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University of Twente, Faculty of Behavioural, Management and Social sciences (BMS), Enschede, The Netherlands.
E-mail: j.huellmann@utwente.nl

Abstract In recent years, the use of communication and collaboration media tools has increased manifold due to a rise in spatially distributed work. Which media tools individuals choose for their communication activities has been a research question of lasting interest. Established research focused on traditional media, for example, face-to-face, phone, or email. Moving the focus from traditional media towards digital tools requires rethinking previous findings. It is unclear whether the factors influencing digital tools' choice changed or stayed the same. This paper replicates if the traditional hypothesized relationships and constructs of media choice still hold in the digital era. In response to a surge in interest, digital traces—activity logs from routine technology use—are analyzed for conceptual replication. The conceptual replication revises the boundary conditions of established media choice theory and shows that the supervisor remains a positive influence, whereas physical location becomes negligible, and the coworkers' influence is inconclusive.

Keywords: media choice, replication, digital traces, digital tools, collaboration.

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1 Introduction

The COVID-19 pandemic has led to an unprecedented wave of working from home and spatially distributed knowledge work (Mattern et al. 2021; Wageman et al. 2012). Distributed workers rely on communication media that enable them to collaborate at a physical distance (Bélanger and Watson-Manheim 2006). In recent years, the availability of communication and collaboration media tools has increased manifold (Statista 2019). When, how, and what media to choose is challenging for employees and requires coordination with coworkers for aligning their joint media use (Chudoba et al. 2005; Karr-Wisniewski and Lu 2010; O'Leary et al. 2014). Insufficient coordination negatively affects performance because non-alignment leads to non-effective media use and collaboration (Watson-Manheim and Bélanger 2007). As a result, effective coordination of joint media use and succesful collaboration requires understanding media choice (Stephens 2007; Watson-Manheim and Bélanger 2007).

Media choice depends on the physical location of employees, social factors such as supervisor and coworkers, and the communication purpose (Riemer 2009). Previous research into media choice focused on traditional media, for example, face-to-face, phone, chat, email, or paper documents (Woerner et al. 2004). However, using digital media tools gains momentum due to more distributed work (Wageman et al. 2012) and a growing collaboration software market, diversifying the tools available in an organization (Gartner 2019). Moving the focus from traditional media towards digital tools requires rethinking previous research. It is unclear whether the factors influencing digital tools' choice changed or stayed the same over the last decade compared to established media choice. This paper replicates if the traditional hypothesized relationships and constructs of media choice still hold in the digital era, posing the question: **How do supervisors, coworkers, and physical location influence media choice in distributed work?**

Addressing this research question provides evidence for generalizing established theory on media choice to the context of digital work. Media choice theory has been empirically validated multiple times using surveys and interviews. Our conceptual replication allows refining and revising established media choice theory by using digital traces as a novel instrument. Digital traces are activity and interaction data

from routine technology use, which have attracted considerable research interest in recent years (Hüllmann 2019; Hüllmann and Krebber 2020).

2 Background

2.1 Replication and Digital Traces

Replications can increase the robustness of scientific advances by providing more evidence for or against a research finding or by determining the boundary conditions of existing theory (Dennis and Valacich 2014). Although exact replication strives to replicate the original study as close to the original as possible, replication is "not always a carbon copy of the original study" (Saunders et al. 2017, p. 342). Dennis and Valacich (2014) distinguish three approaches to replication: exact replications, methodological replications, and conceptual replications. Conceptual replications inquire about the same theoretical constructs as the original studies but use varying operationalization, that is, different measures, instruments and methods (Saunders et al. 2017). There have been repeated calls for replications with novel instruments to examine the boundary conditions of original theory (Eden 2002; Tsang and Kwan 1999). Conceptual replications may also bring theory into a new context, extending and clarifying the original propositions (Colquitt and Ireland 2009). Performing conceptual replications is encouraged over other approaches for well-established theory (Tsang and Kwan 1999).

Media choice is an established theory that has been empirically validated multiple times. Our study tests if the media choice theory generalizes to the digital era and the context of digital tools. Digital traces as a novel instrument for replication are used, which allow for robust and original replication studies (Agarwal and Dhar 2014; Mertens and Recker 2020). Digital traces are longitudinal event log data of routine communication and collaboration systems use (Hüllmann 2021). For example, log data from sending or receiving emails, text messages, or sharing files in Microsoft 365 (Hüllmann and Kroll 2018). Digital traces are typically stored in the cloud and can be extracted without end-user interaction, and they can entail the complete history of using a particular collaboration tool. Hence, digital traces promise a more complete and accurate account of past human behaviours than self-reported data such as surveys or interviews (Chaffin et al. 2017; Scharkow 2016).

Therefore, digital traces are robust for testing the media choice theory that was established using surveys and interviews.

2.2 Digital Era of Media Collections and Media Choice

Spatially distributed workers rely on communication tools to collaborate at a physical distance (Bélanger and Watson-Manheim 2006). Usually, these workers do not rely on a single tool to fulfil their tasks but instead use a subset of tools (Lee et al. 2007; Stephens 2007). We call this subset of tools their **media collection**, which the workers choose from a heterogeneous set of tools available in their organization, i.e., the organization's **media landscape**. Making this choice for a media collection depends on social factors such as supervisor and coworkers, theorized as antecedents of media choice. Previous studies on media choice tested these antecedents for traditional media, for example, telephone, mail, email, or face-to-face meetings (Riemer et al. 2009). Conversely, our replication focuses exclusively on digital media tools in distributed work, thereby testing whether media choice holds in the digital era.

The concept of a media collection is derived from the theory of communication media repertoires by Watson-Manheim and Bélanger (2007). Watson-Manheim and Bélanger (2007) group different media collections according to their communication purpose, for example, coordination (i.e., managing interdependent tasks), information sharing (i.e., exchange of knowledge), or relationship development (i.e., socializing into the organization). Other works characterize media collections by their size (i.e., how many tools are included) and how the tools are used (sequentially or concurrently) (Lee et al. 2007). Tools in the media collection may either be synchronous or asynchronous and require colocation of workers or are spatially flexible (Riemer 2009). However, most tools nowadays provide asynchronous communication features such as text, voice, and video messaging—even if they primarily aim at real-time communication, for example, Skype. Thus, by design, digital tools do not require the colocation of the users as they enable distributed work. Another classification scheme considers the type of communication and the features of tools (Fouss and Chang 2000). However, modern tools converge towards multi-purpose integrated systems (Riemer 2009), making classification by features difficult. As distinguishing media collections by features, synchronicity, or colocation is infeasible for integrated systems in distributed work, we replicate the results of

Watson-Manheim and Bélanger (2007) and focus on the communication purpose for distinguishing media collections.

Media choice theory posits that the social factors, actions, and behaviours within workgroups affect a worker's attitude towards communication technologies and the choice of tools (Fulk 1993). Social factors include norms for media use and the imitation of coworkers' media usage (Fulk et al. 1990), perceived media richness, and media experience (Schmitz and Fulk 1991), task experience, and situational factors (Stephens and Davis 2009), as well as organizational factors, such as job role or position in the hierarchy (Stephens 2007). Despite many factors being researched, previous studies find that the attitudes of coworkers and supervisors are the critical social influence for media choice (Treviño et al. 2000; Webster and Treviño 1995). Supervisors exert influence via verbal statements through which workers adopt the supervisors' perceptions of media choice (Schmitz and Fulk 1991). As part of such verbal statements, supervisors may promote their favourite tool (Schmitz and Fulk 1991). Workers may also choose to imitate the supervisor's media choice to ease communication (Fulk et al. 1990). Consequently, we hypothesize: **H1a: The assigned supervisor is positively associated with the choice of media collection in distributed work. H1b: The assigned supervisor's media collection choice is positively associated with the choice of media collection in distributed work.**

In addition to the supervisor, the coworkers shape attitudes towards tools through everyday talk, discussing the benefits and drawbacks of tools and sharing knowledge on how tools are used. More specifically, the coworkers influence how tasks are perceived and the appropriate media choice to solve a task (Schmitz and Fulk 1991). They establish social structures and norms on media use in the organization through routine tool use (Fulk et al. 1990). Coworkers co-learn about the tools and influence each other's perceptions (Fulk et al. 1990), as they must use the same, or at least compatible tools, to communicate. Because of these reasons, we hypothesize: **H2: The coworkers are positively associated with the choice of media collection in distributed work.**

The original theory argues that social influence disseminates via social encounters such as water-cooler chats, ad-hoc meetings, and random encounters. As the physical location constrains how people meet and communicate, it is another critical

factor for media choice (van den Hooff et al. 2005; Treviño et al. 2000; Webster and Treviño 1995). A change in the digital era is the increase of spatially distributed work across multiple sites, characterized by a reliance on digital tools. Traditional media such as face-to-face meetings are less relevant. Since the physical location is less important if the choice is only between digital tools, we hypothesize: **H3: The assigned location is negligibly associated with the choice of media collection in distributed work.**

3 Methods

Our replication draws from a sample of Microsoft 365 digital traces data. The data is collected from an organizational unit of a global systems integrator and managed service provider with 30,000 employees. The selected organizational unit operates across 18 locations in one European country. The unit consists of IT service consultants, who work exclusively with Microsoft 365, drafting and sharing documents, presentations, and excel sheets. There is a policy that Microsoft 365 must be used, and the machines are limited to this software, including Exchange, OneDrive, SharePoint, Teams, and Yammer. Which of these five tools to choose is left to the employee's discretion. The organizational unit is representative for the organization at hand and represents a typical IT service consulting practice. The unit is divided into subunits distributed across locations with various tasks. An excerpt of the data and the underlying data structure is illustrated in Table 1. The sample consists of 813 knowledge workers and contains usage data that is aggregated per month and covers the timespan from June 2018 until January 2019. The usage frequency of each tool is given as the sum of actions performed per tool and per month. For example, accessing files on OneDrive, or sending an email or chat message. Due to the data's sensitive nature, it cannot be shared publicly.

Table 1: Excerpt from data

ID	Exchange	One Drive	Share Point	Yammer	Teams	Org. Subunit	Supervisor ID	Location
891	10,583	32	69	47	0	Operations	1111	Location1
892	10,670	1,524	48	49	0	Operations	891	Location1

As with any statistical model, we have underlying assumptions that manifest in parameter configuration for our pre-processing and data cleansing. Because choosing fixed values for these parameters would be arbitrary, we test multiple parameter configurations for our models that are common in media choice research—as recommended (Mertens and Recker 2020; Schwab et al. 2011). The most central assumption is the minimum usage frequency threshold that determines whether a worker is actively using a particular tool. A tool is included in a media collection only if the worker is actively using it. We test various minimum usage frequency thresholds (40, 110, 250, 500, or 1000 actions per month). Besides the usage frequency threshold, we filter organizational subunits depending on the minimum number of members constituting an organizational subunit. We test the values 0, 5, 10 for minimum unit members. Two data sources for the assigned subunit of each employee were available: active directory, which was entered by human resources, and Microsoft Teams data, which was entered by the employees themselves. Both sources were available in two versions leading to four different configuration parameters. In our subsequent analyses, we test all parameter combinations (5 usage thresholds * 3 minimum members thresholds * 4 subunits = 60 configurations) and report the mean and box plots for the calculated test statistics. All parameter configurations led to similar results.

We use Ward's hierarchical clustering (minimum within-cluster variance criterion) to identify relevant media collections in use (Murtagh and Legendre 2014; Ward 1963). The cluster analysis is based on a table with binary values that indicate for each tool whether an employee is an active user or not (active=1; not active=0). As stated above, the cluster analysis is repeated for the 60 different parameter combinations. As hierarchical clustering requires choosing a fixed number of clusters a priori, we determine the number of clusters by the differences of average within-cluster homogeneity (Thorndike 1953)—commonly referred to as the "elbow method". We identify the frequently used media collections by visually inspecting the dendrograms, elbow plots, and histograms (Figures 2a,b,c in appendix). The resulting media collections are mutually exclusive. We determine the primary communication purpose of a media collection through its included tools. Based on the majority of purposes of the included tools in the media collection, we derive the purpose of the media collection itself (Lee et al. 2007). Based on Schwade and Schubert (2017), we consider Exchange, OneDrive and SharePoint as information sharing tools, whereas Yammer and Teams are relationship development tools.

For replicating the hypotheses, we operationalize the coworkers' influence through the assigned organizational subunit of the worker. The media collections are given as distinct sets of tools. The supervisor is the direct manager, to who the employee reports, and the physical location is the assigned city and street address. All variables are given as nominal IDs. Because all variables are of nominal scale and the factor levels reach up to 119, an unordered multinomial regression would show different factor loadings for each instance and not yield helpful results (McElreath 2020). For example, it would show the results for 119 managers instead of the general influence of the supervisor. Rather, we show the association between the factor variables and test the stochastic independence using Pearson's chi-squared test and Fisher's exact test (with Monte Carlo simulations for the p-values based on Patefield (1981)). Accordingly, posthoc correlation analysis to estimate the effect size is performed with Cramer's V, suited for nominal measurements (Cramér 1946; Sheskin 2000). Our interpretation of effect sizes follows Cohen's remarks on cross-tabulation (Cohen 1988, p. 224; cited via Ellis 2010, p. 41).

4 Results

Exchange is the tool used by all workers in the sample. The median count of actions performed in Exchange over the eight months is 12,363. The next most used tools are SharePoint, OneDrive, and Yammer with median activity between 113 and 263. Teams is not in use by most workers (see Table 2).

Table 2: Descriptive Statistics

Descriptive Statistics							**Factor Levels**	
Tool/ Statistic	N	Mean	St.Dev.	Min.	Median	Max.	Variable	Levels
Exchange	813	16,049	14,635	495	12,363	128,878	Employee	N=813
OneDrive	813	5,627	33,116	0	114	707,030	Org. Subunit	N=10
SharePoint	813	808	1,852	0	263	19,636	Supervisor	N=119
Yammer	813	454	794	0	113	6,155	Location	N=18
Teams	813	19	183	0	0	4,987	MediaCollection	N=8

From Figures 2a-c (appendix), we identify eight clusters because the difference in average within-cluster homogeneity converges to zero after eight clusters. Looking at the eighth cluster in the dendrograms, we merged further "potential" clusters into

a media collection called "Others" because these clusters had adoption rates close to zero. The elbow plot and dendrogram are consistent across all 60 configurations.

Table 3 depicts the identified media collections. The importance of Exchange is emphasized as 262 out of 813 workers use only Exchange. It is part of every frequently used media collection that we identified. Besides Exchange, SharePoint is another popular tool in the media landscape and part of four media collections. Another observation is the recurring absence of Microsoft Teams, which is not extensively used, and, thus, not part of the media collections, except for the "All" collection. Table 3 shows three media collections with an information-sharing focus, three collections with both information sharing and relationship development focus, but no media collection with only a relationship development focus.

Table 3: Media collections with average active users of each collection.

Media Collection	Purpose	N	Mean	St.Dev.	Min.	Median	Max.
Exchange	Information Sharing	60	268.517	154.500	64	262	498
Exchange, OneDrive	Information Sharing	60	91.050	53.181	13	106	148
Exchange, SharePoint	Information Sharing	60	86.733	37.136	33	96	134
Exchange, SharePoint, OneDrive	Information Sharing	60	75.567	27.111	31	88	106
Exchange, SharePoint, OneDrive, Yammer	Both	60	121.917	108.223	6	87	316
Exchange, SharePoint, Yammer	Both	60	58.617	42.346	6	46	116
All	Both	48	18.167	15.833	3	12	46
Others	–	60	75.400	23.290	35	76	108

Figure 1 and Table 4 show the estimated correlations. The results show a high correlation between the supervisor and the choice of media collection, but only a small correlation between the supervisor's own choice of media collection and the worker's choice (cf. Cohen 1988; Ellis 2010). Consequently, the hypothesis on the supervisor's social influence holds (H1a), whereas its particularization in the imitation hypothesis (H1b) does not hold.

Table 4: Cramer's V correlations

Covariate	N	Mean	St.Dev.	Min.	Median	Max.
Supervisor	60	0.467	0.019	0.430	0.476	0.490
Supervisor Collection	60	0.151	0.016	0.127	0.154	0.184
Subunit	60	0.183	0.047	0.129	0.173	0.311
Location	60	0.164	0.021	0.142	0.156	0.205

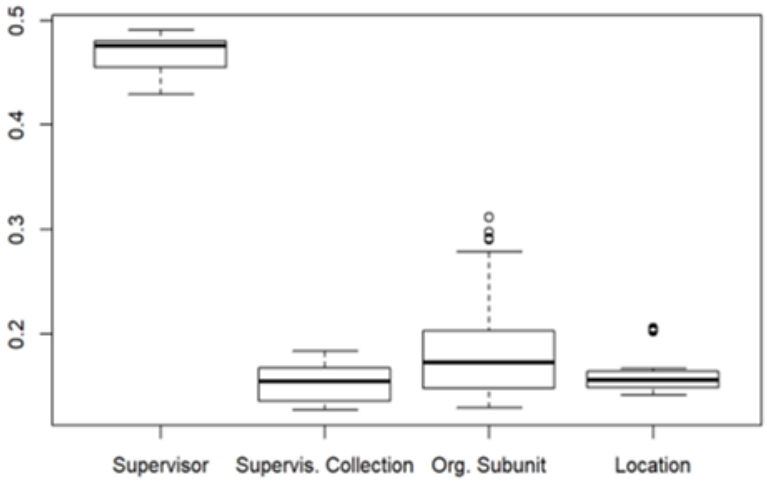

Figure 1: Cramer's V correlations

As coworkers and physical location show a small correlation with the media collection choice, which is lower than the minimum effect size of interest, the hypothesis about the coworkers' social influence does not hold (H2), whereas the negligible association with the physical location does hold (H3). None of the covariate pairs is independent across the tested parameter combinations according to Pearson's Chi-Squared test and Fisher's exact test. In other words, all correlations are statistically significant.

5 Discussion, Implications, Limitations, Future Work

Our results show that Exchange is prevalent in all media collections, supporting Watson-Manheim and Bélanger (2007), who show that email is the most frequently used media tool and is relevant for all communication purposes. We find superior

use of the information sharing collections compared to the relationship development collections, corroborating Watson-Manheim and Bélanger (2007). Explicit relationship development in teams via digital tools is less common, requiring future research in subsequent studies. Lee et al. (2007) find that smaller media collections have more users than larger collections. We also find a tendency towards smaller media collections with "Only Exchange" having the highest active user rate, although the results are not as clear as in Lee et al. (2007). Despite a heterogeneous media landscape (i.e., many different tools being available), the identified media collections clearly show Exchange and SharePoint as the most frequently used tools. Small media collections being favoured implies that explicit management and coordination of media collection choice is not as critical as assumed because there seems to be little coordination overhead. Nevertheless, we only looked at Microsoft 365, and samples with a larger media landscape may yield varying results.

According to Treviño et al. (2000; Webster and Treviño 1995), the supervisors' media behaviours and attitudes influence the media choice of individual workers in distributed work settings through verbal statements as part of conversations, meetings, and collaborative work. The supervisors may also promote specific tools (Schmitz and Fulk 1991). Our results corroborate the association between the assigned supervisor and a worker's media choice. Yet, our results do not substantiate the hypothesis that workers may imitate the media choice of their supervisor for joint communication purposes (Fulk et al. 1990). The supervisor has different tasks than the subordinates and thus may require a different media collection. Except for the imitation aspect, our analysis is agnostic to the specific behaviors of a supervisor that influence the subordinates' media choice. Coworkers establish norms and values surrounding media collections through routine and joint use of tools. They shape the perceived task characteristics and media richness, which Schmitz and Fulk (1991) find to influence the perceptions of appropriate media choice. Our data suggests that the coworkers do not have a clear association with the media choice of distributed workers. Perhaps, the perceived task characteristics and attitudes towards media appropriateness are not sufficiently homogenous within organizational subunits to paint a clear picture. Intra-job differences and a potential lack of widely shared norms on tool use between coworkers may lead to different media collection choices (Treviño et al. 2000). Multiple studies find a relationship between physical location and media choice (van den Hooff et al. 2005; Treviño et al. 2000; Webster and Treviño 1995). The physical location presents a constraint towards

communication, as a high distance prevents face-to-face communication and encourages the use of digital tools. Our analysis shows that the hypothesis of a negligible effect between physical location and media choice holds. The physical location has little effect on media choice in the digital era, as opposed to established theory on media choice. Summarizing, our replication finds evidence in digital traces for the hypotheses that the supervisor has a strong effect and that physical location has a negligible effect on media choice.

Our analysis' limitations include a missing disentanglement of dyadic influences and shared norms on the perceptions of task and media appropriateness (e.g., Stephens and Davis 2009; Webster and Treviño 1995). We only correlate the nominal supervisor and the organizational subunit with the selected media collection. Our results suggest that the influence of coworkers is not as homogenous as expected, i.e., not all coworkers share the same media collection. Potential causes may be a lack of shared norms on tool use or that our analysis misses intra-job differences in the same way as other studies do (e.g., Treviño et al. 2000). For an inquiry into the dyadic social influence of coworkers, digital traces from enterprise social networks may be a future research opportunity (Hüllmann and Kroll 2018). Our study provides a correlational view of the topic of media choice at a time before COVID-19. With the ongoing development of digital collaboration tools, the media landscape is under continuous change, and longitudinal research designs may further elucidate the phenomenon. Our study looks at an idiosyncratic sample that describes a distributed organizational unit from a global services provider. Although Watson-Manheim and Bélanger (2007) show that media collection types persist across two organizations, the identification of media collections is specific to the task structures of the organization. Hence, we expect the nature of the task to influence a worker's choice of a media collection, and our results may not generalize to task structures other than IT service practice. Previous research theorizes other factors to be relevant for media choice that are unavailable in the digital traces of Microsoft 365. For example, individual roles, strategies, and experiences, as well as personal preferences, are theorized to affect media collection choice. Given limitations the available data, we only analyze the influence of supervisor, coworkers, and physical location. Future work can extend the granularity of the digital traces and complement the analysis with interviews or surveys for more insights. The organizational unit under study has an exclusive focus on Microsoft 365. Nevertheless, external communication and collaboration tools that are not part of

the Microsoft 365 suite may be in use by the workers, although such tools are not approved by the organization ("Shadow IT"). These tools are out of the scope of this study and require further data collection. For providing recommendations and best practices on the explicit management and coordination of media use, follow-up research should link performance data to the identified media collections. Elucidating the link between media collections, media choice, and performance will expose levers for managerial interventions geared towards media synchronization and coordination. Since our approach is based on digital traces, caution is required because the analyzed activities in the data set do not necessarily consume the same amount of time, e.g., crafting an email may take longer than downloading a file.

In conclusion, we replicate established theory on media choice using the novel instrument of digital traces and bring the theory into the digital era. In the empirical setting of a global service provider, we identify the frequently used media collections and address the antecedents of media choice in distributed work settings based on analyzing a unique quantitative sample of digital traces. We contribute evidence to media choice research and replicate that information sharing is the primary purpose of media collections. Our analysis partially corroborates the existing theory on collective media choice, showing that the supervisor is associated with an individual worker's media choice, whereas the association with the physical location is negligible. Thus, managers should consider their influence on their employees' media choices. We show that digital traces are a well-suited instrument for conducting conceptual replication studies. Despite the limitations of our data, digital trace research shows prospects for subsequent inquiries and replications, further extending existing research.

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Appendix

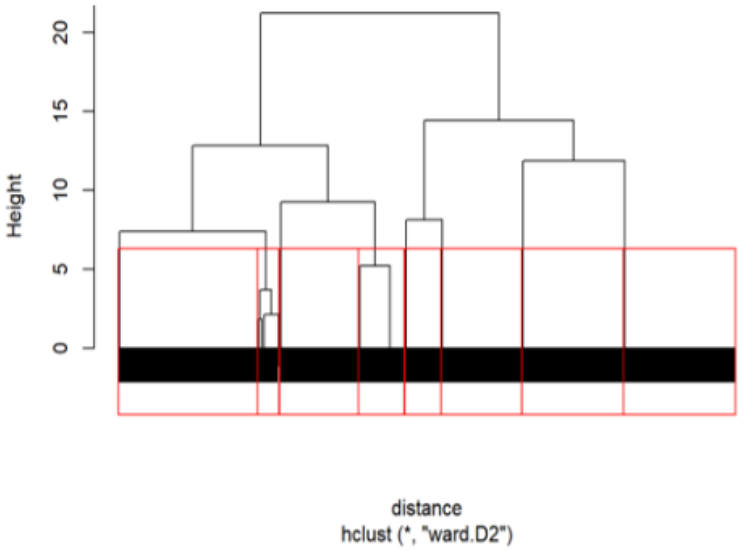

Figure 2a

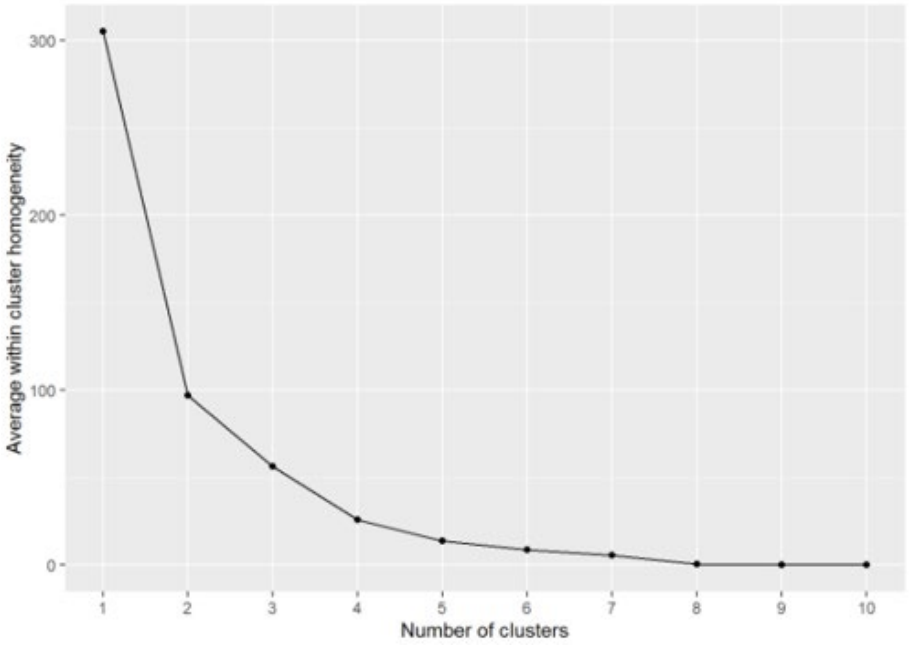

Figure 2b

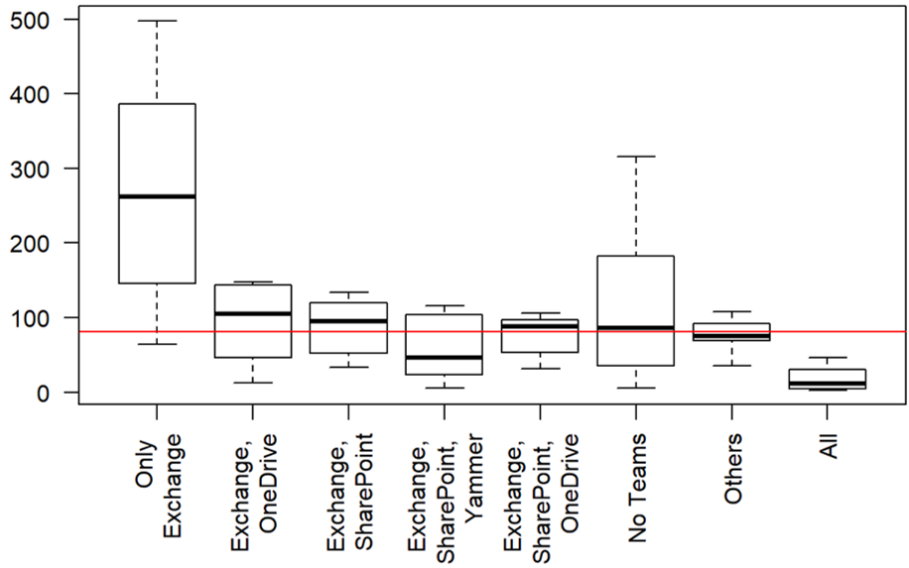

Figure 2c

Figures 2a-c: Representative examples of dendrogram and elbow plot. Box plot of media collection distribution. The red line equals 10% of all employees