Theory-Driven-Design for Open Digital Human Collaboration Systems

Completed Research

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Abstract

Collaboration among individuals via information and communication technologies is today in many areas of activity (crowdsourcing, open innovation, virtual team work etc.). The design of such systems and the interaction possibilities is therefore of central importance for the success of the collaboration in its entirety. In addition, the design of such human digital collaboration systems can benefit when considering the individuals in its central scope and the influence of cognitive processes and their social interaction virtually. At this point, we position this paper and derive design information from seven theories (Media Synchronicity Theory, Multimotive Information Systems Continuance Model, Equity Sensitivity Construct, Yield Shift Theory of Satisfaction, Transactive Memory Theory, Theory of Planned Behavior and Theory of Deferred Action) and argument their relevance for digital human collaboration systems. We first discuss each theory and derive meta-requirements to formulate design principles for designers and developers of such systems.

Keywords

Digital Human Collaboration Systems, Design Principles, Theory, MST, MISC, ESC, YSTS, TMT, TPB, TDA.

Introduction

Digitization has facilitated the connection of people via information and communication technology (ICT). This development has led to a diffusion of distributed workplaces, virtual teams and work environments such as e-commerce, open innovation (Chesbrough 2003) and crowdsourcing (Howe 2006). This shifts todays work practices into the virtual world and enables new virtual workplaces (Richter et al. 2018). Thus, shaping the virtual work environment by designing and implementing ICT is a major challenge (Richter et al. 2018). Therefore, we need to consider humans as the core of ICT in virtual work environments (Richter et al. 2018) and the collaboration among them via ICT as important.

The collaboration between actors virtually is characterized by coordination (Malone and Crowston 1990), cooperation (Piepenburg 1991) and communication (Leimeister 2014) among them towards a common goal (Leimeister 2014) via ICT. Collaboration of different heterogeneous actors can lead to better results, especially in complex tasks, which exceed the capacity and skills of individuals (Bittner and Leimeister 2014; Bowers et al. 2000; Langan-Fox et al. 2004; Wegge et al. 2008). Beyond this, digital collaboration can overcome the challenges of wide distance between the actors, enable the access to distanced resources and form effective virtual teams e.g. in virtual work environments (Curtis and Lawson 2001; Johnson and Johnson 1996). We can conclude that digital collaboration offers beneficial opportunities for the efficiency of task accomplishment. In order to enable the benefits of collaboration among different actors, designing collaboration support with ICT is of high relevance, especially considering the cognitive processes which subsequently influence work processes and social interaction. In addition to such challenges, the permeation of everyday life with technologies and the progress of todays ICT opens up new design possibilities for user-centered solutions, for which grounding the development on sociological and (cognitive) psychological theories can provide essential design information. Therefore, we consider the characteristics of collabora-

tion (communication, cooperation, coordination and common goal) to choose theories to gain design information from. Accordingly, the Media Synchronicity Theory (**MST**) (Dennis et al. 2008) could provide design information for the design of the **communication** among actors on collaboration systems and the Multimotive Information Systems Continuance Model (**MISC**) (Lowry et al. 2015) for the design of the motivation of actors on collaboration systems for more efficient task accomplishment towards a **common goal** by considering also the different types of individuals as in the context of the Equity Sensitivity Construct (**ESC**) (Huseman et al. 1987). Additionally, the Yield Shift Theory of Satisfaction (**YSTS**) (Briggs et al. 2012) could deliver design information to reach more satisfaction with the collaboration process (towards a common goal) perceived by individuals. The Transactive Memory Theory (**TMT**) (Wegner 1987) provides insights for the **coordination** among individuals by considering them and their knowledge sharing and processing during the collaboration process. Design information could also be gained through the Theory of Planned Behavior (**TPB**) (Ajzen 1991, p. 182) to predict human behavior in the **cooperation** context. Design information from the Theory of Deferred Action (**TDA**) (Patel 2009) extends this stream with the concept of considering emergent events to design an adjustable system.

In this research, we zoom deeper in those theories to gain more detailed insights for design information to address the mentioned challenges. Therefore, we ask the following research question **Q:** Which design information can be gained from insights of the theories MST, MISC, ESC, YSTS, TMT, TPB and TDA to consider in the development of digital human collaboration systems? To address the research question, we discuss for each theory the relevant insights for digital human collaboration systems and consider them to formulate design principles for designers or developers of such systems before closing this paper with an overall discussion and conclusion.

The Theories and their Relevance for Digital Human Collaboration

In this section we zoom into each theory and derive **meta-requirements** (**MR**) to capture insights for digital human collaboration systems and for utilization of design information in form of design principles.
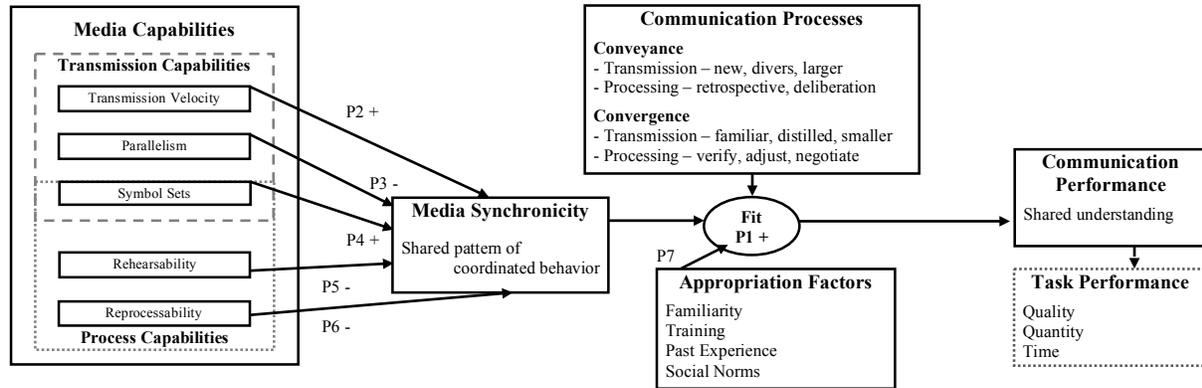
Media Synchronicity Theory

According to Dennis et al. (2008) the Media Synchronicity Theory (MST) describes the characteristics of (communication) media to assist individuals in collaboration by influencing the communication processes. The goal is to focus on the performance of task-related communication as such, not the choice of medium (see Figure 1) (Dennis et al. 2008). The communication processes consist of two primary processes:

- **Conveyance** (-processes: transfer of content to enable the recipient to capture the situation or the information context)
- **Convergence** (-processes: discussion of preprocessed information and the associated, initial, individual information interpretation with the aim of creating a common interpretation/understanding of the content)

Both processes consist of different proportions of information transfer and information processing. Added to this is the aspect of synchronicity (SYNCH), which is defined as "a state in which individuals cooperate with a common focus at the same time" (Harrison et al. 2003). Thus, in convergence processes, there is greater need for SYNCH (concurrent information transfer to achieve a common view) than in conveyance processes. The performance of communication as a whole thus depends heavily on the fit between the SYNCH of the chosen medium and the underlying communication process (see Figure 1, "Fit"). Other factors, such as the familiarity of the communication participants with each other or matching (collected) experiences influence the relationship between the necessary information transfer and processing. As can be seen in Figure 1, various transmission and processing characteristics have an influence (enhancing or attenuating) on the SYNCH of communication media. These are in detail:

- Transmission velocity (The rate at which a medium can deliver a message to the intended recipient (Shannon and Weaver 1949)) - increases SYNCH
- Parallelism (number of effectively possible, simultaneous transmissions (Shannon and Weaver 1949))) - weakens SYNCH
- Symbol sets (number of types of information coding (SW), in particular with regard to the intuitive intelligibility and fit to the transmitted content) - Strengthens SYNCH

- Rehearsability (possibility of the sender to change / refine a message before sending) (Rice 1987) - Weakens SYNCH
- Reprocessability (possibility of reviewing or reprocessing a message during the process of decoding, either immediately during the communication process or subsequently (Rice 1987)) - weakens SYNCH

Figure 1.   Media Synchronicity Theory according to Dennis et al., (2008)

As a key message of the MST, the most appropriate communication medium to ensure efficient communication is generally a combination of media with high and low levels of SYNCH (**MR1**) to optimally support both conveyance and convergence processes (Dennis et al., 2008). To verify this statement, for example, the impact of social media (as a mix of media) on work performance was examined by Cao et al., (2012). By providing communication channels through social media, the building of trust and relationships among employees has been strengthened, which in turn has an influence on knowledge transfer and joint knowledge work. Furthermore, research such as the analysis of globally distributed software development projects (Niinimäki et al. 2010) or two independent studies on the identification of potential for improvement of existing distributed cooperation business processes (DeLuca and Valacich 2005) with respect to the communication media support the content of the MST. The adjustable use of the communication media would ensure the situation-dependent support of the two central processes "Conveyance" and "Convergence" (**MR2**). In addition, the relationship between conveyance and convergence in relation to the task-related communication process is subject to fluctuations, even if the tasks remain the same. The other factors (experience, training, familiarity (see Figure 1) "Appropriation Factors") play a major role here. In this respect, it can be beneficial for the efficiency of the communication to continuously re-evaluate the communication media with regard to the existing requirements for conveyance and convergence processes as well as with the required SYNCH.

Equity Sensitivity Construct

The Equity Sensitivity Construct (ESC) (Huseman et al. 1987) is based on and extends the equity theory (Adams 1963, 1965). The primary goal of this extension is to understand the respond of individuals when equality or inequality is perceived. The perceived equality or inequality focuses on the ratio between input and output in relationships. The following or causal chain summarize the equity theory according to Huseman, Hatfield, und Miles (1987):

- Individuals judge their relationships versus others based on the input/output ratio (ergo: What do I "invest" in this relationship and what benefits do I derive from it?)
- If this relationship is perceived as unequal, injustice exists
- The greater the perceived injustice, the more suffering the individual feels
- The more suffering the individual feels, the harder it will be to reduce injustice (change of behaviour, eventually ending the relationship)

According to Bolino and Turnley (2008), cultural influences could be relevant for the reduction of perceived injustice. However, handling the perceived injustice is a challenge. The ESC introduces three types of individuals, which can be defined by the output / input ratio:

- **Benevolents** - Benevolents are individuals who like to bring more into a relationship or activity than they receive conversely, and often have altruistic traits. If this perception is fulfilled, they are satisfied accordingly. Benevolents suffer (or rather built guilt) when they feel that their output/input ratio is equal to or higher than that of a comparator.
- **Equity Sensitives** - Equity Sensitives are satisfied when the output/input ratio is balanced compared to another person. They suffer when they feel the payment is not fair. On the other hand, excessive pay or remuneration can lead to guilt feelings.
- **Entitleds** - Entitleds are the counterpart to Benevolents and thus rather "takers". They value that their output/input ratio is higher than the comparator and thus can "capitalize" on a relationship or activity.

In this context, it is imperative to note that the respective perspectives or sensations are perceived individually. So it may be that the personal assessment of belonging to one of these types does not match that of another. Furthermore, an individual can be assigned to different types in different areas of life (e.g. work and private life).

Basically, justice and contentment prevail when individuals are in situations or relationships that conform to their particular type (**MR3**). If there are deviations, this can have negative effects. These negative consequences can partly be mitigated by the fact that the relations within the group of individuals are preserved accordingly. For example, it would be less detrimental for an Entitled to be paid or remunerated insufficiently, if comparators within the group receive "even less". The personal sense of justice and satisfaction has a direct impact on the performance and preparedness of individuals in teams or groups (Bing und Burroughs 2001). We can conclude for teams, the more Benevolents in a team, the better is the team's performance (**MR4**) (Bing und Burroughs 2001).

The aim should be to create the greatest possible transparency in terms of tasks and their distribution in the context of digital human collaboration, so that participants have the opportunity to individually evaluate them (**MR5**). In this context, more difficult (or unclear or more complex) tasks can be assigned to different areas of the relation between output and input (and thus influence the perceived ratio). On the one hand, these tasks can be seen as a "reward" (a challenge in a positive sense and thus as an output) or as a "problem" (and thus as an input) which could be justified with appropriate remuneration (Huseman et al. 1987). However, Benvolents focus more on the inputs, rather than the outputs (e.g. payments).

Theory of Deferred Action

The Theory of Deferred Action (TDA) aims to describe the influences on the design of information systems through emergent events (Patel 2009). It is based on the fact that an actor (individual, organizations, etc.) basically pursues a goal or purpose and develops plans for its achievement. These plans (or intentional actions) are often influenced by unplanned and unforeseen, i.e. emergent, events, so that an adaptation of the plans is indispensable.

	Low **Planned Action** High	
High	**Deferred Design**	**Real Design**
	Innovation Knowledge	Competition Knowledge
	Deferred Organisation Deferred Systems	Real Organisation Real Systems
	Deferred KMS Innovation Work, Research Work	Real KMS Strategy Work
	Open Systems	
	Closed Systems	
	Autonomous Design	**Specified Design**
	Manufacturing Knowledge	Project Management Knowledge
	Autonomous Organisation Autonomous Systems	Specified Organisation Specified Systems
	Semi-autonomous Work	Specified KMS
	Expert Systems	Routine Production Work Routine Service Work

Figure 2.   Design Type of the TDA according to Patel (2009)

The central aspects or dimensions of the theory are thus the "planned action, emergence and the deferred action" (Patel 2009). Depending on the relationship between these dimensions, the result is a specific

design type with a corresponding target, as shown in Figure 2. Especially applications, tools or organizational structures that are used in a field characterized by a high occurrence of emergent events have to be designed adaptively. This way an optimum utilization by or the support of the actor can be ensured (Patel and Ghoneim 2011).

Emergent events are an essential feature of complex systems, which include socio-technical systems and thus collaboration tools. They generally appear where there is an unpredictable interaction between actors and their environment. Human behavior in particular is subject to a certain unpredictability and a certain indeterminism (Cziko 1989). Thus, platforms or software for supporting digital collaboration fall within the scope of "deferred design" or "real design." Both design approaches have in common that a final specification of the design object (here: digital human collaboration system) is not possible due to the strong influence of events that happen. In this context, an adaptability of the system is required, which emerges in the context of use by the actors. The users therefore shape their own system to a certain extent or adapt it to their needs (**MR6**). Collaboration as such is consequently supported by customization (Bentley and Dourish 1995).

Yield Shift Theory of Satisfaction

The Yield Shift Theory of Satisfaction (YSTS) (Briggs et al. 2012) aims to describe the satisfaction response, both in the positive and in the negative sense, as an emotion of individuals in relation to their own goal achievement (Briggs et al. 2012). Similar to the TDA, it is based on the fact that every human being has goals that s/he tries to achieve. It is important, however, that not all of the sets of goals can be tracked simultaneously. There is therefore at any time a subset of active goals of the total goal set. As an example, one could cite "hunger" and "thirst". These feelings are a possible manifestation of the goal of "maintaining vitality". If we have just had enough to eat and drink, this goal takes a back seat and leaves our active target. We can thus focus on other goals. This whole mechanism is subconscious. In addition, we subconsciously assign a perceived yield to each of our active goals, which depends on the ascribed utility multiplied by the probability of assessed likelihood (Briggs et al. 2012). The initially mentioned satisfaction response of individuals results directly from a (subconsciously realized) change of the perceived yield of all active goals. If one succeeds in increasing the perceived yield in total, a positive reaction (adjustment of the feeling of satisfaction) can be expected (**MR7**) on the part of the individual. The YSTS explicitly describes and explains only the correlations of satisfaction with the intrinsic achievement of goals. Group goals are not part of the consideration (Briggs et al. 2014).

To increase the likelihood of alignment of individuals with their personal goals by a corresponding design of digital human collaboration systems seems at first glance relatively outlandish, unless the personal goals have a congruence with the group goals (for which the use digital collaboration should serve). However, the aspects of usability and efficiency play a role in the form of an indirect, unconscious way as found in the research of Reinig et al. (2017). The satisfaction with the process and the result of the collaboration gain relevance and create the necessity to design digital human collaboration processes as efficient and goal-oriented as possible (Cheng et al. 2016) (**MR8**).

A change to the active goal set can not be influenced directly by the digital human collaboration systems (and, accordingly, its design), since this serves only as a "tool". However, this can still be influenced by extrinsic factors (**MR9**), such as the perspective of promotion according to Briggs et al., (2012).

Transactive Memory Theory

Transactive Memory Theory (TMT) (Wegner 1987) focuses on the storage, structuring and processing of information or knowledge within groups. Each individual has an internal knowledge, which is managed by three central processes (encoding, storage and retrieval). In our memories we connect information (unconsciously) or establish the connections between information during the coding process (Wegner 1987).

Individuals use external storage media, such as books, calendars, data carriers or pictures as an extension to the internal knowledge store. However, the successful use (in terms of information retrieval) of external storage requires knowledge of the storage location and the associated label. Ultimately, not only items can serve as external storage media, but also other individuals and thus their internal knowledge. A set of individual storage systems in combination with the associated inter-personal communication is referred to as a transactive memory system (TMS) according to Wegner (1987). The combination of diverse individual

knowledge systems of group members through collaboration results in a much more comprehensive and complex knowledge system. Gaining insight into the knowledge and abilities of other group members via communication in order to be able to create appropriate labels for them and the group results in the construction of a meta-knowledge or meta-memory (knowledge of knowledge). Building and supporting these meta-stores is one aspect of the support provided by information systems (Nevo et al. 2012). The coding and storage processes are structured on this basis, since there are also individuals who have more expertise in certain areas than the others in a group they take over parts of these processes (Lewis 2003).

The aspect of knowledge storage and shared awareness can also be transferred to the field of digital human collaboration. Communication is a central aspect of a TMS, only by linking the individual knowledge and skills new knowledge can be generated. The access to knowledge or information should be ensured by the collaboration tool (**MR10**) or at least be supported, for example by a corresponding indexing or keywording (compare aspect of the labels and the storage location). At the same time, however, this means that in order to avoid misunderstandings or misinterpretations, individuals agree on central terms/identifiers whose semantics are identical for all collaboration participants (**MR11**). Finally, the existence of corresponding directories ("Who knows what?") leads to an increased exchange of knowledge between the participants (Yuan et al. 2010). The ability to find experts can be supported by the possibility of assigning individuals corresponding "tags" (labels) based on their knowledge and abilities (Muller et al. 2006). One aspect not mentioned by the author in the description of the TMT is the necessary trust among the collaboration actors and the associated willingness to share knowledge (Jarvenpaa and Majchrzak 2008) (**MR12**).

Theory of Planned Behavior

Theory of Planned Behavior (TPB) is an approach to "predict and explain human behavior in specific contexts" (Ajzen 1991, p. 182). The central aspect for the execution of actions (i.e. behavior) is the intention to act or to behave in a certain manner, as shown in Figure 3. The stronger the intention of the individual to carry out a particular action, the more likely it is that the act and thus the intended behavior actually take place (Ajzen 1991).
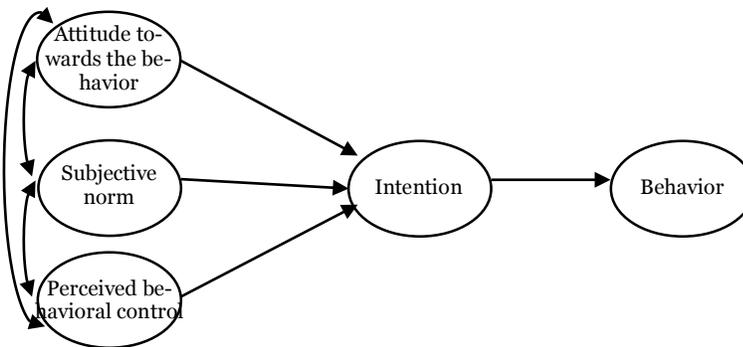
Figure 3.   **Theory of Planned Behavior according to Ajzen (1991)**

Another aspect which has an indirect impact on human behavior and the intention to act is the perceived control of the action or perceived behavioral control. On the one hand it concerns the existence of all necessary resources for the execution of the action (for example the existence of sufficient financial resources at intended acquisitions). On the other hand, factors such as the perceived difficulty of carrying out an action also play a part (comparable to the probability of goal achievement described in the context of the YSTS). Other aspects that influence behavioral intent are the attitude of the individuals as well as normative factors (subjective norm). By examining the attitude of an individual, it can be determined whether a behavioral intent can be attributed to a positive (or negative) effect from the point of view of the person. Normative factors reflect in a certain way the sense of value of our society, i.e. whether the planned behavior can be perceived as morally correct and compatible with one's own conscience (Ajzen 1991, p. 182).

The TPB has already been considered in the digital domain (e-commerce, online commerce etc.) (George 2004; Pavlou and Chai 2002; Pavlou and Fygenson 2006) to explain the respective behaviors and intentions. When referring the TPB to the area of digital collaboration from the point of view of "positive influence", the question of "which behavior/behavioral intention should be promoted" arises. In this context

achieving the common collaboration goal can be relevant. If one relates this behavioral intention to the three underlying influencing factors (posture, normative factors, perceived behavioral control), the following, possible core statements for the design of digital collaboration emerge. First, the tasks or the collaboration content should be designed according to the interests of the collaboration participant ("attitude") (**MR13**), so that a positive basic attitude is ensured. Furthermore, the goal of collaboration should be compatible with the values of the collaboration actors and society (**MR14**). Ultimately, providing the actors with all the tools to perform the task, while at the same time ensuring that the highest possible degree of (perceived) control remains with the participants is purposeful.

Multimotive Information Systems Continuance Model

The Multimotive Information Systems Continuance Model (MISC) (see Figure 4) is based on the model of Bhattacherjee and Premkumar (2004) and represents a modification or extension of it (Lowry et al. 2015). It focuses on the influence of different motives and expectations, their impact on user satisfaction and the related intention when continuing to use information systems. The MISC pursues a similar goal as the TPB (Lowry et al. 2015).

The sustained intention depends on individuals' attitude towards the system (similar to TPB) and the (perceived) capacity of the information system as such. The performance here has various distinct facets, depending on underlying motivation of usage (hedonistic, intrinsic, extrinsic) (Lowry et al. 2015) (**MR15**). One of the key messages of the MISC is that the fulfilment of user expectations plays a central part in the design of software with the goal of continuous use (**MR16**). Important functionalities must be as directly accessible as possible and not hidden in submenus or the like. Thus, with respect to the area of digital collaboration, a detailed analysis of the collaboration objective is necessary so that the corresponding components (or process steps) can be identified and correspondingly placed. A relatively fresh aspect raised by the MISC is "gamification" within information systems (Liu et al. 2017). In sum, all facets of motivation - with different weightings - are always important, and thus also the hedonistic component.
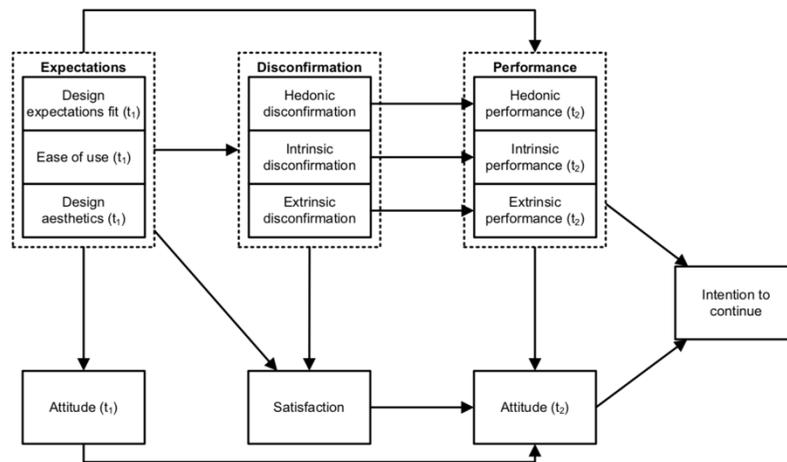

Figure 4.   **MISC Model according to Lowry et al. (2015)**

Design Principles for Digital Human Collaboration

Considering the derived meta-requirements from each described theory, we formulate five action oriented design principles (DP) according to Chandra et al. (2015) as listed in Table 1 to consider for the design of digital human collaboration systems. Some of the MRs were considered for multiple DPs (see Table 1).

T	MR	Description of MR	DP
MST	MR1	The most appropriate communication medium to ensure efficient communication is a combination of media with high and low levels of synchronicity.	**DP1:** Provide the collaboration system with **communication medium** that have at least **one high**
	MR2	Adjustable utilization of the communication media would ensure situation-dependent support of the two main processes "Conveyance" and "Convergence".	and one **low level** of **synchronicity** and mechanisms to make sure **situation-dependent activa-**
	MR10	The access to knowledge or information should be ensured.	**tion** of them to **enable communication** among

T	MR	Meta-Requirement	Design Principle
TMS	MR11	Agree on central terms/identifiers whose semantics are identical for all collaboration participants.	collaboration actors, the **access** to knowledge, the **sharing** of **knowledge** and to build consensus for efficient collaboration among them.
	MR12	Promote the willingness to share knowledge.	
ESC	MR3	Justice and contentment prevail when individuals are in situations or relationships that conform to their particular type.	**DP2:** Provide the collaboration system with mechanisms and functionalities to **identify different** types of **user characteristic**, consider them **for team composition** and **install** suitable **intervention for each type** to increase the probability **to meet the user's expectation** in the collaboration for better team performance and a sustain system.
	MR4	The more Benevolents in a team, the better is the team's performance.	
MISC TMS	MR12	Promote the willingness to share knowledge.	
MISC	MR16	The fulfilment of user expectations is a condition for continuous use.	
ESC	MR5	Tasks and their distribution are transparent for each participant and they have the opportunity to individually evaluate them.	**DP3:** Provide the collaboration systems with **transparency regarding** the **tasks** and **goals** of the collaboration process and **fairly received task distribution by addressing** the collaboration actor's **interest** (considering their different types) to raise the probability to **meet** their **expectations** and to **motivate** them **towards** higher efficiency and **goal-oriented task accomplishment.**
TDA	MR6	Individuals can shape the system to a certain extent or adapt it to their needs.	
YSTD	MR8	The collaboration processes should be efficient and goal-oriented designed.	
TPB	MR13	The collaboration content should be designed according to the interests of the collaboration participant.	
MISC	MR15	The performance of user depends on the underlying motivation of platform usage.	
	MR16	The fulfilment of user expectations is one condition for continuous use.	
YSTS	MR7	Increase the perceived yield of all active goals, a positive reaction (adjustment of the feeling of satisfaction) can be expected.	**DP4:** Provide the collaboration system with capabilities for **reuse, expansion**, and **customization based on structured** and **searchable data** and **knowledge base** on which the actors can ground the perquisites of the collaboration process to **increase** the **efficiency** of the process and the probability of **reaching the collaboration goal**.
	MR8	The collaboration processes should be efficient and goal-oriented designed.	
TMT	MR10	The access to knowledge or information should be ensured.	
	MR11	Agree on central terms/identifiers whose semantics are identical for all collaboration participants.	
ESC	MR3	Justice and contentment prevail when individuals are in situations or relationships that conform to their particular type.	**DP5:** Provide the collaboration system with **incentive systems** to **influence** the collaboration actor's **active goal set** by considering their particular type **towards the preferred goal** set for better management of the collaboration process by **stimulating** their **motivation** towards better task accomplishment.
	MR4	The more Benevolents in a team, the better is the team's performance.	
YSTS	MR9	Extrinsic factors can influence the individual's active set of goals.	
TPB	MR14	The goal of collaboration goal should be compatible with the values of the collaboration actors and society.	
MISC	MR15	The performance of user depends on the underlying motivation of platform usage.	

Table 1. Theories (T), Meta-Requirements (MR) and Design Principles (DP)

Discussion & Conclusion

Through the highest possible degree of transparency, digital collaboration is positively influenced in various ways. On the one hand, a free choice of tasks serves to convey a feeling of control. This is particularly emphasized in the context of TPB (aspect of behavioral control) and TDA (aspect of design control). On the other hand, the transparency of tasks (see DP3) helps to achieve goal attainment transparency at the same time, which can have positive effects on motivation. The effect on the motivation is also described in the context of the ESC if, on an individual level, a challenge is addressed with the achieved goal. The individuals and the experiences they made in the past or their personal/cultural backgrounds are considered influencing factors in several of the theories. This point is reflected in the form of "Appropriation Factors" in the MST or as subjective norms in the TPB. Similar to that, the YSTY refers to the motivation of an individual. In order to consider this as part of the design of a collaboration system, it is necessary to acquire comprehensive knowledge of the collaboration actors as such (as in DP2 and DP3). However, the importance to trigger the motivation with rewards, personal benefits or gamification elements has been emphasized by the YSTS and the MISC. It is important to consider all areas of motivation (extrinsic, intrinsic, hedonistic) with the reward mechanisms to be established. Depending on the type of individuals (Benevolents, Equity Sensitives, Entitleds) the mechanisms can be adapted for better matching (see DP5).

As described by the TDA, socio-technical systems in particular are subject to the influences of emergent events. Therefore, adding flexibility to the designed system as in DP4 eg. through portability or adaptability of the system gains relevance. This is a step towards a sustainable system able to integrate different data sources and expand the knowledge base if needed in the future. Reusing information or already produced outcomes from previous collaborations leads to higher efficiency in the process. In order to establish this higher efficiency, already acquired knowledge or known solutions to problems need to be accessible. But, information and knowledge are not stored exclusively in data or knowledge bases digitally, they are also in the minds of others which can be accessed via communication. This takes the described aspects of the TMT (information retrieval) into account. Communication is a central component of digital collaboration. Based on the MST, the synchronicity of a medium plays a crucial role in the fit of communication and thus also in

terms of the entire collaboration success. In order to be able to support the processes of information transmission and processing according to the particular need (see TMT), communication media with different synchronicity according to DP1 could be of value.

In sum this paper is limited to the considered theories and the gained insights of our argumentation through them. However, we could point out the importance of each theory for designing and developing digital human collaboration systems and report the design information in the shape of DPs. By doing so, we answered Q. Furthermore, this research aims to contribute with "prescriptive knowledge" (Gregor and Hevner 2013) towards a "theory of design and action" (Gregor 2006) with a set of theory-driven MRs and five DPs to guide designers and developers to consider for digital human collaboration systems.

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