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TOWARDS A TAXONOMY OF DIGITAL WORK

Volkmar Mrass
University of Kassel, volkmar.mrass@uni-kassel.de

Mahei Manhai Li
University of Kassel, mahei.li@uni-kassel.de

Christoph Peters
University of St. Gallen and University of Kassel, christoph.peters@unisg.ch

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Mrass, Volkmar, University of Kassel, Kassel, Germany, volkmar.mrass@uni-kassel.de

Li, Mahei Manhai, University of Kassel, Kassel, Germany, mahei.li@uni-kassel.de

Peters, Christoph, University of St.Gallen, St.Gallen, Switzerland, christoph.peters@unisg.ch, and University of Kassel, Kassel, Germany, christoph.peters@uni-kassel.de

Abstract

Despite the increasing importance of digitization for economy and society, there is few structuring of the very heterogenous kinds of digital work. Representatives from business, politics and science need a basis for the development of strategies to encounter the challenges that result from this digitization. We aim at delivering a contribution to that basis by systematically investigating what different types of digital work exist and by developing a taxonomy. As a first important step towards this goal, we investigate in this paper what digital work tools exist since such tools are a major constituent element of digital work. Using a hybrid approach including both a deductive conceptual-to-empirical and an inductive empirical-to-conceptual procedure, we create an artifact that gives business leaders an overview of existing digital work tools as a basis for strategic decisions and at the same time provides researchers with stimuli for future investigations in the dynamic domain of digital work.

Keywords: Digitization, Digital Work, Digital Work Tools, Taxonomy.

1 Introduction

The digitization of economy and society has gained momentum in the last years and is continuing to proceed. The competitiveness of whole countries, economies, branches and corporations depends on how successfully they are able to adapt to the present changes. There is a broad consensus (see for example Brynjolfsson and McAfee (2011), Ford (2015), Kollmann and Schmidt (2016)) that this development will have a huge impact on the world of work. Frey and Osborne (2013) for example investigate in their frequently cited study "The Future of Employment" how susceptible jobs are to 'computerisation' and come to the conclusion that about 47 percent of total US employment is at risk.

Despite the obvious increasing importance of digitization for the economy, there is few structuring of the very heterogenous kinds of digital work. Both academia and practice lack a systematic overview of what occupations and tasks can be regarded as 'digital work' (or not). Business leaders, politicians as well as scientists need such a structuring as a prerequisite for the development of concepts for the future. With our research, we aim at systematically investigating what different types of digital work exist and at subsequently developing a taxonomy. As a step towards this goal, we investigate in this paper what digital work *tools* exist - since such tools are a constituent element of digital work - and compile a corresponding taxonomy (to the best of our knowledge, one of the first of this kind). This taxonomy shall allow business representatives to benchmark their 'digital work tool landscape', to select appropriate tools and corresponding processes for their respective company and to help researchers to better understand this dynamic and increasingly important domain.

This paper proceeds as follows: After the introduction (section 1), we give a short background on this theme and related work in the field (section 2). We then elaborate on the methodology used in this paper (section 3) and present our results, especially the main artifact of this paper, a taxonomy of digital work tools (section 4). Finally, we discuss our results so far and derive our conclusions (section 5).

2 Background

A major part of the current literature in the realm of digital work deals with the possible influence on employment and certain jobs (see among others e.g. Brynjolfsson and McAfee (2011), Ford (2015), Frey and Osborne (2013), Kollmann and Schmidt (2016), Picot (2013), Schmidt (2016), Schwemmle and Wedde (2012), Stone et al. (2016), Raghuram, Tuertscher and Garud (2010), Ross et al. (2016), Veit et al. (2014)). Even though these and other publications do not offer comprehensive taxonomies, they nevertheless provide information that helps to gain an overview of the current status in the realm of digital work. This overview serves as an important source for the development of our taxonomy (for more details, see section 3 methodology). It also serves as an important basis for the decision on the definition of digital work that we use in this paper.

Taking into account the various kinds of digital work from these and other sources, we opted for a definition of digital work that is not too narrow and does not exclude certain areas. In general, work is defined as a purposeful and conscious activity; by contrast, gainful employment denotes the part of work individuals expend to ensure the means of subsistence and income generation (Durward, Blohm and Leimeister, 2016). In this paper, we follow the definition of "digital work" as "effort to create digital goods or that makes substantial use of digital tools" (Durward, Blohm and Leimeister, 2016). When we use the term digital work in this paper, we only look at the financially remunerated part of that work (which the authors mentioned above actually coin "digital gainful employment" and define as "digital work for ensuring livelihood and creating income"). We thus use digital work in this paper for reasons of convenience and better memorability synonymous to digital gainful employment.

Developing a comprehensive taxonomy of digital work, or as a first step in this paper of digital work tools, is an arduous task. One reason lies in the nature of this term itself: A significant part of todays' world of work relies on efforts to create digital goods or makes substantial use of digital tools and therefore falls under our definition of digital work introduced above (see also Orlikowski and Scott, (2016)). In Germany for example, more than 80 % of the employees are currently using digital information and communication technology (ICT) in their working environment (Federal Ministry of Labour and Social Affairs (2016, p. 19)). Holts (2013) states further obstacles for the development of a similar taxonomy (in the area of "virtual work") that also hold true for our realm: One is the challenge of understanding what exactly constitutes such work, especially given the increasingly blurring border between work and leisure time (Holts, 2013). Another challenge according to her is the lack of empirical work that examines different types of work activities. In addition, different disciplines study this domain with different foci (Holts, 2013). What is lacking is an interdisciplinary approach.

Considering all these obstables, it might be tempting to extract a special aspect of digital work, for example platform-based digital work, and develop (only) a taxonomy for this part. The authors of this paper decided to resist this temptation, knowing that developing a taxonomy for the whole area of digital work might be regarded as too broad respectively general or as incomplete no matter how many aspects are included. Being aware of these possible shortcomings, we are nevertheless convinced that such a comprehensive taxonomy is necessary and regard our paper as a first important step towards such a taxonomy. As one of the first attempts of this kind, it aimes at fostering discussion and the development of further - maybe more sophisticated - taxonomies of digital work (tools) in the future.

3 Methodology

Beaulieu, Sarker and Sarker (2015) posit that typology and classification research is used to understand and pursue the sciences of the differences and that without understanding these, one could not theorize about the commonalities. Theories of typologies and classification schemes originally evolved from the biological sciences and allowed to study species after arranging them into homogenous groups (Beaulieu, Sarker and Sarker, 2015). Taxonomies are important for research and management since the classification of objects allows to analyze and grasp complex issues (Nickerson, Varshney and Muntermann, 2013). Sometimes the term "taxonomy" as a form of classification is used synony-

mously with "framework" or "typology" (Nickerson, Varshney and Muntermann, 2013). In our paper, we will refrain from going deeper into the differences of these concepts and will use the term taxonomy as an attempt to arrange different kinds of digital work tools into (ideally homogenous) groups.

To tackle our goal of developing such a taxonomy, we first conducted a literature survey (but not a complete literature review according e.g. to Webster and Watson (2002) since this is not the main goal of our paper; we e.g. did not conduct a forward/backward search) that focusses on scientific contributions in the realm of digital work. We used a university catalogue portal that accesses scientific databases and conducted a search for the keywords "digital work" within the publications' titles. Since we looked for a current topic, we restricted the search period to the last decade, the years 2007-2016. The search generated a total of 512 hits. We then examined the abstracts and key words of the displayed publications and thereby also considered the words "digital labo(u)r" and "virtual work". We identified 107 papers that are relevant for the realm of digital work tools and therefore offered insights for our taxonomy. In addition, we also checked 'popular' media/newspapers such as the German Frankfurter Allgemeine Zeitung (FAZ) in the time span from August to December 2016 for press articles from the realm of digital work and considered 41 of them. Furthermore, publications and sources from government agencies (e.g. Federal Ministry of Labour and Social Affairs (2016) and newsletters (e.g. from consulting firms and research institutions) we received since this phenomenon is currently broadly discussed and these outlets also offered valuable insights. One reason is the fact that scientific contributions are often written way before they are published and sometimes may not reflect the 'state of the art': Several high quality articles (also from adjacent areas, see for example Raghuram, Tuertscher and Garud (2010)) reflect the status from several years ago where many recent phenomena like for example 3D printing, self-driving cars or wearables have not been in the focus of interest yet.

Sources for digital work tools articles	University catalogue portal (total hits)	Identified relevant papers from these hits	Articles from popular media	Publications from government agencies	Newsletters from consulting firms and research inst.
Number	512	107	41	4	17

Table 1. Number of identified articles/contributions with relevance for digital work tools realm

Several papers form the IS area (see for example Barn and Barn (2016), Engelbrecht, Gerlach and Widjaja (2016), Geiger et al. (2011), Haas, Blohm and Leimeister (2014), Peters and Menschner (2012)) offer samples how to deal with the challenge of developing a taxonomy respectively typology. Clearly, there are - proverbially - many "roads that lead to Rome" and the choice of the road also depends on the goal of the taxonomy. We finally decided to follow the recommendations of Nickerson, Varshney and Muntermann (2013) since they provide guidance and a method especially for the realm of information systems (IS). As these authors found out through their comprehensive literature survey, taxonomy development has in IS so far largely been ad hoc. Since they posit a method that relies both on a deductive and an inductive approach, it makes it also from our perspective more likely that the developed taxonomy is as accurate and valid as possible. Nickerson, Varshney and Muntermann (2013) propose several qualitative attributes for a useful taxonomy:

- It should be **concise** and contain a limited number of dimensions and of characteristics in each dimension
- At the same time, it should be **robust** and contain enough dimensions and characteristics to allow a clear differentiation of the objects of interest
- It should also be **comprehensive**, meaning that it can both classify all known objects within the respective domain and includes all dimensions of the objects of interest

- Another requirement is that it should be **explanatory**, allowing a taxonomy to be used to identify where an object is found in the taxonomy or the characteristics of an object found in a taxonomy
- And last but not least, a useful taxonomy should be **extendible**, i.e. allowing the inclusion of additional dimensions and characteristics within a dimension if new types of objects appear

Besides these "necessary" conditions (Nickerson, Varshney and Muntermann, 2013), the authors posit that "a taxonomy is useful if others use it", acknowledging that this condition is tautological. Even though our current taxonomy in progress can meet this condition only after its completion and publication, we plan to evaluate and test a first version of it with both practicioners and researchers.

Nickerson, Varshney and Muntermann (2013) offer a straightforward taxonomy development method that we now will shortly introduce in this section, before applying it and showing first results of this application in section 4. An overview of this method is depicted in figure 1.

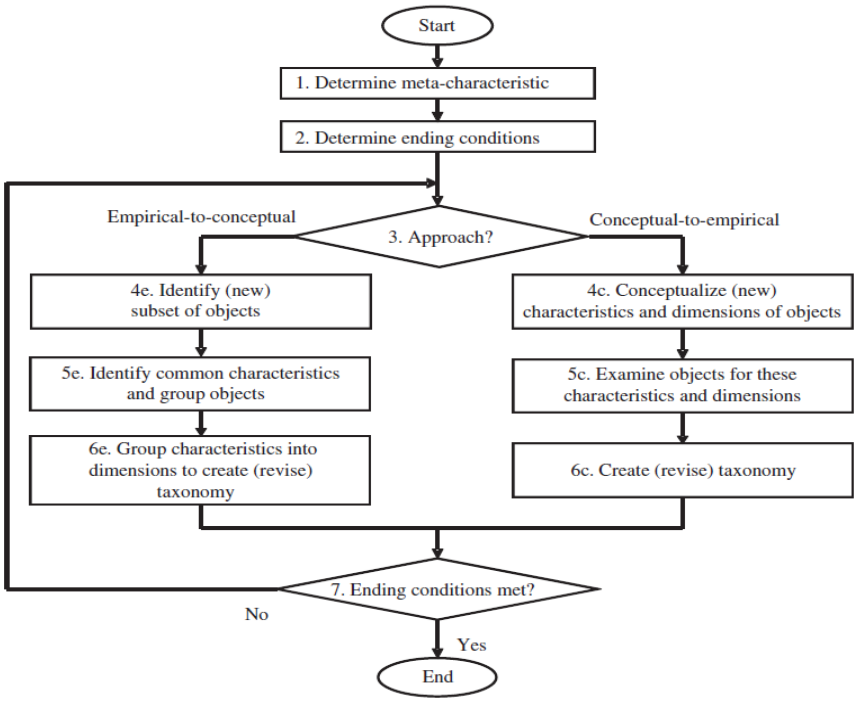

Figure 1. The taxonomy development method according to Nickerson, Varshney and Muntermann (2013)

According to the authors, the first and very important step of this method is the specification of a meta-characteristic that serves as a basis for the choice of the characteristics in the taxonomy; these characteristics should themselves be a logical consequence of the meta-characteristic (Nickerson, Varshney and Muntermann (2013)). The choice of this meta-characteristic depends on the purpose of the taxonomy and is in turn based on the expected use(rs). For the second step, Nickerson, Varshney and Muntermann (2013) propose to identify objective and subjective ending conditions for the completion of the taxonomy, for example that it "consists of dimensions each with mutually exclusive and collectively exhaustive characteristics". Afterwards, their method includes the iterative conduction of steps, beginning with either an empirical-to-conceptual or a conceptual-to-empirical approach and switching between these two. Nickerson, Varshney and Muntermann (2013) *recommend* to start with the conceptual-to-empirical approach if little data are available but the researcher has a good understanding of the domain and to start with the empirical-to-conceptual approach if the researcher has little understanding of the domain but a lot of data about the objects is available. The cycle is repeated until the ending conditions mentioned previously are fullfilled and the taxonomy is therefore completed.

4 Results

After identifying various kinds of digital work tools by conducting a literature survey within the scientific domain and also examining general media, government publications and newsletters from firms and research institutes, we present – following the method described in section 3 - the results derived so far in this section. As a first step, we determine the meta-characteristic and – since this has an influence on it – the expected use(rs) of our taxonomy. The main target group of our taxonomy are business leaders, especially ones concerned with strategic decisions, and researchers. Our taxonomy on the one hand aims at giving business leaders and -strategists an overview of what tools exist in the area of digital work. This overview shall provide a basis for strategic decisions for their corporations to tackle the challenges they face with regard to the digitization of work. The taxonomy could for example help them identify digital work tools in place that are relevant for their business and could have a powerful or even disruptive influence on their respective industries (and therefore help them to identify areas where there is the strongest need for action for them to ensure that they do not lag behind). On the other hand, our taxonomy also aims at paving the way for researchers as a basis to further investigate the dynamic area of digital work. As stated in more detail in section 1 and 2, this domain requires further research to keep up with the fast development and to ensure that science is able to deliver profound recommendations for its tackling. Taking these aims and target groups into account, we identified *digital work tools* as our meta-characteristic. The main reason doing so is that, according to our assessment, these tools offer the most appropriate opportunity to explore the domain of digital work since they are a prerequisite for the performance of digital work. We define them as tools that support the completion of digital work (that we in turn already defined in section 2 as (paid) "effort to create digital goods or that makes substantial use of digital tools" (Durward, Blohm and Leimeister, 2016)).

As a second step, we determine the ending conditions for the development of our taxonomy. Besides the subjective conditions already mentioned in section 3 (the taxonomy should be concise, robust, comprehensive, explanatory and extendible), we decide to use the following objective ending conditions from the options Nickerson, Varshney and Muntermann (2013) provide: All objects or at least a representative sample of objects have been examined, there has been no merger of similar objects or split into multiple objects in the last iteration, no dimensions or characteristics were merged or split in the last iteration and at least one object is classified under every characteristic of every dimension.

In a third step, we now show how we arrived at the current taxonomy depicted in table 3 by running through the whole further cycle with some exemplary characteristics, dimensions and objects. We decide to exemplarly use first the conceptual-to-empirical approach for our iteration and afterwards use the empirical-to-conceptual approach. We proceed with step four: Kollmann and Schmidt (2016) posit the platform model as the dominant digital model with regard to the competition in the digital economy in the B2C area. According to them, already ten out of the twenty biggest companies in the world in the consumer market sector use this model. We therefore derive as a first characteristic for our taxonomy the distinction if the digital work tools are platform-based or not. For this taxonomy, we only look at platforms that act as intermediaries in a sense that they directly control or steer digital work activities and exclude e.g. pure technical platforms such as cloud platforms, operating systems for smartphones, etc., with no direct work steering. We also regard certain platforms themselves as such digital work tools. Also because they are nowadays frequently offered as "platform-as-a-service". From Schmidt (2016, p. 5), we in addition derive a further characteristic: The distinction if the delivery of goods produced via the use of these digital work tools is location-based or location-independent. In step five, we identify instances of this type of digital work tools, i.e. several kinds of platforms. From literature (Leimeister et al. (2016), Mrass et al. (2016), Mrass et al. (2017), Schmidt (2016)), we derive three main types of platforms: Crowdworking platforms (like mikrotask-, market-, design-, testing- and innovation-platforms), commerce platforms (e.g. B2B, B2C and C2C platforms like Alibaba, Amazon or Ebay) and sharing platforms (e.g. in the realms of hospitality like Airbnb or mobility like Uber). In step 6 we create our first small version of our taxonomy (that we enlarge with every following iteration). In the notation used by Nickerson, Varshney and Muntermann (2013), our first taxono-

my T_1 consists of dimension D_1 platform with characteristics C_{11} platform-based and C_{12} not platform-based (but not necessarily platform-independent) and dimension D_2 delivery with characteristics C_{21} location-based and C_{22} location-independent (see table 2):

T_1 = {Platform (platform-based, not platform-based), delivery (location-based, location-independent)}

Digital Work Tools	**Platform** (for work steering)		**Delivery** (of the produced goods)	
	platform-based	not platform-based	location-based	location-independent
Online-Platforms				
Crowdworking-Platforms	x			x
Commerce platforms	x		x	
Sharing platforms	x		x	

Table 2. Taxonomy of Digital Work Tools after iteration 1

Since this is the very first iteration, it is immediately obvious that the ending conditions defined above are not met (e.g. there are for sure additional objects to study) and we can proceed with iteration 2 where we now depict a sample empirical-to-conceptual approach: Since we aim at developing a comprehensive taxonomy and therefore also want to include digital work tools that are relatively common and in parts already 'around' for several years, we select the following from literature (Kollmann and Schmidt (2016), Schwemmle and Wedde (2012)) and own observation from the workplace: Personal computers, workstations, tablets, smartphones, notebooks and wearables. Especially the use of wearables as a digital work tool might not immediately be obvious, but there are nevertheless certain applications (e.g. special glasses for simultation exercises in the military realm). We identify mobility while using these tools as a distinctive characteristic and again identify which tool has which characteristic: Personal computers and workstations are used stationary, tablets, smartphones and wearables can usually be used mobile and notebooks are usually characterized by a hybrid approach, using them both mobile (e.g. on business trips) and stationary (e.g. on a workplace). Because the number of these digital work tools and characteristics is still small, we can again group them manually, leading to our extended taxonomy after iteration 2 (see table 3).

Digital Work Tools	**Platform** (for work steering)		**Delivery** (of the produced goods)		**Use** (degree of mobility)		
	platform-based	not plat.-b.	location-based	location-indep.	stationary	mobile	hybrid
Online-Platforms							
Crowdworkingplatforms	x			x		x	
Commerce platforms	x		x			x	
Sharing platforms	x		x			x	
Devices							
Personal computers		x		x	x		
Workstations		x		x	x		
Tablets		x		x		x	
Smartphones		x		x		x	
Notebooks		x		x			x
Wearables		x		x		x	

Table 3. Taxonomy of Digital Work Tools after iteration 2

As it has been the case after iteration 1, the ending conditions are also not met after iteration 2 and we start the next cycle. It would go beyond the scope of this paper to depict all iterations in detail; these two iterations should nevertheless give a good general insight into how we develop our taxonomy. In

addition to the two digital work tools 'online-platforms' and 'devices' mentioned above, we furthermore identify the groups 'artificial intelligence (AI)', 'machines' and 'vehicles'. Likewise, in addition to the characteristics 'platform', 'delivery' and 'use', we further identify 'autonomy' (from human action/intervention) and 'consistency' (hardware or software) as characteristics. For example, robots would fall under the digital work tool group 'machines' and the sub-characteristics 'hardware' with regard to consistency and 'partial' with regard to autonomy (since they usually still require human action or intervention, even though there are robots in place that are able to learn and apply this learning to new tasks without renewed human action). Similarly, 'decision algorithms' like the ones used e.g. in banks for investment decisions would fall unter 'software' (consistency) and 'full' (autonomy).

Digital Work Tools	**Platform** (for work steering)		**Delivery** (of produced goods)		**Use** (degree of mobility)			**Consistency** (of a work tool)		**Autonomy** (from human action)		
	plat-form-b.	not platf.-b	loca-tion-b.	location-independ.	sta-tionary	mo-bile	hy-brid	Hard-ware	Soft ware	Full	Par-tial	No
Online-Platf.												
Crowdworking	x			x		x			x		x	
Commerce	x		x			x			x		x	
Sharing	x		x			x			x		x	
Devices												
Personal Comp.		x		x	x			x			x	
Workstations		x		x	x			x				x
Tablets		x		x		x		x			x	
Smartphones		x		x		x		x			x	
Notebooks		x		x			x	x			x	
Wearables		x		x		x		x			x	
Servers		x		x			x	x			x	
Machines												
Automats		x	x		x			x		x		
Robots		x	x				x	x			x	
Lines		x	x		x			x			x	
3D printing		x	x		x			x			x	
Vehicles												
Self-driving car		x	x			x		x		x		
SD Public transp.		x	x			x		x		x		
Drones		x	x			x		x			x	
Artificial Int./AI												
Bots		x		x		x			x	x		
Androids		x	x				x	x		x		
Supercomp.		x		x		x		x		x		
Decision Alg.		x		x		x			x	x		
Data Mining		x		x		x			x		x	

Table 4. Taxonomy of Digital Work Tools

Table 4 shows the more comprehensive current version of our taxonomy after several further iterations. It reveals that the more 'state-of-the art' a digital work tool is (comparing e.g. personal comput-

ers that are around already for decades and more recent tools from the AI group like 'supercomputers' such as IBM's Watson), the more likely it falls under the category 'full' with regard to autonomy from human activity/intervention. Autonomy from human action/intervention is one of the main trends business representatives will increasingly face with regard to digital work tools in the future.

5 Discussion and Conclusion

Using a literature survey and a method from Nickerson, Varshney and Muntermann (2013), we presented in this paper the development of a taxonomy of digital work tools as an important milestone towards a comprehensive taxonomy of digital work. After an introduction into the theme, the explanation of our motivation and the depiction of related work, we elaborated on the method we employed and showed in detail what steps we conducted respectively how we proceeded with the development of this taxonomy. This paper delivers several contributions: First, it gives a comprehensive overview of what digital work tools exist nowadays, including a clustering of these tools in homogenous groups. This allows business representatives to benchmark their 'digital work tool landscape' with the goal to prevent their organizations from lagging behind in the competition. Second, it provides characteristica for the differentiation of the digital work tools, allowing business representatives to select approriate tools and corresponding processes for their respective company. If for example a business is based on the delivery of location-based services, one can select what tools might be most appropriate for this company. Third, this paper contributes by shedding more light on the area of digital work which in turn helps researchers to understand this dynamic and at the same time increasingly important domain. It therefore helps to pave the way for future research in this realm. Like any research paper, it nevertheless also faces some limitations. Nickerson, Varshney and Muntermann (2013) have shown that taxonomy development in IS has often been ad hoc respectively intuitively. Even though we follow a structured approach in our paper and simultanously use literature in an intense way for the development of our taxonomy, our work is still not free from judgements we had to make on our way. For example, the selection of the meta-characteristic greatly influences the outcome of the taxonomy development. Other researchers may therefore arrive at a different taxonomy. Furthermore, it is not always possible to assign a digital work tool sharply to one group. For example, self-driving cars could also be put into the AI (instead of the vehicle) group since they mimic cognitive functions of humans (in this case, the ability to drive. We follow the guiding principle that a taxonomy has to be useful (Nickerson, Varshney and Muntermann, 2013), not 'perfect'.

On the whole, we nevertheless are convinced that our paper offers a valuable contribution in the area of digital work. As Beaulieu, Sarker and Sarker (2015) state, for future research to be most effective, it needs to have a common foundation of knowledge. We plan to evaluate our taxonomy with a group of business representatives, especially from technology-savvy companies, and with a group of researchers from the information systems area, to further develop and refine it. To do so, we plan a two-level approach: First, we will communicate this taxonomy in written form to both target groups independently with the request that every individual gives us feedback and suggestions. We then include the insights gained from the individual responses into our taxonomy and afterwards conduct two workshops with each target group to discuss the new version.

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