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Dissertation

# Agency in Socio-Technical Systems

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### *Affidavit*

I declare in lieu of oath, that I wrote this thesis and performed the associated research myself, using only literature cited in this volume. If text passages from sources are used literally, they are marked as such.

I confirm that this work is original and has not been submitted elsewhere for any examination, nor is it currently under consideration for a thesis elsewhere.

Vienna, June, 2020



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## Associated Publications

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- (3) Zafari, S., Schwaninger, I., Hirschmanner, M., Schmidbauer, C., Weiss, A., Koeszegi, S.T. (2019). “You Are Doing so Great!” – The Effect of a Robot’s Interaction Style on Self-Efficacy in HRI. in proceedings of IEEE International Symposium on Robot and Human Interactive Communication (*RO-MAN*), pp. 1-7
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# Table of Contents

<b>Acknowledgements</b> .....	iii
<b>Associated Publications</b> .....	iv
<b>List of Abbreviations</b> .....	vi
<b>List of Figures</b> .....	vii
<b>List of Tables</b> .....	viii
<b>Abstract</b> .....	ix
<b>1. Introduction</b> .....	1
1.1 Background and Motivation.....	1
1.2 Research Questions and Objective.....	3
1.3 Research Approach and Method.....	6
1.4 Overview and Abstracts of the Papers.....	8
1.5 Theoretical contributions.....	11
<b>List of References</b> .....	13

# List of Abbreviations

AI	Artificial Intelligence
HRI	Human-Robot Interaction
HCI	Human-Computer Interactions
HRC	Human-Robot Collaboration
ICT	Information and Communication Technology
NARS	Negative Attitudes toward Robots Scale
RAS	Robot Attitude Scale
RQ	Research Question
STS	Socio-Technical System

# List of Figures

Figure 1: Our conceptual model in which the perceived control moderates the relationship between attributed agency and attitudes toward robot.....	30
Figure 2: Participants watch a video vignette that presents a collaboration between a person and a robot.....	31
Figure 3: Interaction of attributed agency and perceived control on NARS-S1.....	35
Figure 4: Interaction of attributed agency and perceived control on NARS-S2.....	35
Figure 5: Interaction of attributed agency and perceived control on RAS.....	36
Figure 6: The setup of the experiment with a house of cards built by a participant and the Pepper robot looking at the scene.....	44
Figure 7: Self-Efficacy in HRI per condition.....	48
Figure 8: Duration of engagement per condition.....	50
Figure 9: Number of cards used per condition.....	50
Figure 10: Subjective task ratings of enjoyment and frustration per condition (1 = strongly disagree, 4 = strongly agree).....	51
Figure 11: Hypothesized relationships between variables.....	62
Figure 12: Interaction of autonomy (via temporal and spatial flexibility) and perceived organizational alignment on work engagement.....	67
Figure 13: Interaction of temporal flexibility and perceived organizational alignment on organizational identification.....	67
Figure 14: Interaction of autonomy via spatial flexibility, spatial flexibility and perceived organizational alignment on job satisfaction.....	68

# List of Tables

Table 1: Work Packages per paper.....	8
Table 2: Typology of autonomous artificial agents .....	21
Table 3: Means, standard deviations and correlations for the study variables.....	34
Table 4: Moderation analysis results for attributed agency as independent variable.....	37
Table 5: Examples of the robot’s verbal reactions for different conditions and different events.....	45
Table 6: Mean rank of perceived personality scores per conditions.....	48
Table 7: Means, standard deviations, and intercorrelations.....	66
Table 8: Confirmatory Factor Analysis of flexible work arrangement (6 items).....	68
Table 9: Moderation analyses results for temporal flexibility as independent variable.....	69
Table 10: Moderation analyses results for spatial flexibility as independent variable.....	69
Table A1: Latent method factor.....	76

# Abstract

Investigating the role of new technology is a continuing concern within organizational research. With the rise of robotics and digitalization, the basic configurations underlying organizing are changing dramatically. This is not merely altering the work we do but also who does the work that opens new social challenges, such as whether being the author of actions means being in charge or which consequences the emerging roles and forms of interaction with these technologies have on our agency. Given that humans are the end-users and sense-making actors of the organizations, it is vital to analyze the challenges that are associated with the integration of emerging technologies into our social systems.

With a focus on system level, this dissertation displays a combined interest in the material and social dimensions of organizing in explaining two working processes, namely human-robot collaboration and flexible work. In doing so, I focus on social factors crucial in the integration of emerging technologies in workplaces and show how these particular ways of working are shaped by material (technology) changes and social (human) forces at workplaces.

The thesis concludes that changes in work do not only depend on assumed human agency but the engagement with technologies also creates the conditionality that made certain sociomaterial practices enacted. Our analytical and experimental results show a significant impact of social and cognitive factors on people's responses to technologies. That emphasizes the importance of informal structure in enhancing the success of the technological integration. Our findings suggest a set of contextual factors that influence the enactment of new ways of working which can serve as a guideline for managers to align their resources and capabilities for supporting new ways of working and optimizing their organization for the transformation journey.

*Keywords:* Socio-technical system, Agency, Human-robot collaboration, Flexible work

# 1. Introduction

## 1.1 Background and Motivation

The constantly evolving technological environment is bringing organizations to integrate innovative emerging technologies into their operational activities to enhance their competitive performance. However, the integration of these technologies into the organization has disruptive impact on labor market. Information and Communication Technologies (ICTs) enhance the potential for organizations to extend their boundaries and enable us to work anytime and anywhere. The service robots are assisting us with different activities, ranging from households to manufacturing, and as a result our tasks and degree of participation in work processes are affected. These examples show that the material changes implicated in technologies are not merely changing the nature of jobs but also how we organize the work. There is a growing body of literature that recognizes the way we organize our tasks is not the result of technologies per se but of the association of their features with organizational arrangements and practices that support their application (Leonardi, 2012; Orlikowski, 2009; Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007). While much of the technology that allows sophisticated system to initiate or respond to a variety of interactions with humans already exists, the social implications of these interactions have not been fully addressed yet. After all, recent studies have shown that the subjective experience and willingness of humans to accept this integration is as relevant as the objective properties and functionalities of these technologies (De Graaf and Allouch, 2013; Echterhoff, Bohner, & Siebler, 2006). Given that humans are integral parts of the systems as sense-making actors and not only the end-users, this dissertation carefully analyzes the challenges that are associated with the integration of emerging technologies into our social systems.

In order to have a balanced emphasis on social and technical aspects of work processes, Socio-Technical System (STS) approach is used. This theoretical framework suggests that within organizations, human (social) and technology (material) continually constitute the features of others. The notion of socio-technical system is developed by Trist and Bamforth in mid-twentieth century to describe systems consisting of a complex interaction between humans, machines and the environmental aspects of the work system. Prior to this time, the material dimension of organizations was considered as an external discrete input to the study of the social dimensions of organizations. As a result, it undermines the role of social context in

shaping the designs and uses of new technologies over time. This framework, however, takes a relational ontology perspective (Law, 2004) and stresses the reciprocal interrelationship and entanglement of humans and technologies that shape both the technical and social conditions of working. While the social subsystem consists of the individuals as members of the organization, the relationship among them and their social attributes, the technical subsystem consists of the devices, techniques and skills used by individuals to perform the task in the organization (Leonardi, 2012). Thus, with a focus on a constitutive effect of material and social, both properties of technology and human should be considered in order to explain how new affordances for working are created (Orlikowski, 2009; Zammuto et al., 2007).

An underlying premise of this approach is that capacities for action are enacted in practice (Orlikowski & Scott, 2008). Thus, a great attention shall be given to the notion of agency. Agency is regarded as the capacity to act (Gray, Gray & Wegner, 2007). Two abstracted properties of agency are intentionality and autonomy (Bandura, 2001; Banks, 2019). Intentionality can be characterized by the capacity of agent to process the contents of the mental state and to justify the action or decision. According to the theory of action (Davidson, 1963), an action is intentional when it is caused by the certain mental states. Thus, if no patterns of interaction and coordination based on expectations is identified, it is a coincidence and unintended. Autonomy is a combination of two Greek terms, auto (self) and nomos (governance) and is expressed in two dimensions of self-directedness (i.e. free will) and self-sufficiency (i.e. free act) (Bradshaw et al. 2013). While former describes the agent's capability to take care of itself and creates its own agenda, the latter describes the extent to which an agent is independent on external control. Taking this together, if no contingency or deviation from the set of course is involved, an action is determined and pre-programmed.

Focusing on the agency of employees and representative bodies in a system can help developing more robust theories of interrelationship of humans and technologies within a workplace as well as potentially informing future strategy objectives for organizations that aim to integrate emerging technologies. Therefore, this dissertation analyzes how social and material entities and their agencies are continually co-constructed to enable two new ways of working—Human-Robot Collaboration (HRC) and flexible work.

HRC refers to a collaborative partnership between humans and robots in completing tasks and focuses on coordinating joint activities among them (Ajoudani et al., 2018). We can differentiate collaboration from cooperation, where tasks for achieving a common goal are

divided among participants and each agent is responsible for only a part of the problem solving. Collaboration is characterized by „the mutual engagement of participants in a coordinated effort to solve the problem together” (Roschelle & Teasley, 1995, p.70). Furthermore, the focus of HRC is not on replacing the human by the artificial agent but on complementing each other by contributing their strengths toward the mutual goal (Kolbeinsson, Lagerstedt, Lindblom, Kolbeinsson, & Lagerstedt, 2019).

Flexible work is defined as working arrangement which allow the employees to autonomously decide to a certain extent when, where and for how long work-related tasks are carried out (Hill, Grzywacz, Allen, Blanchard, Matz-Costa, C., Shulkin & Pitt-Catsoupes, 2008). It is characterized by temporal and spatial flexibility in performing work-related tasks (Martin & MacDonnell, 2012). Temporal flexibility reflects the fact that the period and duration of work are subjected to flexibility. Whereas spatial flexibility takes into account that flexibility also includes the place where the work is carried out. To foster beneficial outcomes in flexible work arrangements, organizations need to become aware of the underlying process of adaptation for flexible work in the specific workplaces.

## 1.2 Research Questions and Objective

The aim of this dissertation is to provide a framework of social factors crucial in the integration of emerging technologies in workplaces. While these technologies have acquired the ability to enter several domains of our lives ranging from personal to social spheres, it is necessary to have a better understanding of their impact on human beings. We restrict our research scope to work relations and settings and investigate how the interplay between technology and humans enables new ways of working. For this purpose, we examine their social impact on micro level of individual motives and cognition by focusing on agents (human or artificial) and interactive processes. Since social is affecting but also is affected by material, it is necessary to study whether and how human behavior is changing through the interaction with robot and what implications these then have for our social life and society. However, the macro level and societal consequences of emerging forms of interaction with technology are out of scope of this dissertation.

To build an effective system, one needs to examine how integrating technology reconfigures the main domains of organization: division of labor and integration of efforts. While the former focuses on how to distribute tasks and decision rights among agents (human or artificial ones), the latter elaborates on how to assure that efforts of different agents are aligned with the

organizational goals. Therefore, studying the agents within this system is the first step in developing a better sense of the sociomateriality development process.

Several theoretical models, such as Actor-Network Theory (Latour, 1996) and Double dance of Agency (Rose & Jones, 2005), suggest that ascribing agency is not limited to humans but also to non-human entities, such as technologies. For this reason, we differentiate between the agency of humans and that of machines and study how these types of agency are interrelated. Recent developments in the field of AI suggest an increase in the agency of machines, as we are assigning them roles that would have previously been fulfilled by humans. However, the unpredictability of the actions undertaken by artificial agents leads to situations where agency becomes an issue (Weber et al., 2013). In addition, understanding the notion of machine agency can be relevant for improving user acceptance in human-machine interactions (Kim, 2016; J.-G. Lee, Kim, Lee, & Shin, 2015), building trust in this relationship (Engen, Brian Pickering, & Walland, 2016) and analyzing the ethical implications of smart technologies (Lin, Abney, & Bekey, 2012). Given that human and machines do not have the same capabilities (Engen et al. 2016; Rose & Jones, 2005), we investigate the concept of agency and comprehend the properties that humans seek when ascribing agency to non-human entities such as robots.

*RQ1) what is agency and how is it ascribed to technology?*

Ascribing agency to another entity highly depends on the physical and behavioral features of the entity as well as the characteristics of perceiver, especially cognitive or motivational features (Takayama, 2011; Waytz, Gray, Epley, & Wegner, 2010). Studies in human robot interaction (HRI) have mostly focused on the former (e.g. Itoh & Inagaki, 2004; Lee et al., 2015; Lee et al., 2006) and there is still very little understanding of cognitive processes that take place during human-robot interactions. User studies about Roomba robot for instance, show that the owners exhibited different behaviors to the same robot vacuum cleaner, some giving it a name or emptying its way and some treat it like any other home application and do not talk to it, since the status of an entity's agency is not static (Takayama, 2011; Forlizzi & Disalvo, 2006). This implies that not merely the predefined and programmed functions of the entity but also the perception of agency influence how we behave and interact with an entity. Moreover, recent studies (Appel, Izydorczyk, Weber, Mara, Lischetzke, 2020, Złotowski, Yogeewaran, & Bartneck, 2017) have shown that not only experience, as a dimension of mind perception, but also agency is related to uncanny feeling towards humanlike robots and therefore requires a better understanding of how ascribing agency elicit uncanniness or negative

responses. Throughout the collaboration, the activities of human and robots are taking place in the same physical and social spaces (Dautenhahn & Sanders, 2011) that highlights the importance of social aspects of interaction between these agents. While several technology features in robotics (such as sensitivity and safety) allow collaborative robots to support joint action in close contact with humans within shared workspace (Bauer et al. 2008), lack of effective management of social and cognitive features such as psychological safety (Edmondson 1999) and situational awareness (Cramton 2001) burden the collaboration between human and robots. Moreover, the *supporting* nature of robots has several implications on the HRC. From the perspective of cognitive sciences, providing support could mean much more than facilitating tasks that may require too much from humans. Sometimes assistive robots or persuasive technologies encourage us to behave in a certain way. Thus, *supporting* could take the form of manipulating humans in the direction of particular behaviors that puts high emphasis on how aware the human partner is of the particular *supporting* act. To provide insights into the human cognition and the intentional stance of humans while interacting with artificial agents, the second research question is:

*RQ2: how does attributing agency to robot affect the attitudes toward robots?*

The development of robots operating in the same physical and social spaces as humans puts higher demands on the quality of the interaction between the human and the robot (Kolbeinsson et al., 2019). Research predicts that service robots will grow soon to be used within the social sphere of human agents as ‘natural’ interaction partners (Floridi, 2008). With the increasing entanglement of human-robot interaction, questions regarding the needs concerning the design of social robots applications are pushing themselves to the fore. The appropriate design and implementation of robots serving *with* humans proves to be more challenging than old-fashioned industrial robots serving *for* humans. Robots serving *for* humans need to be capable of operating more or less autonomously and learning from errors, while robots serving *with* humans require the ability to communicate and interact with humans on a level which involves understanding and responsiveness towards the human interaction partner (Kolbeinsson, Lagerstedt, Lindblom, Kolbeinsson, & Lagerstedt, 2019; Decker, 2013). That puts higher demands on the quality of the interaction between the human and the robot. Thus, to examine how the design of robotic technology could improve work practices while supporting social dynamics, the third research question is:

*RQ3) how should the interaction style of the robot enact the human robot collaboration?*

With technology entering the social territory of humans, their influence on human agency and autonomy enters new potentialities, both in the positive and the negative sense. While digital technologies are most likely to influence the nature and quality of work (e.g. Thompson & Briken, 2017; Spencer, 2018), their transformative and disruptive capacities on the social structure of the organization should not be undermined. Indeed, strong mediation, mobility and connectivity inherent to ICTs pose challenges (but also potentialities) for organizing work processes as they are changing the routines, norms and expectations in the organizations (Ghosh & Sahney, 2011; Zammuto et al., 2007). ICTs mediate the interaction to facilitate the coordination of work outside the regular office space and any working hours. While ubiquitous and wireless technologies are used to enable a new form of working, they may interfere with established work practices and have an unforeseen impact on relations of power, nature of coordination, and consequently on work related outcomes (De Menezes & Kelliher, 2016; Fitzpatrick, 2000; Shin, 2014; Spreitzer et al., 2017). For instance, greater flexibility provided by these technology to autonomously engage in their work increase the productivity and improve performance within the organization (Martin & MacDonnell, 2012) can also cause work intensification (Kelliher & Anderson, 2010) and a tendency to work all the time from everywhere (Mazmanian, Orlikowski & Yates, 2013). As a result, considering the role of either technical or social aspects alone would lack a clear understanding of how this form of working is enacted. Whether the influence of ICTs is to be defined as extending, limiting or even eliminating human autonomy depends on the wider context in which it is provided. In other words, we need to understand how material and social entities affect one other and provide the possibilities for flexible work. Thus, the following research question focuses on both social and technical factors related to flexible work.

*RQ4) how should the functionality of ICTs and the social practices of employees enact flexible work?*

### 1.3 Research Approach and Method

This dissertation has an exploratory research design attempting to analyze the challenges associated with new ways of working by exploring the interrelationship of humans and technologies within a workplaces. At first we gain new insights into the concept of agency and form a more precise problem of interacting with artificial agents (paper 1). That lays the groundwork for our future research. Then we explore the research topic with varying levels of depth by focusing on the two ways working within their context. That helps us to have a better

understanding of the problem and provide a detailed picture of HRC (paper 2 & 3) and flexible work (paper 4).

Taking a sociomaterial approach to analyze new ways of working does not mean defining and categorizing social and material actors and their actions but rather showing the conditions of possibilities for these assumed categories or actors to behave in certain ways. Accordingly, it focuses on the flow of sociomaterial practices enacting such actions and performance as appropriate (Hultin, 2019). Different research methods have been used in order to explore how entities (people and technologies), their properties and identities are continuously performed to enable new ways of working.

The focus of the first paper is on building and elaborating a theoretical typology, in which I incorporated variable dimensions to develop a typology of artificial agents from a theoretical perspective. Typology is a conceptual classification that is mostly used in social rather than natural sciences (Baily, 1994). It is one of the common style of theorizing that systematically categorizes specific dimensions and features in order to create distinct types and profiles (Cornelissen, 2017). This style enables a deeper and more extended analysis of theories in the literature about (social) agency and develops the framework for my empirical research.

While there is little theoretical knowledge regarding the agency of robots, it is also necessary to go further than describing and conduct an empirical study aiming at explaining under which conditions attributed agency have a positive/negative impact on the attitudes toward robots. For this purpose, a vignette survey was conducted in the second paper of this dissertation. Vignettes refer to text, images or video that shortly describe a specific situation to evoke the attitudes or believes of participants about the presented situation (Hughes and Huby, 2002). The flexibility of vignette allows exploring factors and elements of interest by combining traditional survey and experimental design (Steiner, Atzmüller, & Su, 2016). Particularly, participants of my study were asked to watch a video and responded to a post-video questionnaire from the vignette character's perspective as if they were that person in that situation. The video vignette was developed at Pilotfabrik TU Wien in which a Panda arm from Franka Emika was used.

Given that how a robot interacts with people can affect the efficiency of collaboration (Schulz, Kratzer, & Toussaint, 2018), the third paper is centered around the interaction style of social robots. To address this issue, a laboratory-based experiment was conducted with a Pepper robot developed by SoftBank Robotics using the built-in software. For designing the interaction style of the robot, we referred to the “Big Two” dimensions of agency and communion (Bakan,

1966). Although the external validity of laboratory experiments is relatively lower than field experiments, they have been a common method for HRI study. A possible explanation for this is that most of the social robots are not easily accessible for daily usage since they are still in research and development phase (Von der Puetten, Krämer, Becker-Asano, Ogawa, Nishio & Ishiguro, 2018). Laboratory experiments benefit from the high control over the extraneous variables that facilitate the replication of the conditions (Tanner, 2018). Therefore, they are useful method for testing predictions and providing implication for designers of future robots.

Finally, to understand how digitalization is changing the way we work, an online survey was conducted in the fourth paper. Since flexible work commonly takes the form of informal agreements between employees and their supervisors (De Menezes & Kelliher, 2017) and flexible workers are difficult to distinguish from the general population, we employed respondent-driven sampling (Salganik & Heckathorn, 2004) and selected participants via snowball sampling through targeted participants' personal networks to attract participants from different sectors. Throughout this sampling method both flexible and non-flexible employees participated in the survey.

## 1.4 Overview and Abstracts of the Papers

This cumulative dissertation consists of four papers. Two of these papers (paper 3 and 4) were written together with co-authors. Table 1 summarizes my work packages for these co-authored papers.

TABLE 1. WORK PACKAGES PER PAPER

<b>Paper no.</b>	<b>My work package</b>
Paper 3	Leading efforts literature review
	Equal efforts conducting the experiment
	Leading efforts analyzing data
	Leading efforts coordination publication process
Paper 4	Equal efforts literature review
	Leading efforts analyzing secondary data
	Leading efforts coordination publication process

Due to the cumulative nature of the dissertation, the research questions are addressed by different papers, where each research question covers the objective of this dissertation to a

different extent. Paper 1 is a conceptual study that offers a typology for artificial agents. It suggests a framework for analyzing agency of robots and addresses mainly the *RQ1*. Paper 2 is an attitudinal study that focuses on perceived control and investigates the relationship between attributed agency and people's attitudes toward agentic robots (i.e. perceptions, worries and reservations). While attitude toward using technology is a good predictor of social acceptance of robots, other factors, such as self-efficacy, effort expectancy and attachment, also indicate the social acceptance in HRI (Weiss, Bernhaupt, Lankes & Tscheligi, 2009). Accordingly, paper 3 is a HRI study that investigates the association between a humanoid robot's interaction styles and self-efficacy in HRI, people's perception of the robot, and task engagement. Together these papers evaluate attribute-based factor in HRI and thereby address *RQ2* and *RQ3*. Finally, paper 4 focuses on the *RQ4*. It is a survey study that focuses on organizational context and investigates the relationship between autonomy of flexible work and work-related outcomes. Data for this study has been collected by a student for his master thesis.

### **Paper 1: Machine agency in Socio-Technical Systems: A Typology of Autonomous Artificial Agents**

Robots are expected to become a significant part of our lives in the future. In this conceptual paper, we discuss how (social) agency is ascribed to robots and how this form of machine agency can be conceptualized for an analysis of socio-technical systems. Further, we develop a typology of autonomous artificial agents which can be used to address their social impacts within a socio-technical system. We conclude by outlining implications for designers and advancing an agenda for future research.

### **Paper 2: Attitudes toward Attributed Agency: Role of Perceived Control**

Previous research suggests that the increased attribution of agency to robots may be linked to negative attitudes toward robots. If robots are truly expected to assume various roles in our social environment, it is necessary to further explore how increasing agency, for example through increasing levels of autonomy, affects attitudes toward them. This study investigates the role of perceived control as a moderator explaining attitudes toward attributed agency in a collaboration context. Austrian-based participants (N=102) watched a video of a robot collaborating with a person to assemble a mixer – the robot was presented as either agentic and capable of proactively collaborating with the human or non-agentic and only capable of following human commands. The results show that attributing high levels of agency to robots

is associated with negative attitudes toward them when individuals perceive low control during the collaboration.

### Paper 3: “You Are Doing so Great!” – The Effect of a Robot’s Interaction Style on Self-Efficacy in HRI

People form mental models about robots’ behavior and intentions, as they interact with them. The aim of this paper is to evaluate the effect of different interaction styles on self efficacy in human-robot interaction (HRI), people’s perception of the robot and task engagement. We conducted a user study in which a social robot assists people while building a house of cards. Data from our experimental study revealed that people engaged longer in the task while interacting with a robot that provides person related feedback than with a robot that gives no person or task related feedback. Moreover, people interacting with a robot with a person-oriented interaction style reported a higher self-efficacy in HRI, perceived higher Agreeableness of the robot and found the interaction less frustrating, as compared to a robot with a task-oriented interaction style. This suggests that a robot’s interaction style can be considered as a key factor for increasing people’s perceived self-efficacy in HRI, which is essential for establishing trust and enabling human robot collaboration.

### Paper 4: Flexible Work and Work-related Outcomes: The Role of Perceived Organizational Alignment

Recent developments in information and communication technology have led to renewed interest in the impact of flexible work on work-related outcomes such as job satisfaction, organizational identification and work engagement. Although there is a vast amount of literature indicating the positive association between job autonomy and work-related outcomes, there has been little discussion about the contextual conditions that strengthen this relationship. This paper analyzes the role of perceived organizational alignment as a conditional factor and shows that autonomy alone cannot explain an organization’s success in improving work-related outcomes. An analysis of online survey from 481 employees shows that the perceived organizational alignment moderates the positive effect of autonomy on work-related outcomes in the context of flexible work. For employees who perceive organizational alignment to be high, the positive relationships are strengthened for work engagement and organizational identification, but attenuated for job satisfaction. Theoretical and practical implications of these findings are discussed.

## 1.5 Theoretical contributions

This cumulative dissertation contributes to a better understanding of new ways of working that coincide with the introduction of new technologies with a perspective on agency. I used STS approach in explaining two specific working processes, namely human-robot collaboration and flexible work, and showed how these ways of working are shaped by material (technology) changes and social (human) forces at workplaces.

The results of this dissertation indicate that changes in work do not only depend on assumed human agency but the engagement with technologies also creates the conditionality that made certain sociomaterial practices enacted. Our findings suggest a set of contextual factors that influence the enactment of new ways of working which can serve as a guideline for managers to align their resources and capabilities for supporting new ways of working and optimizing their organization for this transformation journey. This contribution can be classified as intermediate theory (Edmondson & McManus, 2007) that identifies new relationships among phenomena by re-conceptualizing explanatory frameworks. We mapped two particular ways of working with general requirements in the form of contextual factors and explain how a specific type of technology is effective in the given context. In this process, the key constructs are defined, the relationship between them is explained and findings are discussed to demonstrate the viability of theoretical methods that have little empirical support.

Our findings contribute to the theory by providing frameworks on how agency does not belong to any actors and emerges from the interaction between human and technology. Taking STS framework in to account, one has to put the emphasis on the larger scale “system” at the heart of the analysis rather than talking about single agents to explain better organizational challenges. Since the attributed agency and autonomy to an agent (human or artificial one) may change in scale, over time and from one situation to another, we refer to the agency within sociotechnical system as a collaborative agency (Kuziemsky & Cornett, 2013), where artificial agents are under the authority of human agent. This is in line with relational ontology that argues agency is constantly forming within the action itself (Barad, 2007).

Despite its exploratory nature, this dissertation offers some insight into how to approach designing systems that support the complex social situation of these ways of working. Our analytical and experimental results show a significant impact of social and cognitive factors on people’s responses to technologies. That emphasizes the importance of informal structure in enhancing the success of the technological integration. In other words, the impact of assigning

roles to human or artificial agents in organizations is not limited to formal domains of organization (i.e. division of labors and integration process) as the autonomy of individuals, their work roles and the social structure of organization are also affected. Thus, for a successful integration of artificial agents into the workspaces a mindful consideration of the social components of interaction and collaboration is essential.

Investigating the role of technology in organizations is a continuing concern within organizational research. While we welcome technologies, such as ICTs and robots, for their capacity to create new ways of working, their disruptive impacts should not be undermined. This calls for a social science and human factors perspective to analyze the domains where these technologies potentially can and should be used, and where they can but should not be used as their implementation may pose threats and challenges to specific groups or society. The scope of this study was limited in terms of work organization and analyze how ICT or robotics are changing the way we work. A natural progression of this work is to analyze the possibilities and consequences of integrating these technologies into the tasks or activities that cannot be assigned to the artificial agents such as those requiring empathy or creativity. Further research could also usefully go beyond dyadic interactions between a human agent and an artificial agent and explore how the team characteristics (e.g. team diversity and composition) affect the work dynamics and collaboration. The process of the collaboration has a fundamental social component that with robots serving as the physical interaction partners of the human agent, comes a great risk on fundamental structures that usually brought forth within human-human interaction. For instance, how artificial agents affect our lifestyles and disciplines and whether interacting with robot maid make the children lazy and vain. The long-term and societal consequences of artificial agents penetrating into our social lives is an intriguing one which could be usefully explored in further research.

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