social-centric’ dimension in the research as these provide crucial insights to the cultural and identity impact of this major new European policy addressing the digital transformation.

1. Introduction

1.1. Background

On 12 November 2021 the EU published the results of the 2021 Digital Economy and Society Index[1], which summarises indicators on Europe's digital performance and tracks the progress of EU countries (DESI2021 press release[2]). In short the study, which reports data pre-Covid-19, shows that despite recent investments at national and European levels, progress in digital transition towards reaching the targets set up in the 'Path to the Digital Decade'[3] is still slow. DESI 2021 presents the state of the digital economy and society in the first year of the COVID-19 pandemic and has been adjusted to reflect the two major policy initiatives set to have an impact on the digital transformation in the EU in the coming years: the Recovery and Resilience Facility (RRF)[4] which commits Member States to spend at least 20% of their national endowments from the Recovery and Resilience Plan on 'digital' and the 2030 Digital Compass: the European Way for the Digital Decade[5], which is focused around four fundamental points: skills, infrastructures, digital transformation of businesses and public services. In all areas, all Member States seem to lag substantially behind. The COVID-19 pandemic has radically changed the role and perception of digitalisation in EU economies and societies and accelerated its pace. It has highlighted the need to invest in new solutions and tools to bridge the digital divide, to support the labour market and to guarantee equality in access to digital infrastructure to construct a fair digital community (COM (2020) 575 final; Regulation (EU) 2021/41).

Concerns about the potential of the digital transition to exacerbate social inequalities are particularly relevant when it comes to the prospect of jobs being displaced on a wide scale; automation is crystallizing concerns. The European Commission is seeking to ensure that people and companies have the right skills in place to take advantage of the digital transformations, as evident in the Pact for Skills[6], a shared engagement model that helps companies and workers prepare for the green and digital transitions, playing matchmaker for Europe's talent supply and demand.

Another step towards the definition of a digital Europe was taken on 26 January 2022, when the European Commission proposed a new EU Declaration on Digital Rights and Principles[7] for the Digital Decade, which aims to represent a reference point for policy makers and companies to strengthen the human dimension of digital ecosystem with the Digital Single Market as its core.

1 https://digital-strategy.ec.europa.eu/en/policies/desi

2 https://ec.europa.eu/commission/presscorner/detail/en/ip_21_5481

3 https://ec.europa.eu/commission/presscorner/detail/en/ip_21_4630

4 https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

5 https://digital-strategy.ec.europa.eu/en/policies/europes-digital-decade

6 https://ec.europa.eu/social/main.jsp?catId=1517&langId=en

7 https://digital-strategy.ec.europa.eu/en/library/declaration-european-digital-rights-and-principles

1.2. Outline of the report

The aim of this report is to identify the future trends of research relevant to understanding the impacts of digital transition on labour market. Following a short introduction, parts 2 and 3 of the report focus on a range of data gathered from research projects and academic publications. Data were harvested from the published objectives of the projects funded under H2020, and then gathered in a 'corpus'. This corpus was analysed to identify the main themes and topics, and their relative position, on the knowledge 'landscape'. This first strand of the study provides evidence of the broad set of topics covered by SSH research projects in H2020. The identified themes and topics, when plotted in the form of a mapped landscape, help to highlight the range of topics and themes, where there is a concentration of H2020 projects under those topics, or where there is a lower density of projects dealing with specific and relevant questions. This map helps to determine the current contents of the 'knowledge repository' and gain some insight into the areas where little or no work is being done or where there is a rich body of work from which to draw evidence to guide the elaboration of policy.

Part 3 looks at academic publications and adopts a similar initial approach. The relevant policy documents were used to identify the main policy themes and these themes were then used as the basis of searches in Web of Science (WoS) for the publications which are most relevant to the digital transition policy topics and labour markets. Having identified the main academic publications a more detailed analysis of the publications themselves was undertaken (a more detailed explanation of the methodology used appears in the Bibliometric section). The topics were mapped into a landscape to help understand the relationship between topics and to identify the places on the landscape which are more sparsely populated and represent a gap in knowledge. This part also gives a detailed overview of the literature drawn from H2020 funded projects.

Part 4 focuses on the analysis of the data that emerged in the first part and introduces the knowledge of the experts involved in the task force. They collected some knowledge on the basis of their own projects, publications and personal understanding and later analysed the data as they emerged from the projects and publications data. This part is organised by macro-topics areas and for each one specific research areas are highlighted. Finally, the last section is dedicated to a set of general policy recommendations for future investment in research.

2. Data analysis: H2020 projects and a bibliometric study

2.1. EU Funded research projects data collection: methodology

The main source of project data for this report is the CORDIS database containing all EU research projects funded through the European Framework Programmes and the ERC. The register is maintained by the EC and publicly available. From this sample the team identified just over 4,000 social sciences and humanities (SSH) projects across all societal challenges and ERC. For this analysis the registered objectives of each project were used to identify the relevance or connection between projects and the policy themes previously identified.

The SSH projects were located by using the euroSciVoc codes. The euroSciVoc codes contain a path of topics. The path starts by identifying the overall topic of the project (social science, humanities, engineering, etc.) and then getting more and more specific as it proceeds down the path. The codes were created by using a computer program which, through textual analysis, can determine the topics for a given project. A project can have more than one topic.

By first selecting the topics, based on an epistemology assessment, the projects from the H2020 project database, which fall under social sciences and humanities disciplines were identified and afterwards a list of projects was drawn up which were characterized as social science or humanities by the euroSciVoc codes. 4013 social sciences or humanities projects were identified by filtering the projects based on whether they contained at least 60% euroSciVoc social science or humanities classifications. This filtering was made as some projects were assigned more than one euroSciVoc classification. Filtering the projects this way ensured that interdisciplinary projects were included.

2.2. From corpus to landscape of topics

The text from the project objectives was cut into individual words and stop words (common but non-specific words) were removed. The interpretation drew on an analysis of the relationships and correlations between the topics as it is summarised by Multiple Correspondence Analysis (MCA)[8].

The terms/topics in the SSH landscape (both in H2020 and the ERC) were then located to give the reader context of how the overall space of topics is configured before diving into the specific labour market focus. It is important to understand how topics are distributed across the programme, how they relate to each other, and what the defining trends are in each space. The distance between the topics on the map equates to the distance between the topics in the intellectual space, cognate terms and topics. In other words, two topics far away from each other are rarely being used in the same paper, or

[8] Le Roux, Brigitte., & Rouanet, Henry. (2004). *Geometric data analysis: From correspondence analysis to structured data analysis*. Kluwer Academic Publishers.

connected in research themes, while topics close to each other often have closer connections in research themes/topics.

The first pair of maps shows the density of the individual projects, their position in the landscape and the cloud of topics related to those projects. These are the clearest maps to spot if there are certain areas where the density of projects is low, and if there is any area where there are missing projects. These density problems can either mean that simply there are no projects (because of lack of funding, research interest etc.) or that it has not been possible to locate any project correctly using the discipline classifications.

The last pair of maps are those showing the supplementary terms. With these the placement of the terms matter, so it is possible to determine how the terms relate to each other in regard to placement. The brighter red terms are used more frequently than those of a darker shade of red. In a way this map mirrors that of the density clouds.

2.3. Naming of axes

The dimensions of the maps are decided by the MCA. The first dimension is the one which describes most of the variance, the second dimension the second most variance etc. When the dimensions have been decided they are called an axis. The actual naming of the axis is based on a qualitative review of the projects lying along the two axes. An example of this naming process can be explained looking at figure 2. The first axis runs from technology to identity. The projects at the technology end are characterised by topics such as optimise, cloud, solution, and system and for the identity end they are feminist, indigenous, and anthropological. These topics along with a reading of the project descriptions help inform how the axis should be classified.

Different maps have different axes. The maps of the digital transition topics are recomputed in the MCA so as to optimise the variance along the axis. This is a requirement when conducting MCA's as this is the optimal method of showcasing the relational nature of the projects and their topics. The focus change of the different axes also helps to highlight that the different subspaces (or subsets of the larger corpus) have different foci. The projects focusing on digital transition tend to have a different focus than the average H2020 funded project. To understand the space, it is therefore necessary to understand what shapes the space. Therefore, the axes change names from map to map.

Topics and terms in the centre of the maps are typically the most used among the ones mapped. Not only are they frequently used, they are also used equally by all projects in the space. Examples of this are some of the terms in the centre of the SSH map (fig.2), which are international, European, and research. These terms can be fairly generic, but they do help to characterise an overarching theme of the space. The overarching theme of this map is the focus on European research, which is to be expected and confirm that the space is defined in a proper manner.

2.4. Research areas and topics

In this graph (fig.1) the density and position of each H2020 project is visualised along the first and second dimension (technology/identity and Economics/Art). Optimally the cloud would be perfectly round, which is not the case for the cloud generated on the

basis of the SSH projects. A rounder cloud indicates a more even distribution of projects across the topic landscape. It is noteworthy that there are fewer projects down the art axis. The projects are intensified in two areas: along the technology axis and a little towards the economy axis. The concentric lines on the map can be read in much the same way as contour lines on a geographic map which denote increase/decrease in height. In this map the contours mark similar density of projects.

Figure 1: SSH projects within H2020

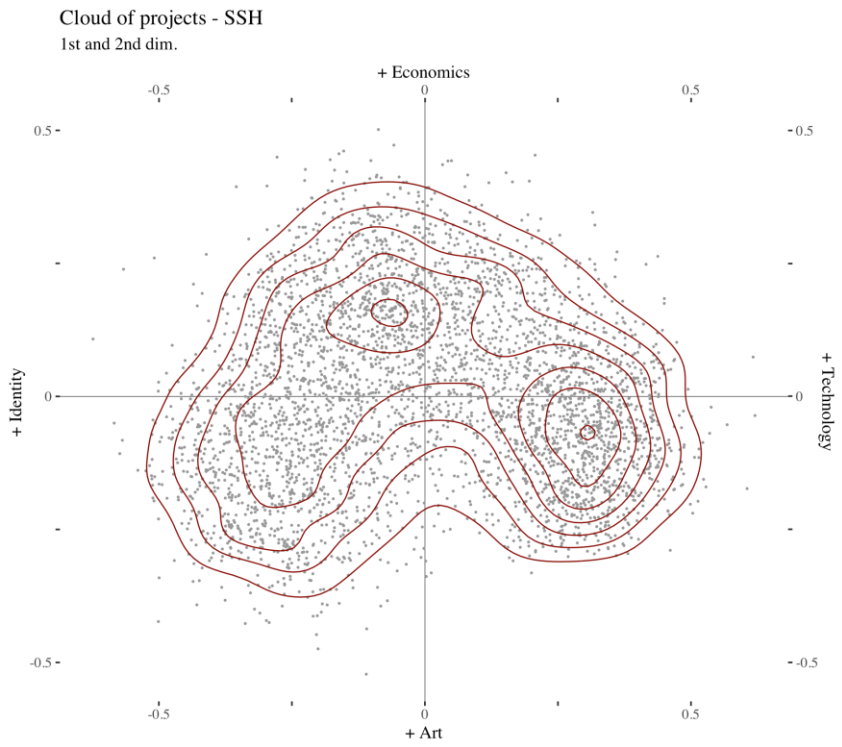
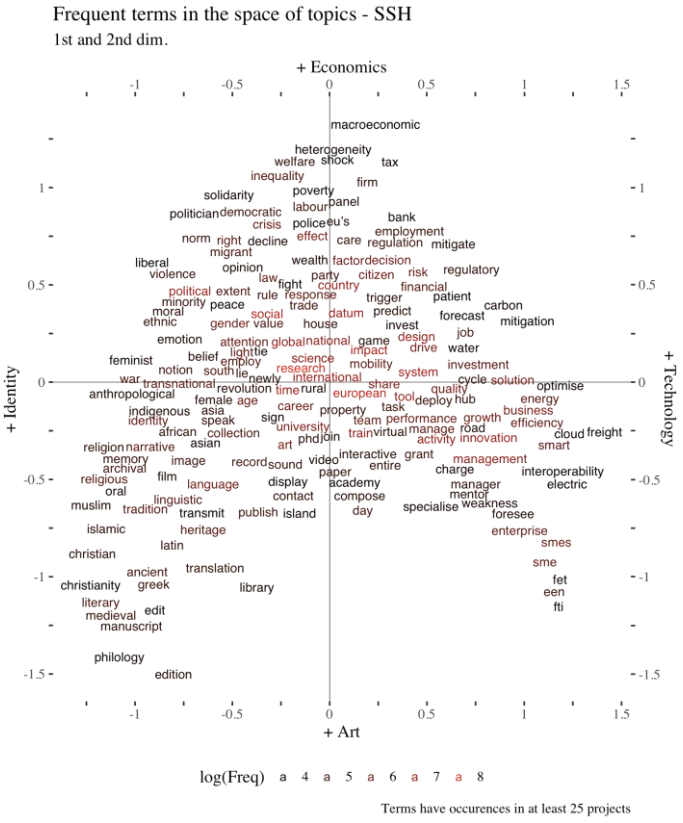


Figure 1 shows the most frequent terms in the H2020 SSH corpus of projects. It is based on this space that the axes were named. The axes are not drawn as opposite, but rather indicate broad areas or topics.

The economics extreme was identified by topics like heterogeneity, poverty, labour, and tax. The other end of the axis, named art, was harder to identify because of the lack of topics. Based on the topics located in the lower left corner it is assumed that the bottom of the y-axis is indeed art projects. The other axis ranges from technology to identity. The technology extreme is identified by topics such as optimise, cloud, solution, and system. The other end, identity, is identified by feminist, indigenous, and anthropological.

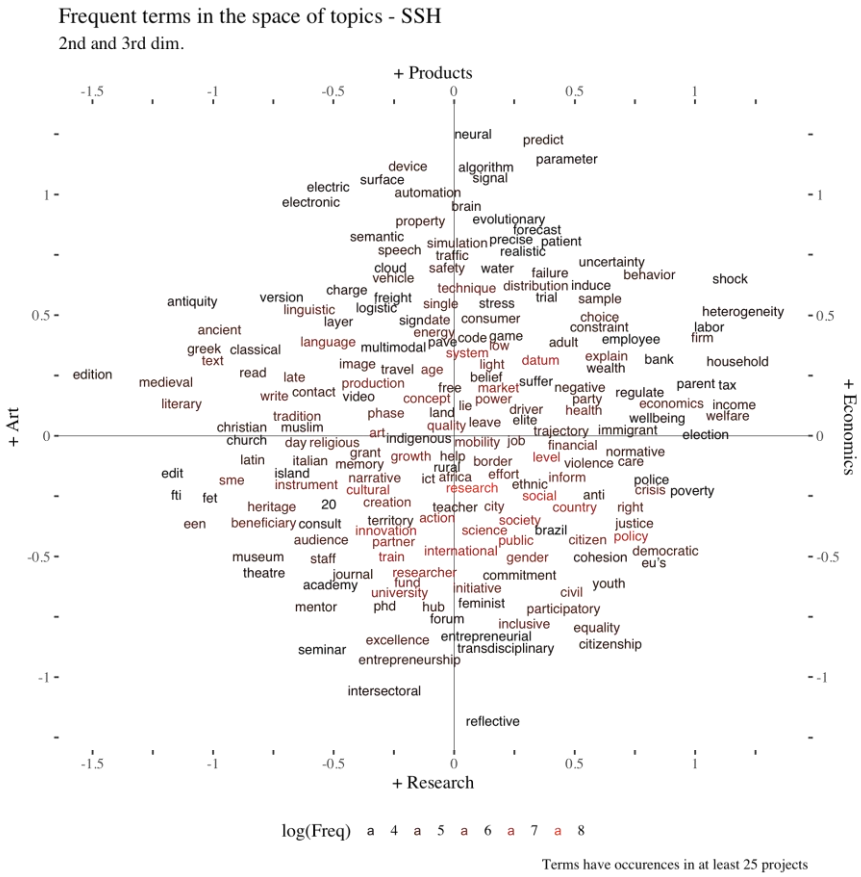
It is also worth noting some of the quadrant between the axis. Between economics and identity there is a space of political topics and between identity and art there is a space of historical/literary topics. The lack of art topics is apparent in the cloud of topics as well, the cloud forming a ‘crescent’ shape around the ‘Art’ axis.

Figure 2: Frequent terms in the space of SSH topics



The third dimension (Products/Research, fig.2) represents the final use of the outputs of the projects more than which academic discipline they belong to. The axis spectrum goes from a product focus identified by topics such as device, automation, algorithm, and vehicle. At the other end of the axes topics such as reflective, PhD, university and initiative are found, which are indicative of an academic research focus.

Figure 3: Frequency of terms – 2nd and 3rd dimensions



Key take-away points:

- There is a large gap in the bottom of the map (fig.1 and fig.2) where the 'art' projects should be. This could be caused by a relative under-funding of humanities projects, which is due to the top-down method for designing H2020 work programmes and its topics, driven by the policy interests of the EU.

- The topics 'international', 'European', and 'global' (as well as 'national') indicate that one common theme for all projects funded through H2020 is an international outlook in their research. Again, this will be a confirmatory result given the explicit need for projects funded under H2020 to contain consortium partners from a number of different EU and associated member states.

2.5. The space of labour, market and economy research in all H2020 projects

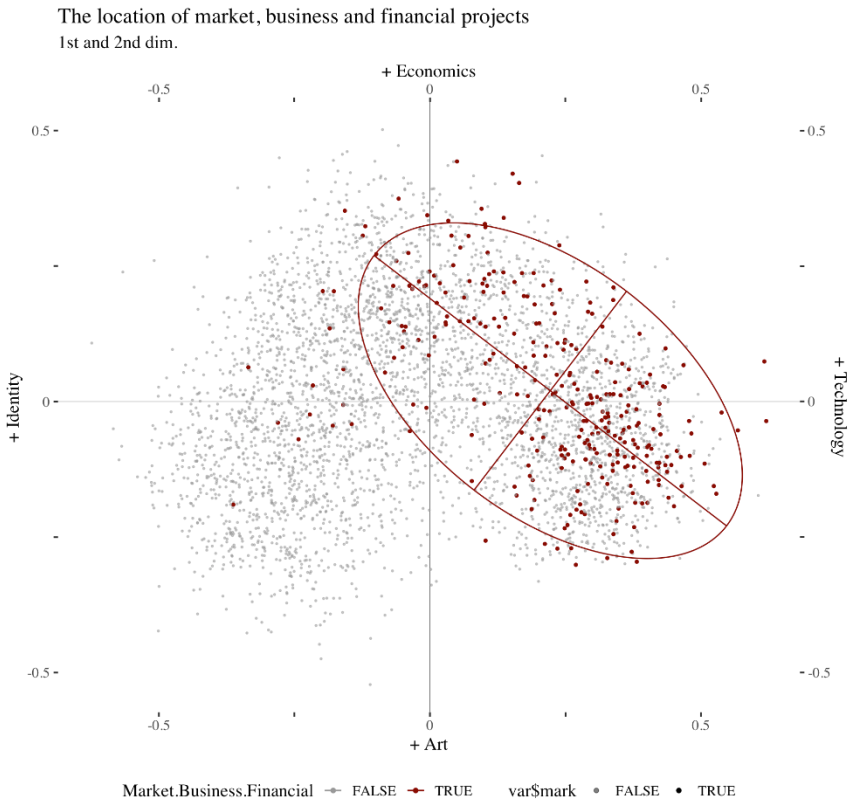
The importance of these maps is to show how the topics 'labour', 'skills', 'market', etc. are located in the H2020 topic space. In these maps the area in which projects have a labour, market, and/or economy topic connected to it have been marked. The area in which the projects are located is within the red circle in figure 5.

The first map (fig.4) is generated from the topic '*market.business.financial*'. Although finance may appear out of place, out of the 100 topics created in the Latent Dirichlet

Allocation (LDA), this topic was one of the few which had a consistent relation to labour and skill. Therefore the topic is located in the quadrant between economics and technology while it stretches down into the quadrant between technology and art. The large nature of the space indicates that a lot of projects have at least some interests in market, business and finance. Interestingly the area is not overlapping significantly with the quadrant between economics and identity - the one we identified as political and social science - and it is far removed from the quadrant in the bottom left between identity and art.

The exemplary projects are chosen based on the topic also used to locate the 'labour', 'skills', 'market' space. This means that the exemplary projects selected for the topic *market.business.financial* are the five projects with the highest score within this topic (i.e. the terms identified in the project descriptions fits the topic well). It is in other words a quantitative method of locating exemplary projects rather than a qualitative one based on expert knowledge.

Figure 4: Location of market, business and financial projects

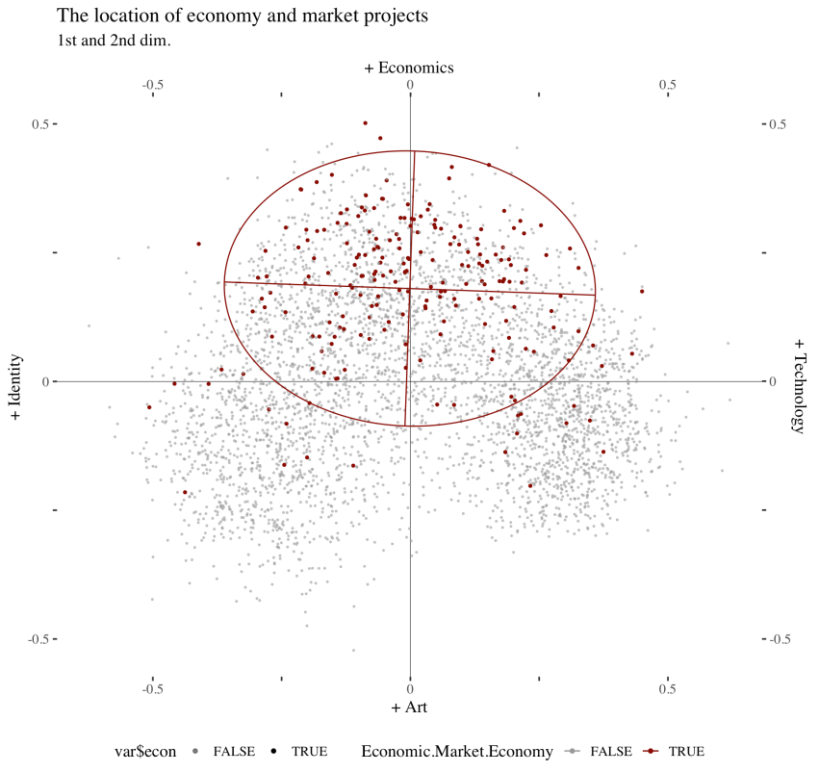


The second map (fig.5) is different from the first. It builds on the topic *economy.market.economic*. It is located at the economics axis extreme and encompasses both of the top quadrants. This could be the result of political science projects taking an interest in economic issues rather than business and financial ones. Unlike the previous map, very little of the ellipsis covers the bottom half of the map.

Figures 4 and 5 should be read in conjunction with the map that shows the contours and density of projects. Therefore, it is important to remember that the ellipsis covers 80% of the projects. There are some tending to towards arts, but overall, the majority of projects are technology and economics focused. It is likewise worth noting that the projects within the ellipsis have a large occurrence of collaboration between public and private

corporations. This indicates a high degree of interest from private actors in research projects with a focus on labour, market and economy.

Figure 5: Localisation of economy and market projects



Key take-away points from figures 4 and 5:

- These projects are placed along the technology and economics axes. While there might be projects related to work and labour along the other axes, these would be in the minority.
- Collaboration between both public and private organisations, especially with projects focused on business, is quite high. A lot of parties are involved in the projects, with a mix of universities, research organisations and for-profit companies.

2.6. Digital transition

The projects relating to digital transition were located by using keywords and assigning a score to each project based on the number of keywords present in their project description. The keywords used for locating the digital transition projects were based on keywords used by the EC's own description of digital transition[9]. They are:

- Digital

[9] https://ec.europa.eu/reform-support/what-we-do/digital-transition_en#ecl-inpage-670

- Digitalise
- Society
- Policy
- Feedback
- Transition
- Accessibility
- Network
- Efficiency
- Interaction

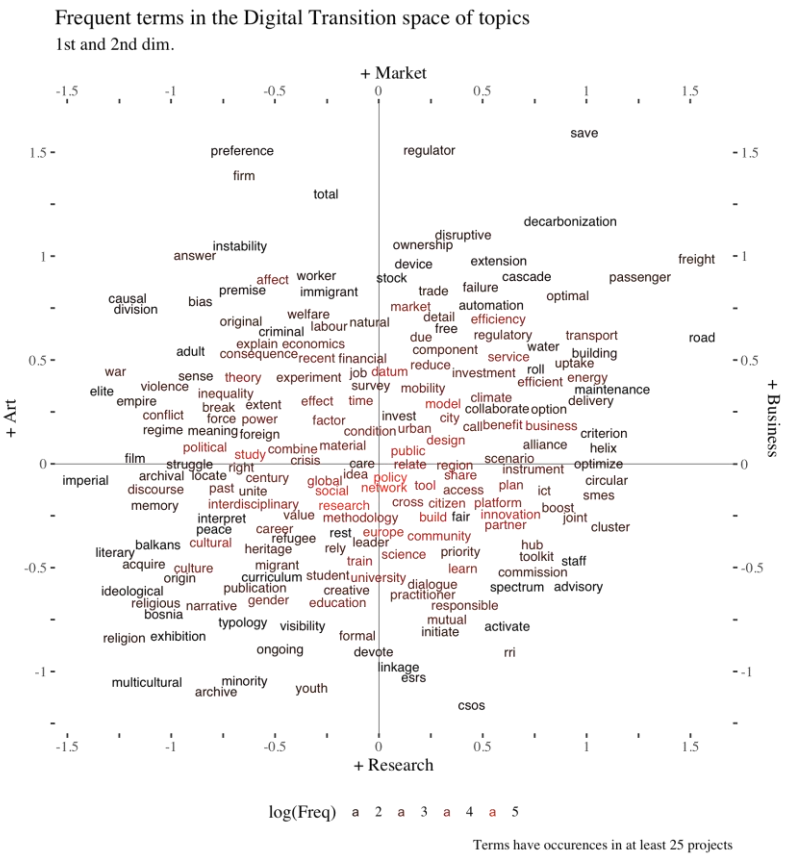
By using this method 349 projects were located representing 8.7% of the total SSH projects which have a particular relevance for the digital transition. This is a relatively small proportion of the overall number of projects.

As axis naming is related to the projects, the first axis in digital transition (fig.6) ranges from business to art, with the business extreme containing topics such as business, reduction, accelerate, and investor. At the other end examples of topics pertaining to art are historical, imperial, book, and politic. The second axis ranges from research to market with research being characterised by topics like webinars, university, guideline, and excellence. The topics at the market extreme are for example instability, income, worker, and supply.

The bottom left quadrant between research and art is defined by topics such as discrimination, religious, gender, and heritage pointing towards projects focused on identity and history.

The projects in the lower right quadrant consist of topics such as RRI (Responsible Research and Innovation), circular, green, and community. These topics could indicate a focus on green transition within the digital transition space. In the upper right quadrant are topics located between business and market. Examples of the topics are: passenger, logistics, efficiency, and disruptive. As mentioned, these topics indicate a graduation from a micro to a macro focus (from business to market), with a focus on freight transport in the area between the two extremes.

Figure 6: Digital transition topics



On the map of the second and third dimensions, we are looking at the expected use of the project outputs, not the academic field. The new axis is one which ranges from a product focus to a societal focus. Topics at the product extreme include translation, machine, firm, and privacy. At the other end, the topics are democracy, foreign, struggle, and internationally.

The upper left quadrant does suffer from a slight lack of topics, but there is still a pattern to detect. The topics in this quadrant have a focus on transport, passenger, flexible and mobility, which mirrors the lower right quadrant from the previous map. The lower right quadrant between market and society consists of topics such as economics, poverty, employment, micro, and macro which could indicate that the projects placed here focus on the interplay between society and market.

In the upper left quadrant between products and research are topics such as literary, language, cultural, and heritage which indicates projects focused on the analysis of literature. Given the nature of the space it is not far-fetched that this analysis uses digital tools as an aid to analyse the given literature. The lower left quadrant is located between research and society. The topics within are for example strengthen, leader, career, and student. These topics seem indicative of a focus on education.

Key take-away points:

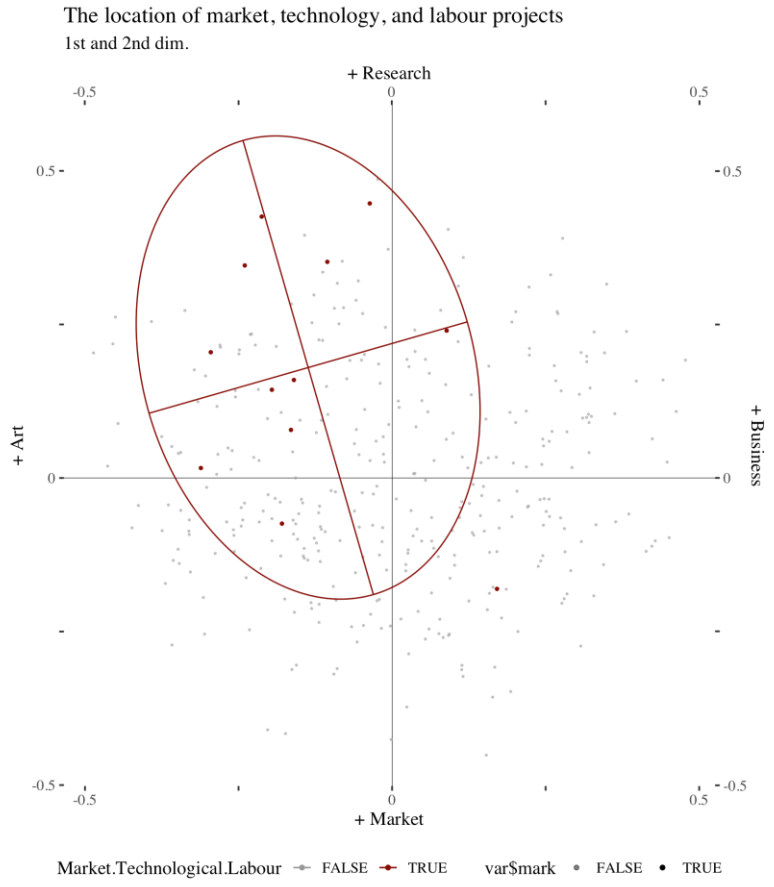
- The digital transition space is made up of 349 projects, which is 8.7% of the total SSH projects.

- The digital transition projects have a utilitarian nature. This is mirrored in the terms observed in the maps.

2.7. The space of labour, market and economy research within digital transition projects

The first topic that has been mapped is '*market.technology.labour*' (fig.7) and it is primarily located in the upper left quadrant between research and art. This map shows the ellipsis is fairly limited, and that only a small number of projects relate to the topic *market.technology.labour* in their objectives.

Figure 7: Location of market, technology and labour projects



Key take-away points:

- Unlike the SSH map, we do not see the ellipsis crowding a specific axis but are rather spread out. There are two main reasons for this:
    - The fewer projects mean less siloing of disciplines.
    - The topics created for the digital transition space are broader in capturing work, labour, and skills.

- The map and projects mirror the general digital transition map, in the sense that the projects are still utilitarian in nature, except with a labour, skills, and work focus. This is likewise mirrored in the size of the ellipses.

- The first mapped topic (*market.technology.labour*) is not primarily located in the vicinity of the market axis, but rather that of research and art. This indicates that projects focusing on labour have more to do with art projects than other labour related projects.

2.8. The SSH space in ERC projects

The topics in this map (fig.8) are the topics from the general H2020 topics. The yellow topics are the least used H2020 topics in the ERC space. The green and blue topics are used regularly and the two purple topics, RECEIVE and SCHOLAR are used in a high concentration. The most useful use of this map is perhaps the interpretation of the yellow topics as these are scantly used or under-explored topics in the ERC funded projects. These topics are comparative, qualitative, western, multiple, narrative, standard, union, health, domain, discipline, and draw. These topics are less used which might indicate under-explored topics in ERC funded research.

Figure 8: SSH ERC topics

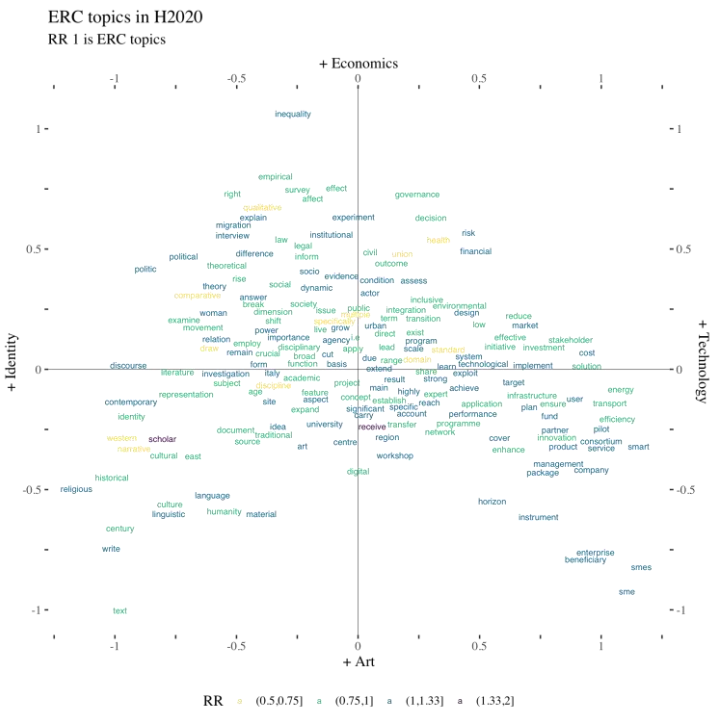
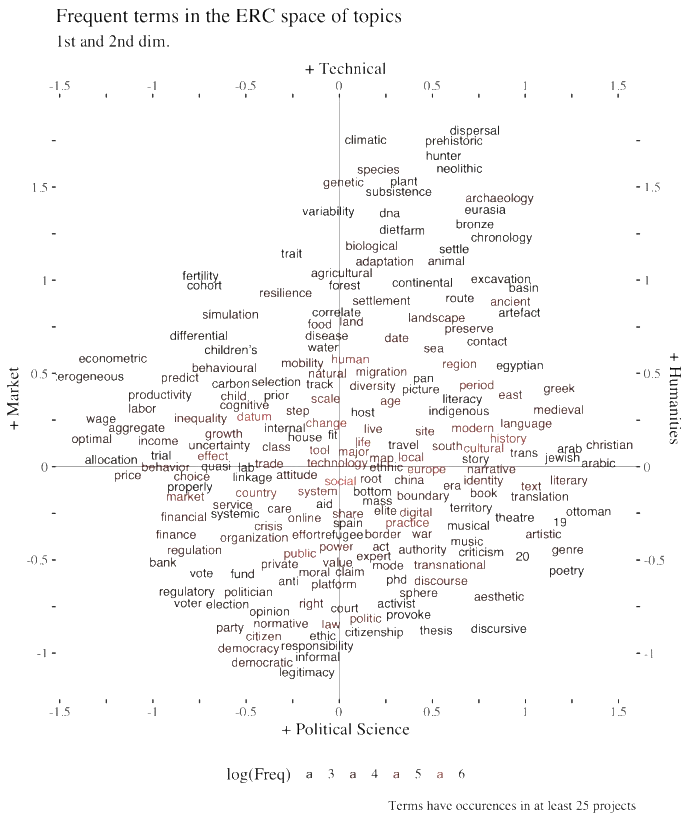


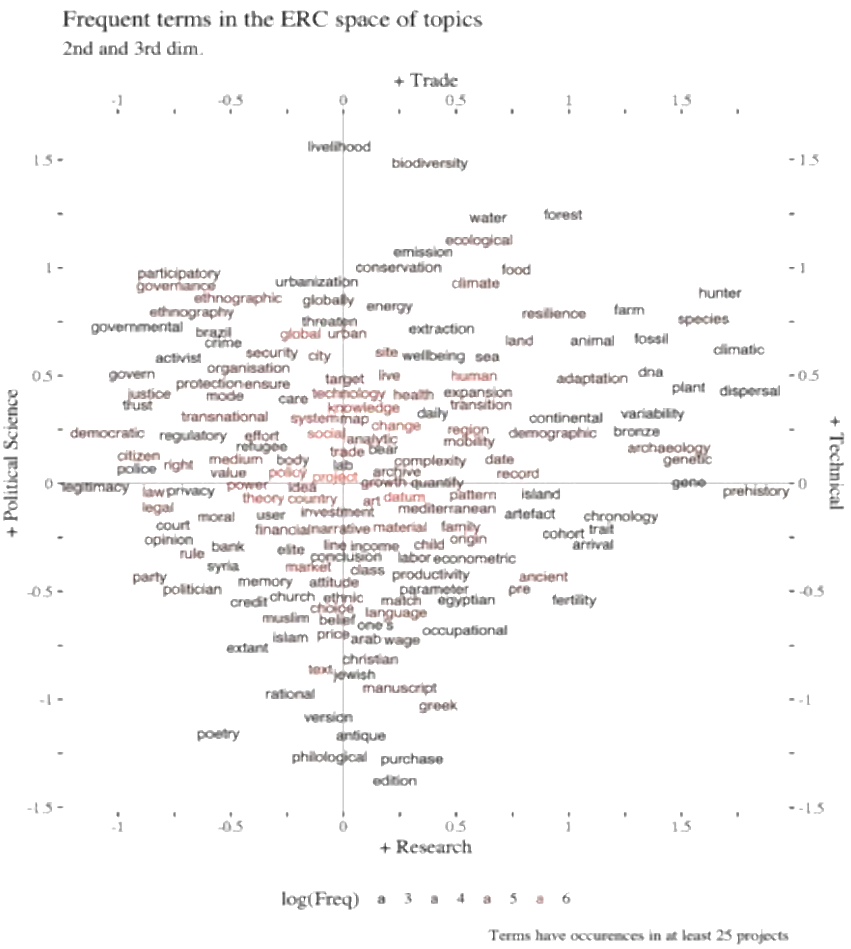
Figure 9: Frequent terms in ERC space of topic



In figure 9, the upper left quadrant between technical and market gathers topics such as biodiversity, forecast, monetary, and fluctuation indicating a space for mathematical explanations of social issues. There is however not a high concentration of topics in this quadrant. In the lower left quadrant, between market and political science, there is a gradient of topics from the political science axis to the market axis; from solely political topics such as democratic, legitimacy, and justice to more market oriented political topics like labour, welfare, and corporate and ending up being primarily market topics.

From humanities to technical in the upper right quadrant, there is a space focused on archaeology and history and topics like isotope, ancient, reconstruction, and continental. In the lower right quadrant, there are topics like transnational, philosophy, war, and aesthetic. They seem to indicate a focus on culture/heritage and science in an international and political science perspective.

Figure 10: Digital transition



In figure 10, the third-dimension axis is the one spanning from trade to research. At the trade extreme topics pertaining to debt, financial, credit, and income is located. At the other extreme, research, there are topics such as engineer, scientific, communication, and knowledge.

In the upper left quadrant, between trade and political science, the theme of the topic is international politics, with topics such as geopolitical, authority, war, and power. In the lower left quadrant, the topics still centre around political issues, but the focus has shifted. The topics include moral, democratic, value, and philosophy. The overarching theme here is the study of people with a philosophical and ethnographic perspective.

The upper right quadrant contains topics such as connectivity, growth, labour, and fluctuation with a focus on economic issues. In the lower right quadrant between technical and research there is a space for archaeological and statistical projects. The connecting characteristic between the two is the reliance on technical tools in the form of computing power. The topics located here include variability, environmental, behavioural, and Bayesian.

Key take-away points:

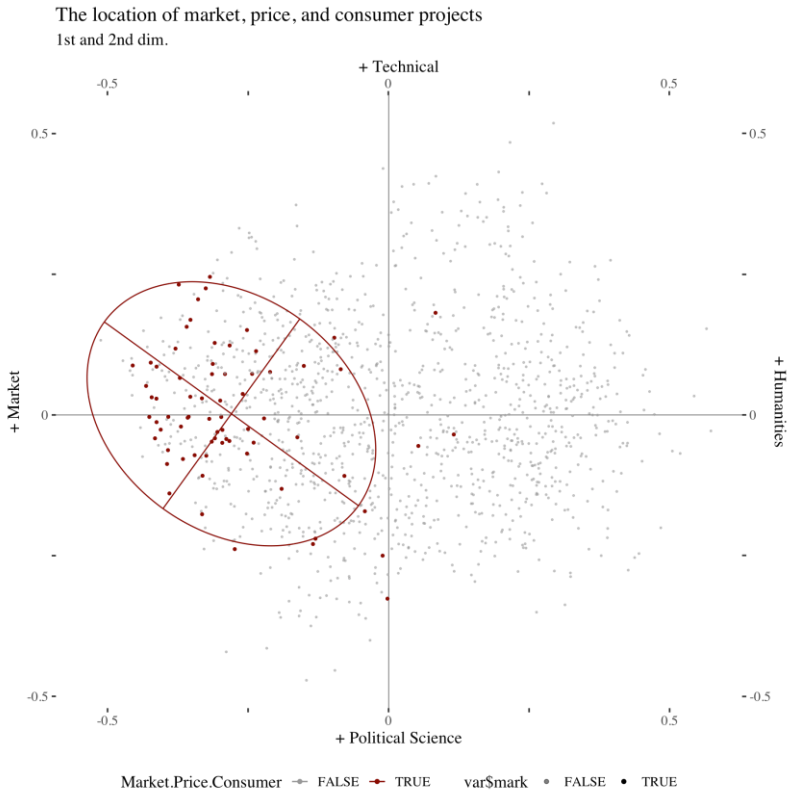
- The ERC projects are a subset of the H2020 projects. This makes the size of the corpus 1247 projects or 31%.

- The change to only ERC-funded projects affects the topics. One notable example is that the art projects are now present.
- Social sciences have moved from the 1st and 2nd dimension to the 3rd. Meaning the social science topics are less structuring of the space than business/art and research/market dimensions.

2.9. The space of labour, market and economy research in ERC projects

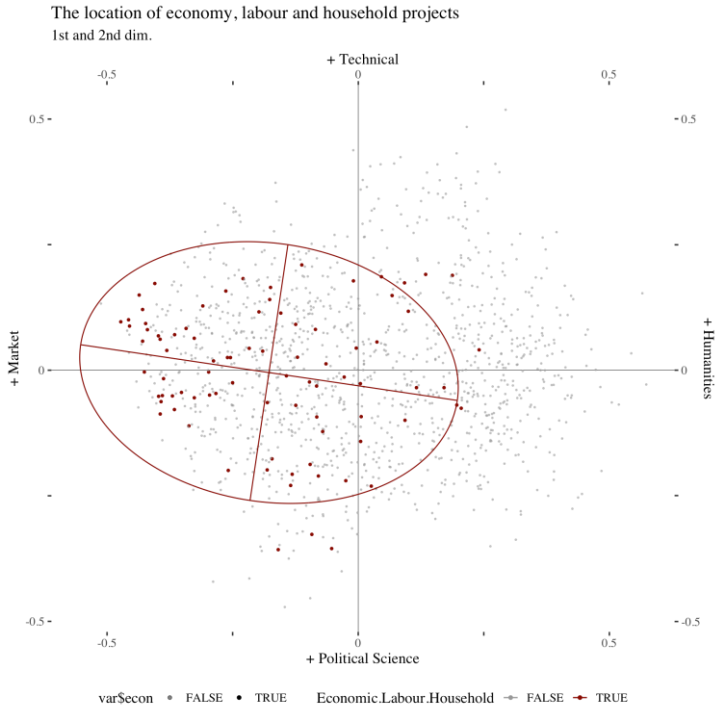
This map (fig.11) is made of the topic *market.price.consumer.products* and the ellipsis is firmly placed on the market axis, without any of it on the humanities axis. It covers both the upper and lower left quadrant somewhat, meaning projects focusing on technical and political issues are all, at least somewhat, focused on this topic as well.

Figure 11: Market, price, and consumer projects



This map (fig.12) looks a lot like the previous one, as does the topic: *economy.labour.household*. The one difference is that the ellipsis is bigger, which means a broader range of projects is included in this topic. The inclusion of the term household might be a key word in this regard as more humanities project include this term.

Figure 12: Economy, labour and household projects



Key take-away points:

- As with the SSH space and unlike the digital transition space, the work-related projects are trending towards the market axis.
- The inclusion of the term labour, does once again, broaden the ellipses as opposed to topics where the term is not present.
- Fewer projects are collaborative than the SSH work projects.

Bibliometric analysis

Academic publications available via the Web of Science (WoS) database were reviewed. These datasets cover most of the academic publications across all fields of science and are regarded as the most comprehensive resource for journal publications, particularly those published in the English language. Neither datasets capture SSH research comprehensively but while the coverage is adequate for the social sciences, it is less so for the humanities. A large number of humanities publications are not included in WoS because most of the publications tend either to be included in monographs or book chapters or in national scientific journals in languages other than English.

These datasets are useful to identify publications in the fields related to digital transition and the second dimensions of labour market. The 750 publications published between 017-2021 were reviewed.

3.1. Methodology of the Bibliometric Analysis

An initial set of policy related themes drawn from relevant EU policy documents connected to the digital transition were identified and then those which appeared most commonly were identified on the basis of word co-occurrence - the most frequently appearing word pairs in the documents.

Using these themes bibliometric searches in the WoS publications database were constructed and tested. The search sought to identify the publications with the following characteristics:

- Themes in the research which were relevant to the policy themes of the digital transition and which
- Included the secondary theme relevant to labour markets
- Published in the period 2017-21; and,
- Held in the SSH libraries of WoS, and therefore excluding work from non-SSH fields.

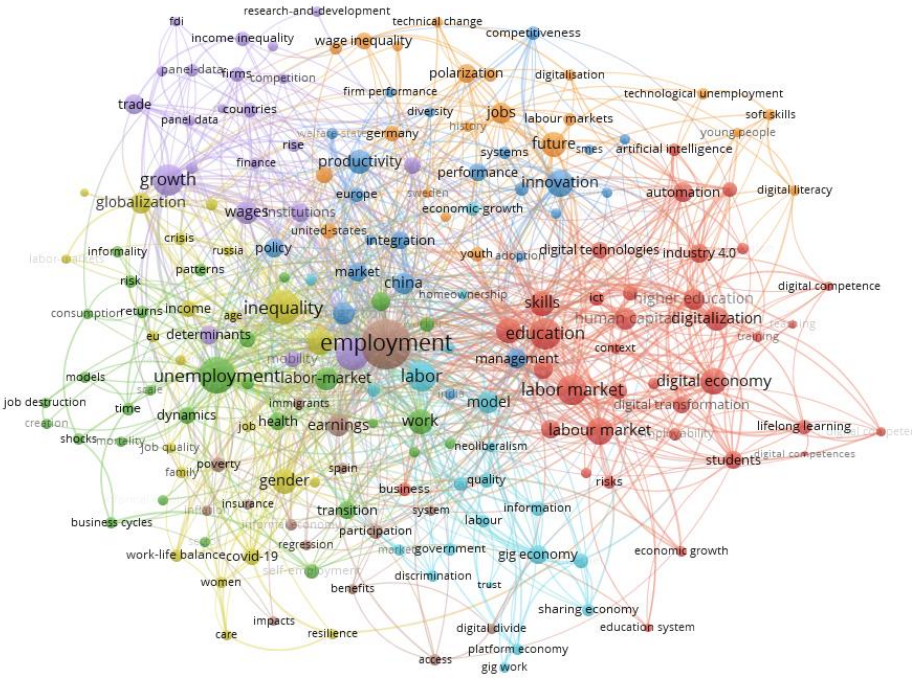
Nearly 750 publications from the WoS library were extracted which contained at least one of the main policy themes identified as relevant to digital transition, and which also held the second reference to labour market themes.

3.2. Bibliometric analysis

The academic publications identified as relevant to the policy topics and labour markets were then analysed using the keywords attached to each publication. Using the keywords a map of the most commonly appearing keyword themes (pairs of keywords, that appear in publications) was created. The keyword pairs were used to create a mapping of the keyword themes across a landscape. The size of the keyword nodes relates to the frequency each keyword appears in publications. Proximity between keyword themes in the mapping relates to the frequency of occurrence of the keyword

being paired in the publications. Keyword themes located in close proximity on the map indicate related themes in the research. Clusters of the related themes were created from this methodology (fig.13). The mapping of the clusters provides an initial structuring of the topics of the publications. Once the structure is created, it is then possible to identify a sample of the underlying publications contributing to each cluster. The abstracts of those publications are then read to identify more details of the publication topics. In the following section an interpretation of those topics underlying the clusters which have emerged from the academic literature in the past 5 years is given.

Figure 13: Cluster of related themes (academic publications 2017-2020)



3.2.1. Red cluster: impacts of the new digital technologies

The first group (fig.13, RED cluster) brings together topics/themes/concepts such as artificial intelligence (AI), automation, competences (digital), digital economy and digital skills, education, employability, entrepreneurship, higher education and human capital.

The themes of the publications underlying the red cluster relate to the introduction of new digital technologies and digital capabilities into the economy: for example, artificial intelligence and automation. The research work highlights the changes not only to the manufacturing business sector through automation of routine actions, but also to services and knowledge industries like professional services where artificial intelligence will be used to automate, to speed up, to make more accurate the large-scale processing of routine tasks and actions. The introduction of new digital technologies and capabilities is identified as having significant implications across the economy but in particular this study has focused on the impacts on labour markets. New digital technologies will create new jobs across the majority of sectors but will also make existing jobs redundant and change the nature of career expectations for those in and entering the labour market.

New skills will be needed to access the new jobs that will be created, and existing job holders will need to retrain for these new jobs on a regular basis.

The literature deals with the impact on the labour market and highlights actions for policy making to mitigate the effects of the introduction of new digital technologies. Here the literature assesses the need for members of the labour market to acquire new or upgrade existing competencies and digital skills. ([10])

The literature guides policy makers towards actions that can help the labour force to transition through the 'digi-tech' driven changes, by signposting the importance of new education policies that focus on the employability of those entering the new labour force from schools and higher education. Policy makers will need to address education and skills through multiple channels; in particular, universities as providers of education from degree and professional/vocational programmes to life-long learning for those needing to reorientate their career pathways into new roles. Education to the age of 18 is identified as requiring reorientation to ensure that similar skills or attributes are acquired by young citizens who will be entering the labour market for the first time, and who will otherwise be ill equipped to compete for the new roles.

Research identifies other attributes needed by employees, which take them beyond the job-specific skills that we currently expect. Employees are identified as needing a range of additional 'soft skills'; such as critical thinking, problem solving, effective communication, creativity. In "Innovating Education and Educating for Innovation: the power of digital technologies and Skills" the OECD reports results of the REFLEX survey which interviews graduates 5 years after graduation:

> *"Among the self-reported use of skills that most distinguish innovative from non-innovative workers are 'up with new ideas and solutions' (creativity), 'a willingness to question ideas' (critical thinking), and 'the ability to present new ideas or products to an audience' (communication)"*[11]

Entrepreneurship is seen as a critical attribute to be acquired by individuals in the labour force as a driver of innovation, which in turn can generate new businesses that harness the new technologies. Entrepreneurship is most often seen as a driver of new business creation, however, entrepreneurship is an increasingly important personal attribute demanded by new employers of the staff they recruit. As such an entrepreneurial approach in staff or potential new recruits is strongly connected to ideas around employability. Research identifies the importance of its introduction into the curriculum for secondary and higher education.

Research highlights the effect of migration (green cluster, fig.13) and immigration (brown cluster, fig 13) on the labour market. Particularly in relation to a positive contribution in entrepreneurial activity. Some research work highlights the potential negative effects related to migrants/immigrants (whether EU internal mobility, or external immigration) whose lack of competitiveness in their new local labour market is the result of their home education and training. The introduction of a significant number of new members in a labour market as a result of migration without the appropriate education and skills attributes affects the capacity/capability of the labour market to resist the shocks created by new policies steering the digital transition, or by the adoption of new 'digi-tech' by

[10] Research reveals that "43% of the EU population has insufficient digital competence, whereas 22% has no digital competence at all" European Court of Auditors (2021) https://www.eca.europa.eu/Lists/ECADocuments/RW21_02/RW_Digital_skills_EN.pdf

[11] Innovating Education and Educating for Innovation: the power of digital technologies and Skills, OECD, (2016) https://www.oecd.org/education/ceri/GEIS2016-Background-document.pdf

business. This will affect the ability of the host economy and the local labour force to respond to shocks, without the right education and training compatibilities.

The acquisition of digital skills and digital competence is at the same time a necessity for businesses and institutions as much as for individuals. The literature shows how the digital divide will mark the line between success (survival) and extinction in this reshaped economy. The digital competencies for business will help to ensure that the broader economy is both resilient to the shocks that will occur in the digital transition and create the agility the economy will need as it is re-shaped. The publications also address the importance of ensuring that those recruiting and managing the new roles in an organisation, with more flexible and mobile staffing models, have the expected skills and competencies. Policy making will play a critical role in preparing policies, which adjust for the differential effects of the digital transition in different business sectors, between different countries or cross-border regions, age groups and gender-based differentials in outcomes.

Investment in human capital (fig.13, red cluster) will need to be given more deliberate policy attention so that the stock of competencies and qualities that constitute human capital are relevant for the period of transition. Human capital is noted as the “knowledge, skills, and abilities acquired by an individual, traditionally through education and work experience”. Research highlights the importance of investment in human capital through the positive relationship with entrepreneurial success, business growth, and economic development, all of which will be facets required in the economy and labour market undergoing change due to both the effects of policy and the changing business models of companies and employers undergoing their own digital transition.

3.2.2. Green cluster: impact of the disruptions to the labour market from digital technologies

The next cluster of research themes to examine is the green cluster (fig.13), to the left of centre of the map. The major terms identified in this cluster relate to health, informality (informal employment), investment, job destruction, precarious employment, self-employment, unemployment, work and workers.

Some of the clear themes emerging from this cluster relate to the implications of the disruptions to the labour market and changing profiles of jobs/careers and the re-constitution of businesses and business sectors. A large theme relates to the impacts on the physical and mental health of individuals as a consequence of work-based vulnerability in a period of significant change and uncertainty.

Another theme around health relates to work/un-employment driving households’ poverty, including an increasingly common observation of ‘in-work poverty’ in some economies, where the fragmented nature of work, the instability of roles and the lack of skills required in new trades reduce wages for many of those still employed close to or below the poverty line.

Again, research highlights the potential for the shocks caused to the economy by the transition to a new digital economy to create significant disruption and reductions in disposable income, living standards, which themselves have an impact on health and wellbeing outcomes across communities.

A noticeable body of research relates to the changing nature of roles as the economy journeys through the digital transition and the potential rise of more informal employment. Research predicts the rise of informal employment as roles change and as roles become

redundant. This is already seen in the rise of ‘gig jobs’ in the ‘gig economy’ (light blue cluster, bottom/centre, fig.13). Research also suggest that the effects of this transition will have differential effects across geographies, business sectors, and in particular for migrant populations, whether within the EU (mobility) or from outside (immigration).

The informal employment literature sits alongside work on other precarious forms of employment which replace the old jobs that people may have expected to remain stable throughout their career. Research identifies the rise of self-employment as among the categories of precarious employment alongside ‘gig jobs’. Self-employment (green cluster, Fig.13) is subject to the same unpredictability and restricted access to social/employment support and is an indicator of greater risk of poverty and reduced health outcomes. Changes in social policy provisions for self-employment and highly mobile workers are still to be designed and need to be informed by a large pool of evidence.

Young people have often combined precarious employment in the gig economy with study. However, research suggests that this is not a reliable route to permanent employment as it may have been in the past. As set out in the first section, education is identified as a mitigation against the changes in the labour market and can help to provide a route to improved employment chances in the new digital economy. In the past some employment provided opportunities for students without previous in-work experience to gain work experience while completing education. Research suggests that these opportunities are decreasing in relevance given the new emphasis placed on ‘soft’ skills discussed earlier.

However, for those in more precarious employment more fundamental education, training, and skills development is not always a route open to them because of costs or the time commitment clashing with other responsibilities. Research identifies the rise of ‘micro-credentials’ – short ‘competency-based industry aligned units of learning’ – as a suggested mitigation in this more precarious end of the labour market. However, the evidence for a positive effect on chances of securing and retaining employment appears to be weak. The same applies to the uptake of micro-credentials for the self-employed. In a future labour market where people may have multiple careers, the acquisition of micro-credentials relevant in one role may not be transferable into future roles, and they therefore have short-term relevance.

The above are highlighted as routes for people to remain in one form of employment or another, whether precarious or not. Other research results highlight the possibility and consequences of unemployment as roles disappear and new ones emerge particularly for traditionally disadvantage groups in the labour market (such as women, minorities, and older workers).

3.2.3. Blue cluster: ways to resist and mitigate the shocks of the digital transition

The third significant group (mid-blue cluster, fig.13) relates to competitiveness, innovation, productivity, and immigration. Research identifies several characteristics in the economy, which will help to resist the shock caused by the transition to a digitally based economy. In particular, the research highlights the outcomes for economies in resisting shocks by hosting a competitive higher education sector. Previous sections have shown how higher education will help to give graduates the skills and attributes demanded in the new roles being created in the ‘digital economy’. These are the skills

that help to support cross-cutting areas, like innovation and entrepreneurship, which help to raise levels of competitiveness both within business as well as the wider economy. The research shows that again, education, new curricula and pedagogy are critical components as are the place of soft skills and transversal skills such as initiative, problem solving, collaboration and critical thinking which will prepare individuals for the future of work based on unpredictable career paths. Within this cluster there are publications examining the place of diversity in education and also the call for employers to seek a more diverse workforce as a social benefit.

Firm performance is a major component in the successful transition to a digital economy. Much of the performance at the firm level, in particular productivity, relies on the availability of people in the labour market with the attributes that have already been outlined. Performance will also depend on managers being able to organise staff to respond to variable and flexible conditions. This presents a significant management challenge. The quality of management at the 'firm' level is already identified as a critical issue to the success of businesses.

Science investment, capacity and capability in the scientific base will continue to be strongly indicative of regions and countries that will be most effective during the digital transition. Literature on the economics of science and technology shows that research intensive universities – that is institutions which focus on basic research - positively affect innovation activities in regional economies and produce positive outcomes in the digital labour market. Problem solving skills, creativity and socio-emotional skills gain much more importance than before, as well as functional literacy and technical skills related to the use of ICT. The impact of the adoption of new technologies in specific country's labour market depends on industrial and occupational structure, the skill mix of the workforce, organization of work and the extent to which new technology is already present in the local economy.

3.3. Bibliometric analysis conclusions

Competitiveness of economies and labour markets relies on education at all levels, and on the competitiveness or employability of individuals in the labour market. Research highlights the differential effects and competitiveness of advanced economies compared to others. The highlights look at education systems and competitiveness of labour.

There is research drawing out the spatial differences in resilience across regions and countries. Also, how vulnerable members of the labour force will experience more negative outcomes as labour markets experience shocks and how these negative outcomes will vary according to spatial differences where impacts of digital transition polices are concentred in a geographic region, perhaps due to the dominance of a business sector as an employer in a local labour market. Research also highlights the vulnerability of female employment which typically shows low resilience as a result of labour market shocks. Policy options highlighted move beyond the labour-market to connect into regional infrastructure investment. This remains a key issue and requires future understanding about how to create better policy integration.

Education and skills development are shown by research to be the foundation of a resilient and agile labour market. Policies for education/skills development conceived only at local or national levels will need to be more connected across the EU. Policy making for the EU level will need to encourage the adoption of commonly accepted sets of attributes for education/training to be adopted at local/national levels to ensure that

individuals engaging in mobility/migration are equipped to participate in the local labour markets of their new homes.

Vocational education and training (VET) has been an essential part of EU policy since the very establishment of the European Community. VET has a key economic function in upskilling and integrating young people into the labour market and in providing high quality technical skills, promoting their talent and strengthening their entrepreneurial skills, all of which produce benefits for the hosting labour-market.

Entrepreneurship is one of the main soft-skill competencies for guaranteeing success in the future and in the labour market. What is certain is that, nowadays, creativity is a value on the rise due to its close relationship with problem solving and entrepreneurship. Creativity and innovation are crucial skills needed to enable countries' to address the challenges they face in the economy, the environment, and society as a whole.

3. Experts' analysis

3.1. Research areas for the impact of the digital transition

The penetration of digital technologies into all aspects of society is having a disruptive transformative effect. A heterogeneous range of digital technologies has emerged across a multiplicity of types of application. This situation has called for a change of organisational processes or the creation of new business models and has influenced many aspects of social life.

Figure 14: Impacts of the digital transition: main scenarios and related specific research areas

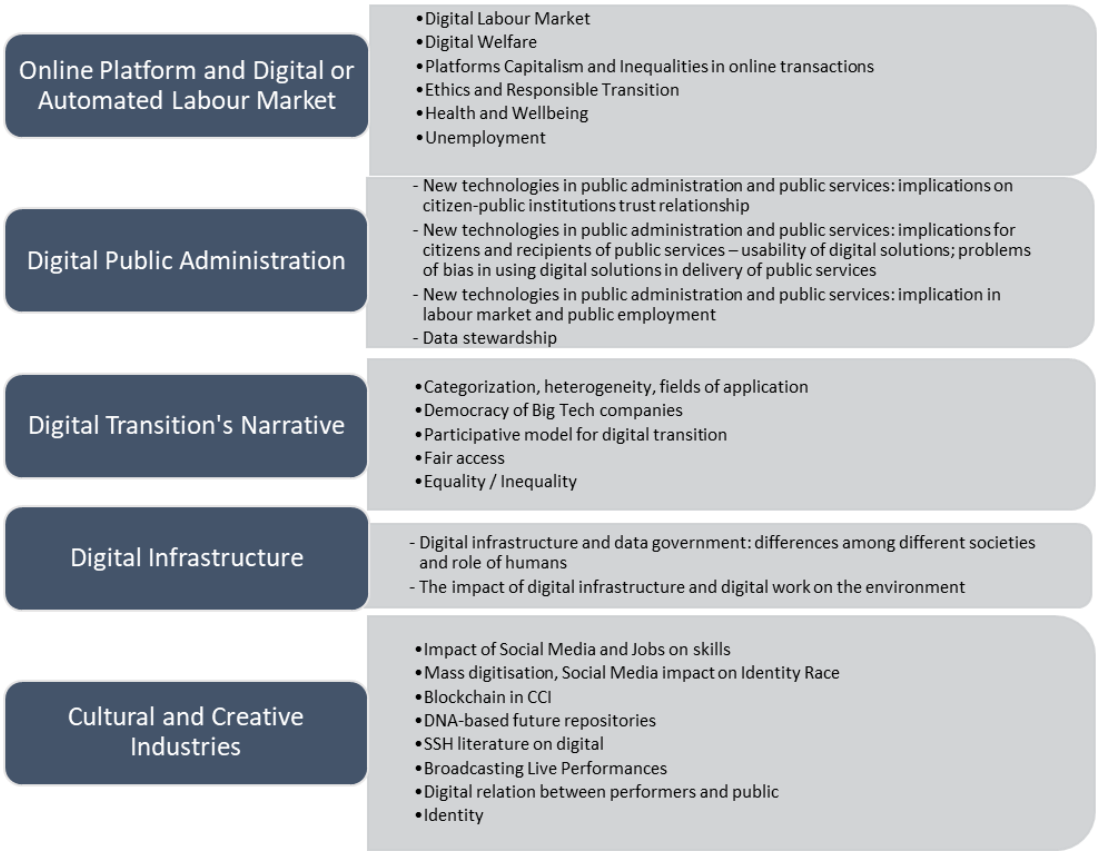


Figure 14 gives a list of examples of where more research is required. The list does not claim to be exhaustive but rather aims to highlight some research areas in line with the main recommendations of this report. In the sections that follow some key questions for future SSH research are highlighted in four of these areas: online platforms or automated labour markets; digital infrastructures and public administration; cultural and creative industries; and, the digital transition's narrative.

3.1.1. Online platforms and digital or automated labour market

Literature on emerging platforms has been growing exponentially in recent years. A seminal work that tackles the world of platforms is *Platform Capitalism* by Nick Srnicek (2016). Srnicek defines platforms as "digital infrastructures that enable two or more groups to interact. Platforms therefore position themselves as intermediaries that bring together different users: customers, advertisers, service providers, producers, suppliers, and even physical objects".

An inspiring and focused analysis is provided by the report of the High-Level Group on the Impact of the Digital Transformation on EU Labour Markets (HLG), led by Professor Maarten Goos. The impact of the digital transformation on EU labour markets (2019) and by other EU-funded projects such as Platform Labour in Urban Spaces (PLUS)[12]. Considering the impact of the digital technologies through a wide range perspective, the 2019 report focuses on changes of labour demand (digitalisation "cannot automate all tasks currently done by workers") and supply. The authors note that "the introduction of new technological intermediaries or 'platforms' … lower barriers to labour market entry and thus include more people in the market". Consequently, digitalisation has changed labour relations and created a multiplicity of "nonstandard" works with "profound consequences" on social protection. As the report argues, "today's social protection schemes continue to largely focus on standard, full-time work"[13], which is something that needs to be deeply rethought.

Furthermore, the report highlights that "digitalisation is leading to job polarisation" threatening middle-skills workers. It also notes that "the increase in non-standard work has […] apparently not been at the expense of standard work, but rather reduced unemployment and inactivity, though significant national differences exist"[14].

Indeed, as reported by Wood[15], according to EU statistics for the period 2002-2018, standard employment in the European Union has remained at roughly 40%, although the growth of nonstandard employment was particularly high, including platform-mediated employment which now represents the main source of income for 2% of the population. Globally speaking there are roughly 70 million platform workers. The growth of this phenomenon of new ways of working needs considerable further attention.

The general demand for expansive labour and social policies has been acknowledged by governments and European legislators. Research proposes a model for regulating labour through digital platforms tailored to the specific characteristics of this business model and to the different ways in which labour is carried out. This framework suggests two considerations: on the one hand, digital platforms organize labour with different degrees of intensity and through changing patterns, and, on the other hand, workers' needs are not always the same. The main points now are which kind of protections must be addressed to platform workers (do they depend on the contractual scheme or is it necessary to think of them independently?) and which is the level of their guarantee (Regional/Local? National?). Future R&I actions will have to deal with these issues. Moreover, they will have to consider which forms of welfare could guarantee social

12 M. Goos (2019) *The Impact of the Digital Transformation* https://digital-strategy.ec.europa.eu/en/news/final-report-high-level-expert-group-impact-digital-transformation-eu-labour-markets; ; https://project-plus.eu/.

13 *Idem,* p.19

14 *Idem,* p.24

15 Wood, A. J. et al., 2018. *Good gig, bad gig: autonomy and algorithmic control in the global gig economy*, Work, Employment and Society 33(1): 56-75.

inclusion and effective protections for all workers, especially considering the high fluctuations in employment levels.

In the areas of automated labour markets and digital welfare astonishing advances in robotics and artificial intelligence imply that an increasing number of job tasks can soon be entrusted to machines. Machines are no longer just competent in performing routine tasks but are also increasingly capable of performing non-routine tasks too[16]. These developments have implications for existing jobs[17] and the skills required for these jobs. In automated labour markets, workers' employability and productivity will be defined by the extent to which they can compete or cooperate with machines and complement artificial intelligence[18]. The impact on jobs depends on the speed of innovation, adaptation of technology, the automatability of job tasks, and policies[19]. However, all sectors of the economy will be affected.[20]

Digitalisation makes possible effectivization and automation of jobs previously performed by people from cashiers in shops to bankers and HR-managers. A debate that has been ongoing for almost a century is whether automation will lead to job-loss, more leisure-time, or something else. So far, the category "something else" has been the answer, as people have moved from sector to sector as jobs are being automated (from farming to industry to service). A question is whether we have run out of sectors to move to as service jobs are also being automated. Considerably more research will be needed to unpick the likely outcomes to improve on the current best guess of "something else."

The following research areas have been highlighted:

- A greater understanding of the social, political and environmental impacts of the digital transition on the workplace and on employment.
- What kind of protections must be developed for platform workers (do they depend on the contractual scheme or is it necessary to think of them independently?) and which is the level of their guarantee (Regional/Local? National?). Future R&I actions will have to deal with these issues.
- Which forms of welfare could guarantee social inclusion and effective protections for all workers, especially considering the high fluctuations in employment levels.
- How employees and users might be involved in the development of digital systems to ensure participation which is not alienating and which provides

16 Brynjolfsson, E. and A. McAfee (2014), *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, New York: W. W. Norton and Company. Susskind, R. and D. Susskind. (2015), The future of the professions. How technology will transform the work of human experts, Oxford: Oxford University Press.

17 Arntz, M., Gregory, T., & Zierahn, U. (2016) *The risk of automation for jobs in OECD countries: A comparative analysis*.; Acemoglu, D., & Restrepo, P. (2019), *Automation and new tasks: How technology displaces and reinstates labor*, Journal of Economic Perspectives, 33(2), 3-30.

18 Brynjolfsson, E. and A. McAfee (2014), *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, New York: W. W. Norton and Company.; Frey, C. B., & Osborne, M. A., (2013), *The future of employment: How susceptible are jobs to computerisation,. University of Oxford*.

19 Hötte, K., Somers, M., Theodorakopoulos, A., *Technology and jobs: A systematic literature review*, in Technequality. Understanding the relation between technological innovations and social inequality, Deliverable D6.1, 2021 (https://technequality-project.eu/files/d61fdstateoftheartv1124-12-2021pdf).

20 Grigutsch, M., Koutroumpis, P., Levels, M., *Is this time really different? Evidence on the impact of technological revolutions*, in Technequality. Understanding the relation between technological innovations and social inequality, Deliverable D6.2, 2021 (https://technequality-project.eu/files/d62fdisthistimerealydifferentv1031122022pdf).

protection for the workers. In particular principles and methodologies for such involvement need to be considered.

- The use of Artifical Intelligence (AI) and how that is developed ethically and in ways which promote social inclusion and diversity.
- The benefits of digitalisation to improve health and safety at work.
- Consideration of the impact of AI on employment and whether we have run out of sectors to move to given that service jobs are also being automated.

3.1.2. Digital infrastructure and public administration

In the world of digital technology humans have a new role as information producers and 'data subjects'. The way this works is very different depending on the organisation of society. In the context of capitalism citizens' data becomes an economic resource; in a totalitarian context, a resource for control and in a social democracy something more like a governmental resource. In this sense, the issue of data is gaining ever more importance posing challenges in terms of acquisition, control and use.

Research questions in this area concern issues such as:

- Understanding data governance, how institutions may manage data efficiently.
- What are the economic and social costs of current and future infrastructures and data stewardship?
- Models for the transparent governance and dissemination of digital public services; how to build a culture of transparency.
- Data curation.

3.1.3. Cultural and creative industries

In the EU territory there are 65,000 public libraries with around 100 million visitors which represents approximately one fifth of the whole population of the EU[21]. 2221 archives are registered on the Archives Portal Europe[22]. While these data refer to the pre-COVID 19 emergency, the ongoing digital revolution with an ever-growing number of texts and resources available online through libraries and archives, coupled with the COVID-19 emergency, has radically changed the relationship between users and these institutions: the physical aspect of libraries and archives is becoming less important whilst the online service these institutions are asked to provide has become more complex.

Three main digital transition developments are expected in the transformation of the present acquiring of knowledge into validated data-driven SSH and Cultural Heritage research and education platforms and in reformulating the role of libraries and archives as data-based information centres employing data stewards and data curators to help future users in finding the requested data:

21 https://www.europarl.europa.eu/RegData/etudes/STUD/2016/585882/IPOL_STU(2016)585882_EN.pdf, p. 7.

22 https://www.archivesportaleurope.net/directory

- Mass digitisation;
- Provenance authentication of online cultural heritage of digital objects through blockchain;
- DNA-based future repositories.

3.1.3.1. Mass digitisation

Today, GLAM (galleries, libraries, archives, museums) are increasingly, but sometimes randomly, transforming Cultural Heritage artefacts into digital objects to be uploaded onto platforms/portals/repositories with relevant but heterogeneous criteria and metadata. The process is time consuming and labour costs are high. Scanning and meta-dating each record or book page will take years to complete. Instead, automatic scanning, without opening the volume or container, is a ground-breaking solution and techniques differ according to the ink components in handwritten or printed materials[23] (either through tomography[24] or terahertz (THz) technology and imaging[25]). In recent years, considerable progress has been made in increasing the speed and the safety of the entire digitization process of ancient collections and a further investment in research and application of these methods, coupled with machine learning for optimization, HTR[26] and Writer ID[27] techniques will massively and significantly contribute to new directions in SSH research through the possibility of OCR-based text mining or more refined

[23] F. Albertin et al., "*Pringing materials and Technologies in 15th- 17th century book production: An Undervalued research field",* in *Microchemical Jourrnal*, vol. 138 (2017), pp. 147-153.

[24] Stromer, D., Christlein, V., Schön, T., Holub, W., & Maier, A., "Browsing Through Closed Books: Evaluation of Preprocessing Methods for Page Extraction of a 3-D CT Book Volume", in *IOP Conference Series: Materials Science and Engineering* (Vol. 229, No. 1, p. 012005), IOP Publishing, (2017, September); F. Albertin et.al., "From closed testaments to books: Virtual X-ray Reading as an alternate digitization technology for fragile documents", *Archiving Conference 2017*, Vol. 2017, No. 1, pp. 14-18; M. Bettuzzi et. al., "X-ray computed tomography applied to investigate ancient manuscripts", *Il Nuovo Cimento C*, Geophysics Space Physics, C 40, 2017, article 102; Hammernik, K., Würfl, T., Pock, T., & Maier, A., "A deep learning architecture for limited-angle computed tomography reconstruction", in *Bildverarbeitung für die Medizin 2017*, Springer Vieweg, Berlin, Heidelberg, pp. 92-97; Rosin et al., "Virtual Recovery of Content from X-Ray Micro-Tomography Scans of Damaged Historic Scrolls", *Scientific Reports* 11901 (2018); Schön, T.; Holub, W.; Stromer, D.; Maier, A.; Anton, G.; Thilo, M.; Vossiek, M.; Schür, J., "System for analyzing a document and corresponding method", WO2018EP72815 20180823 (https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2019038403); D. Stromer, et al. "Dose reduction for historical books digitization by 3-D X-Ray CT", in *Proceedings of 8th Conference on Industrial Computed Tomography* (iCT 2018), ed. by U. of Applied Sciences Upper Austria. Wels (Austria), 2018, pp. 1–2.

[25] Ljubenovic M., Bazrafkan S., De Beenhouwer J., Sijbers J., "CNN-based deblurring of terahertz images", VISIGRAPP 2020 - Proceedings of the 15th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, vol. 4 (2020), pp. 323-330 and Ljubenovic M., Bazrafkan S., Paramonov P., De Beenhouwer J., Sijbers J., "CNN-Based Deblurring of THz Time-Domain Images", in Computer Vision, Imaging and Computer Graphics Theory and Applications, book series (CCIS,volume 1474), 2022, pp 477–494.

[26] L.Kang, M. Rusiñol, A. Fornés, P. Riba, M. Villegas, "Unsupervised Adaptation for Synthetic-to-Real Handwritten Word Recognition", Winter Conference on Applications of Computer Vision (WACV), 2020; Christlein V. et al., "Competition on Image Retrieval for Historical Handwritten Documents", International Conference on Document Analysis and Recognition (ICDAR), 2019; Reeve Ingle R et al., "A Scalable Handwritten Text Recognition System", 2019 International Conference on Document Analysis and Recognition (ICDAR), IEEE, 2020; Flor de Sousa Neto A., et al., "HTR-Flor: A Deep Learning System for Offline Handwritten Text Recognition", 2020 33rd SIBGRAPI Conference on Graphics, Patterns and Images (SIBGRAPI), IEEE, 2020, pp. 54-61. It is expected that the global market for document extraction software would grow to $12.6 billion in annual revenue by 2027. This represents an annual growth rate of approximately 10 percent over the course of the forecast period. https://parashift.io/en/the-market-for-document-extraction-software-is-gaining-ever-more-relevance/

[27] Christlein V., Handwriting Analysis with Focus on Writer Identification and Writer Retrieval, Ph.D. thesis 2019; Durou A. et al., "Writer identification approach based on bag of words with OBI features", Information Processing & Management, Vol. 56, issue 2 (March 2019), pp. 354-366.

techniques[28]. This sector has demonstrated a skill in training personnel with very interdisciplinary skills.

Digital Humanities has emerged as an inherently interdisciplinary science, building on traditional humanities research methodologies applied to cultural sciences and on developing computer-assisted procedures to create digital resources. It has created the need for people, who can combine these skills of humanistic competences with technological and computer sciences competencies in order to create innovative approaches to cultural heritage. The wide spectrum of digital humanities has revolutionised the whole field of conservation, reading, and preservation of our memory and has led to radical changes in the job market, creating a pressure and a demand for a skill-set which is little understood as this is not viewed as a traditional business sector. There is no data or knowledge about the impact of digital transition on this public business and on the labour market related to it. It has also an important effect on new ways of learning which then impact a large population which use and consume knowledge on a regular basis.

3.1.3.2. Online provenance authentication – digital objects through blockchain

Provenance – the means of ensuring that a digital object is a faithful replica of the 'original' one, or the obligation to specify the changes made – is an issue of increasing importance. Knowledge today is acquired mainly through the web via data in markup languages (HTML, XML, XHTML) or via digital objects (JPEG, PDF, PNG, BMP, GIF, TIFF, PSD). One can find on the web a myriad of Cultural Heritage digital objects produced by private entities in different formats, resolution, density, tonality, size and metadata. The question of provenance is not considered a priority issue, although the danger of fake data used not only by private entities but in SSH research and education is extremely high. This situation raises the problem of establishing an agreed standard for validated data provenance. Although the International Image Interoperability Framework (IIIF) provides a standardised method of describing and delivering images over the web (as well as structural metadata) about structured sequences of images, no information is delivered regarding the original source of the digital objects, or the changes made during the replication. The IIIF can serve as a basis for such provenance authentication, but it needs a strong validation framework in order to carry it out.

Gartner Hype Cycle for Digital Government Technology (2021) forecasts that it will be 5 to 10 years before authenticated provenance technology for civil administration will be available[29]. However, even with such technology available to governments there will still be the problem of Cultural Heritage digital objects already on the web. New proposals to authenticate archival records using blockchain technology already exist,[30] but the burning questions are twofold: the platform that will eventually validate the provenance and the "reward" for validators.

[28] https://research.aimultiple.com/ocr-accuracy/ ; https://www.iqt.org/text-extraction-via-optical-character-recognition/

[29] Gartner Report Top Strategic Technology Trends for 2022: Hyperautomation; Thales Group, *Emerging Technology and Trends Impact Radar: Drones and Mobile Robots*

[30] A. Lo Duca, C. Bacciu, A. Marchetti, (2019) *The use of Blockchain for Digital Archives: A Comparison between Ethereum and Hyperledger*, AIUCD, Umanitistica DIgitale, 4, (8). M. Basile et al. (2019) A Blockchain-based support for safeguarding the Cultural Heritage, in EVA Proceedings of the Electronic Imaging and the Visual Arts ed. Cappelling, Firenze, FUP, pp.64-73.

3.1.3.3. DNA-based future repositories

It has been estimated that since 2010 there has been a gap between storage capacity and data generation[31]. A recent Gartner report[32] has estimated that "In 2020, humans likely generated in excess of 400 ZB of digital 'stuff' – equivalent to 400 million petabytes or 400 billion terabytes (or 40 'shoeboxes' of DNA data storage). Further, "Gartner considers a 35% per-year growth scenario – closely reflecting the actual growth we saw beginning in 2010, a year that might be considered the birth of the cloud storage area – to be most likely." Conservative estimates suggest that, by the year 2025, traditional data storage technologies will be able to store less than half of the digital data generated. Increasing the production of traditional silicon-based digital data storage is not seen as a sustainable solution. Semiconductor Research Corporation has predicted that demand for digital data storage will exceed the global supply of silicon by 2-3 orders of magnitude by 2040[33].

In this scenario, DNA represents an alternative technology for storing digital information thanks to its ability to synthesize and its interesting properties[34].

Each human cell contains a genome consisting of approximately 6 billion base pairs of double helical DNA, organized into 23 groups of chromosomes (3 billion base pairs of DNA correspond to the chromosomes in each half of the set). The DNA in these chromosomes encodes approximately 1.6 gigabytes of information in total, per cell. Adding up all the cells in our body amounts to about 100 zettabytes of information contained in our DNA.

However, DNA does not only have the capacity to store a very large amount of data: the density of information it can accommodate is far superior to any other technology, as is its way of storing data in three dimensions - hence its volumetric capacity - which makes this technology more effective as it saves physical data storage space. Another reason for advocating the use of DNA as a data storage technology is its stability: it is capable of preserving data for centuries and, in the event of degradation, redundancy and error correction systems are able to overcome the problem. Finally, copying the DNA using procedures already known in the field of molecular biology is fast and low cost[35].

The first idea of using DNA as a data storage "platform" dates back to 1995[36], but the first experiments were carried out in 1999[37]. After a few years of stalemate due to the problems of DNA synthesis and the use of sequencing techniques, recently, and after a few years of collaboration between Microsoft, the University of Washington and Twist Bioscience, the researchers managed to encode 200 MB of information in DNA and

31 R. Fontana, G. Decad, *Storage Media Overview: Historic Perspectives. Presentation*, May 4, 2016.

32 Gartner, 'Emerging Technologies: New Active/Accessible and Deep Archive Data Requirements – DNA Data Storage', John Monroe, April 23, 2021.

33 V. Zhirnov, R.M. Zadegan, G.S. Sandhu, G.M. Church, W.L. Hughes, *Nucleic acid memory*, Nature Materials 15 (2016), 4, pp. 366-370.

34 D. Raines, "Repositories del futuro", *La storia in digitale. Teorie e metodologie*, ed. D. Paci, Milano, edizioni Unicopli, 2019, pp. 307-312

35 Bornholt et al., A DNA-based archival storage system, «IEEE Computer Society» (2017), 3, pp. 98-104: < https://homes.cs.washington.edu/~bornholt/papers/dnastorage-toppicks17.pdf >.

36 E.B. Baum, *Building an associative memory vastly larger than the brain*, «Science» 268, 5210 (1995), 4, pp.583-585.

37 C.T. Clelland, V. Risca, C. Bancroft, *Hiding messages in DNA microdots*, «Nature» 399, 6736 (1999), 6, pp. 533-534.

recover this data with 100% accuracy[38]. Today, the challenges facing researchers are of three types: increasing storage density, correcting errors in DNA synthesis and sequencing and compensation techniques for possible DNA degradation[39]. Ethical issues may arise and will need to be tackled at the EU level.

3.1.3.4. Research questions relating to the impact of digital transition in the cultural and creative industries

Research questions in the broad area of the impact of digital transition in the cultural and creative industries include:

- Understanding more about the impact of digital transition in the GLAM sector and on the labour market related to it.
- The impact of digital transition on learning.
- Understanding more about the platform that will eventually validate the provenance of digital objects and the "reward" for validators
- How storage density for digital data can be increased.
- Correcting errors in DNA synthesis and sequencing.
- Compensation techniques for possible DNA degradation.
- The ethical issues which will arise in the development of new storage solution.

3.1.4. SSH literature on the digital transition

Digital technologies are inextricably linked to narratives about possible futures, hence the importance of metaphors and images to talk about digitalisation. Narratives of possible futures are often polarised, especially in popular culture. AI appears to be a notably persistent and divisive subject. Sometimes robots take on all the difficult and tedious work leaving humans with time for creative and loving tasks, as in Ishiguro's recent novel Klara and the Sun (2021). This is very different from representations in which humans will all be killed or enslaved by their robot overlords, famously envisioned in The Matrix movies. As far back as 1976, Weizenbaum feared that computerization would risk replacing human judgements. More recent accounts of AI highlight issues of accountability, as well as problems arising from an allegedly neutral decision making, and technologically implemented discrimination of minoritized groups. At the same time, many of the early internet metaphors were evocative of comparatively optimistic hopes as regards digital technologies, especially their potential to augment communication and physical interaction. Notions like 'the superhighway', 'surfing the web' and 'digital frontier'

[38] DNA-Based Digital Storage, *Twist Bioscience White Paper*, pp. 1-5, URL: < https://pdfs.semanticscholar.org/fbd5/af58f65f69a0661e26a496d1a440979ab25b.pdf >.

[39] D. Panda et al., *DNA as a digital information storage device: hope or hype?,* «3 Biotech» 8, 5 (2018), pp. 1-9, URL:https://www.researchgate.net/publication/324945710_DNA_as_a_digital_information_storage_device_hope_or_hype >.

have distinct spatial connotations, most evident in the term ‘cyberspace’. We see these themes and metaphors returning again and again.[40]

Studying the narratives surrounding the digital transition leads to a very important understanding of the deep change that digital transformation has on our societies and identities. Some communities were identified by their jobs and individuals characterised by their own professions. The digital world has changed such connotations and many jobs based on digital means have pre-empted the notion of identification via “what you do”. The knowledge society is based on a widespread network of workers who are active via their own devices but who do not actually relate in a physical environment, only in a digital world. The act of producing digital products, intellectual as well as business products, is no longer regarded as being part of a profession but as part of being active in society. It is no longer the job that characterises a person but vice versa. Research on understanding these new communities which have digital identities rather than identities based on a specific occupation is also important in relation to the development of social policy relevant to such communities.

Thus research questions need to include:

- Studying the narratives surrounding the digital transition to improve collective understanding of the profound change this transition and transformation has on everyone’s lives;

- Understanding how communities with digital identities differ from traditional communities based on specific occupations – fishermen, miners and so on – and what this means for social policy.

[40] See a recent publication on this topic *Metaphors in critical Internet and digital media studies*, by Sally Wyatt, 2021 (sagepub.com).

4. Conclusions

The digital transition affects so many different aspects of society that it should be understood and interpreted through the lens of a wide range of social science and humanities scholarship. What emerges from our analysis of the projects funded under H2020 and academic publications is a complex picture for the future research agenda of Horizon Europe.

In the cooperation projects funded under H2020 the first conclusion to draw is that the topics and objectives have had a narrow focus. There is greater attention to project outcomes producing tangible impacts, rather than a better understanding of issues, cause and possible solutions.

As the analysis of projects shows, **in H2020 projects, there are fundamental and deep gaps with a clear finding of under-representation of insights from research in the humanities disciplines**. Contributions from a different set of research perspectives would allow the development and deployment of tools to examine the cultural and identity impacts of labour market changes. **In particular, what is missing is literature around the themes, which express human anxiety about profound changes in labour relations and job security, or more importantly unemployment and the impact these changes have on community identity**.

The knowledge society – which is what is highlighted in the digitalisation process – identifies winners and losers in the labour market and shows in particular a deepening gap within societies and across the continent. The publications analysis indicates that there are other areas where there are strong differential effects; these appear in comparative studies between regions or countries and across different business sectors. Research will be needed to better predict the differential effects across geographies, business sectors and social groups as the digital transition policies create changes. The nature of change and the impact of change under the digital transition is hard to predict in the same way that seismic events are hard to predict: where, when and how impactful.

Comparing the results of the two parts (projects and publications), **we see that the themes and topics of the H2020 projects are narrower than those that emerge from the publications analysis**. There are fewer projects funded under H2020 that include major elements looking at education and skills, new forms of digital education for labour forces to respond to the new conditions created by new policy, for older workers or other disproportionately affected groups. **The economics perspective on labour markets research**. This may not be surprising given that the H2020 projects topics are largely determined by the 'top down' process of thematic prioritisation, which yields a narrower focus.

One other significant issue to highlight for both the projects and publications studies is that there are very few findings as regards the Covid-19 pandemic. Digitalisation has been accelerated in many areas, and made little progress in others, yet at present the Covid-19 related body of knowledge will take more time to emerge from projects and literature.

From the analysis of publications, we would also highlight that the research topics are diffused across a range of dimensions that affect labour markets, and not only the digital transition. This indicates that while there is a line of research on the impacts of new technology and ICT on the labour market, this has not yet been refined into research which focusses on the emerging digital transition agenda.

5. Recommendations

Research disciplines and perspectives

- **Broaden the lens beyond economic perspectives**: in line with the strength of research on labour markets, analysis in both the H2020 projects and academic publications reveals the bias towards viewing the set of challenges around the digital transition as primarily economic. What the analysis reveals is the gap left for examination of the digital transition from other perspectives and in particular the examination of the cultural and identity effects of major labour market disruptions. Such work would include: studies on behaviour, inequalities and on the digital transition as an opportunity or a challenge for designing not just products and tools but also for its transformative value in changing society's patterns of employment.

- **Consider the ethical implications**: Investment in research which looks in more detail at the ethical implications of the use of some digital technologies, e.g. in the use of diagnosis in health care, the use of AI technologies in public administration and decision automation capabilities, to ensure that there is an overriding principle to maintain a human-centred approach.

Policy areas, priority themes and topics

- **Shocks to labour markets**: the analysis of publications reveals the wealth of previous and ongoing research around the range of causes of shocks to labour markets. We recommend the continuation of funding for this research – in particular around education, digital skills, soft skills, employability, entrepreneurship and creativity

- **The 'gig' economy**: more research is needed on the growth of what is variously called the gig economy, portfolio careers, flexible working, etc. Digitalisation has been accompanied by an expansion of different forms of casual labour, often with very poor working conditions.

- **The impact of the digital transition on minorities**: especially with regard to cultural heritage digital artefacts and the impact of the digital transition on their identity and sense of community.

- **The pace of change and societal adaptation**: the digital transition, although it has the potential to drive fundamental changes, may not be very different from past radical changes in society when evolutionary and deep transformation have occurred. The impacts though may come about at a faster pace and be longer lasting. Research questions therefore must focus more on the compatibility of a digital strategy with the pace of societal adaptation; social evolution, family dynamics, population studies, social integration (especially age groups, ethnic origins and mix-skilled workers).

- **Digital social divide and the creation of new social exclusions**: in particular, the need to identify the intensification of existing social exclusion of older citizens, those with disabilities and those struggling with mental health. Accessing the range of services, care and support in a 'digital' world presents an increased risk of new forms of 'social exclusion'.

- **The impact on public service provision**: is also a broader research concern. More research is needed to address how the greater use of digital tech solutions to public service provision have implications in the context of labour markets and employment supported by public services and public authorities.

- **Welfare and employment platforms**: the above issues are also relevant when considering welfare and employment platforms, especially in legal terms. European regulation would not be enough to guarantee fair working conditions, therefore there is a need to review the contents of contracts, especially considering cross border issues and cross border workers.

- **Health and wellbeing of workers**: is an important research area as more occupations and sectors intensify their reliance on digital tools of different types. New technologies including AI, automation and robotics will change the working environment, potentially making it safer. It may create an environment where people work longer because 'heavy' work is taken away from humans. What are the implications of more remote working on mental health and health in general, and safety in the workplace, which is also your 'home space'.

Programme processes and architecture

Review the process for defining new research work programmes and priority research themes and topics to address the drawbacks of the previous focus on socio-economic research and introduce a broader spectrum of perspectives which can provide insights into the cultural and identity impacts of a major new policy initiative like the digital transition.

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