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Abstract	Achieving tangible benefits from digitalization often requires changes in processes, culture and reward systems. This need is especially acute in research and development, yet the attitudes and skills of R&D staff may impede their use of automation. We examine the ongoing digitalization of R&D activities at Unilever. Using thematic analysis, we analyze in-depth interviews to uncover attitudes towards, and experiences with, digitalization of R&D using robots. We build on these findings and conduct sequence analysis to extract a number of within-interview sequential associations between themes. These associations have been mapped onto patterns aligned with four established models of digitalization and IT adoption: the Technology Acceptance Model, Resistance to Change, Task Technology Fit and Process Virtualization.

Keywords	Digitalization uptake - R&D automation

Adoption of Digital Technology in Corporate R&D Context

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Abstract. Achieving tangible benefits from digitalization often requires changes in processes, culture and reward systems. This need is especially acute in research and development, yet the attitudes and skills of R&D staff may impede their use of automation. We examine the ongoing digitalization of R&D activities at Unilever. Using thematic analysis, we analyze in-depth interviews to uncover attitudes towards, and experiences with, digitalization of R&D using robots. We build on these findings and conduct sequence analysis to extract a number of within-interview sequential associations between themes. These associations have been mapped onto patterns aligned with four established models of digitalization and IT adoption: the Technology Acceptance Model, Resistance to Change, Task Technology Fit and Process Virtualization.

AQ1

Keywords: Digitalization uptake · R&D automation

1 Research Context

The digitalization of industry, along with new developments such as the Internet of Things and Smart Factories, is likely to bring disruptive changes to businesses (Oks et al. 2016). The adoption of automation and digital technologies in manufacturing companies will lead to better efficiency and innovation performance (Kroll et al. 2018). In particular, in manufacturing, research has focused on the digitalization of manufacturing processes, for instance the application of big data analytics, advanced manufacturing technologies with sensors, advanced robotics and advanced tracking and tracing technologies, and the impacts of these digital technologies on the production management, such as supply chain management and smart operations in factories (Fazili et al. 2017; Ivanov et al. 2019; Nguyen et al. 2018). The emerging discussion on robotic process automation (RPA) among practitioners reveals the concerns and issues for the advanced digital technology adoption. Debrusk proposed five risks for organizations to execute pilots with robots across operations, including standardization issues, adherence to underlying systems, jeopardized success, the lack of process owner incentives and elimination of rethinking capabilities (DeBrusk 2017).

Digitalization and automation are argued to represent potential sources of disruption to corporate R&D that may lead to better, faster and cheaper R&D (Schimpf 2016). R&D staff are usually recruited following advanced scientific training that

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confers occupational identity with strong emphasis on autonomy. Traditionally, this was consistent with the needs of corporate R&D. Thus, the corporation accorded R&D staff considerable autonomy - since the autonomy that R&D enjoys compared to other function is strategically crucial for innovation. The implementation of automation and digitalization in R&D gives rise to potential tension between the corporate strategic need to make full use of the benefits of the new technologies associated with automation and digitalization, and the occupational autonomy that R&D staff expect and have traditionally been given within the R&D function. This paper presents an exploratory case study on the technology adoption issues in the corporate R&D digitalization process and examines the underlying factors for accepting technology. This case study is focused on the fast moving consumer goods company Unilever and its ongoing digitalization R&D activities. Unilever produces a wide range of personal care, home care and food products many of whom are based on formulation chemistry. A formulation is a mixture of chemicals that do not react chemically but are designed to produce a final product with desirable characteristics (e.g. a hair shampoo or a domestic cleaning product). Digitalization of R&D has been adopted most rapidly in the pharmaceutical, aerospace and automotive industries, while companies in the formulation industries have been slower to adopt. Nonetheless, over the last decade, large companies in the formulation industries such as household and personal care, food, agrochemicals and coatings have been slowly incorporating modelling and automated high-throughput experimentation processes into their R&D activities (Chemistry Innovation and Intelligent Formulation 2011).

Unilever is making significant investments in automation and digitalization in its newly established R&D facility, the Material Innovation Factory (MIF), opened in 2017. MIF is a public-private research partnership between the University of Liverpool, Unilever and the Higher Education Funding Council for England (HEFCE). It focuses on materials chemistry, soft solids and complex mixtures. The MIF includes a dedicated floor for Unilever research groups to work on internal R&D programmes, and this floor represents the single largest concentration of robotic experimental and test equipment in Unilever. Some robots were relocated from Unilever's Port Sunlight R&D centre, yet most are newly designed and built as part of the investment in the MIF.

This paper makes two contributions to knowledge: Firstly, we establish the relevance of four established models of technology adoption to digitalisation in professional R&D context. We thus set the foundation of an adoption framework to reflect the distinct characteristics of R&D professionals in the context of advanced technology adoption, for example a stronger focus on performance, rather than ease of use and learning costs. Secondly, we use mixed methods approach, thus providing methodological insights for future case study research. We use qualitative approach (thematic analysis) combined with quantitative approach (sequence analysis), to analyze the data collected via semistructured interviews. Thematic analysis helps the researchers to get a comprehensive understanding of the research context and research questions, whilst the sequence analysis supports the researchers to identify association links between constructs.

2 Theoretical Background

Digital transformation is seen as a fundamental and disruptive change to all aspects of business, differentiated from the impacts of automation on manufacturing and processing environment. Therefore the introduction of robots and digital technologies in highly knowledge-intensive professional functions is expected to generate significant impact. This paper focuses on the introduction of robotics and digitalization in industrial R&D. The Industrial Research Institute (US) reports on a project on Digitalization and R&D Management, exploring a range of issues relevant to the digitalization of R&D, including virtual experimentation and simulation; the use of digitalization as a tool for internal and external collaboration; and Big Data (Chemistry Innovation and Intelligent Formulation 2011). Digitalization is reported to shape R&D and R&D management, in the form of virtualization, artificial intelligence, and other technologies (The Industrial Research Institute 2017). However, there is a lack of research examining the organizational and behavioral issues that arise in the adoption of these new technologies by industrial R&D professionals (Euchner 2017). This digital transformation may have a profound impact on the innovation process and the R&D function within large companies. Research has identified that professional workers, such as R&D staff, differ from other workers in the production process, in terms of professional identify and the acceptance of standardization and routinization process caused by digitalization (Susskind and Susskind 2017). R&D departments in large firms, as the highly knowledge intensive department and the core creators of new technologies and innovation, could be affected by the automation and digitalization process differently.

Given the lack of research focused on R&D digitalization in process industries, this paper considers a wider field of theories and frameworks of Information Systems (IS) technology adoption, including the Technology Adoption Model (TAM), the Theory of Planned Behaviour (TPB) and the Theory of Reasoned Action (TRA). Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975) seeks to explain and understand why people accept or reject computers, from the perspective of their intentions. The key construct described in TRA includes behavioral intention - defined as the strength of an individual to pursue a particular behavior which in turn is influenced by attitude and subjective norms; behavioral attitude - an individual's positive or negative feelings about performing the specific behavior, and subjective norms - an individual's perception that most people that are important to them think that they should or should not perform the behavior. Theory of Planned Behavior (TPB) (Ajzen 1991) is built on the TRA and extended the TRA by adding the construct of perceived behavioral control, which is defined as an individual's perception of the ease or difficulty of performing the behavior. The model has been applied to the understanding of adoption of many different technologies and in various industries (Harrison et al. 1997; Mathieson 1991; Pavlou and Fygenson 2006). The Technology Acceptance Model (TAM) (Davis 1989) extends the TPB by focusing particular attention on the role in adoption of the perceived usefulness and perceived ease of use of the innovation. In this model, attitude to use and intention to use are based on the definitions used in the TRA/TPB. For instance, perceived usefulness is defined as the degree to which a person believes that using a particular innovation will enhance their

job performance, while perceived ease of use is defined as the degree to which a person believes that using a particular innovation would be free from effort.

These models offer differing but complementary insights into the process of innovation adoption (Solbraa Bay 2016). In particular, in highlighting the importance of Attitude – all three models have at their core an emphasis on the importance of individuals' beliefs or perceptions as key independent variables for adoption behavior; Ease of use and complexity – the TAM emphasizes perceived ease of use as an important factor in the adoption decision; and the Usefulness and relative advantage – the TAM highlights perceptions of usefulness or relative advantage in the intention to adopt an innovation.

3 Research Methodology

The aim to explore the automation and digitalization process of R&D activities and to understand the factors and conditions which determine success of the robotics uptake in an industrial context motivates our adopting the exploratory case study methodology (Yin 2009). This methodology has been widely used in social science fields like sociology, industrial relations and innovation studies (Lundvall 2007; Motohashi and Yun 2007; Xibao 2007). It is considered as a research strategy concerning how and why questions and allowing investigation of contextual realities and the differences between what was planned and what actually happened. It is also used as an empirical inquiry that investigates a contemporary phenomenon within real-life context (Yin 2009) and probes an area of interest in depth which enable the researcher to understand the complex real-life activities (Noor 2008). The case study approach enables researchers to go into the field, acting as an observer while collecting data for analysis and theory building, understanding the conditions, constraints and challenges of the research topic in the practical environment.

Within the scope of the explorative case study, semi-structured interviews were undertaken to conduct data collection and mixed methods (qualitative and quantitative methods) were adopted to conduct data analysis, in order to uncover the research context with a holistic view and explore the research question through multiple lens. Especially, this research adopts 18 semi-structured interviews with management team and engineers/scientists working with the automatic and digital tools for the data collection process. Different data analysis methods are adopted to analyze data collected via various approaches. The qualitative data collected via semi-structured interviews is analyzed using thematic analysis. The resultant list of themes and subthemes is then analyzed using sequence analysis in order to identify patterns and relationships between themes and subthemes.

Figure 1 shows the methodological pathway of the research, including data collection and analysis methods used. The remainder of this section will introduce the rationale for selecting these methods and present the results from this selection.

A research protocol to guide the semi-structured interview was developed based on the understanding of research context and the study of existing literature on adoption of technology. Protocols were developed with the above factors in mind and related to the business context – to understand the progress and issues with the newly opened R&D

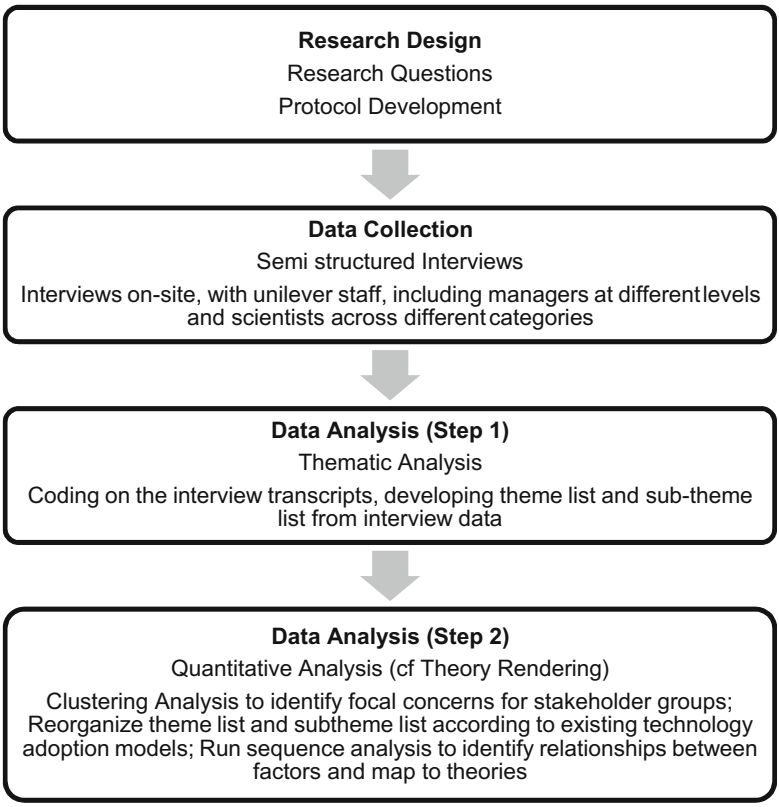

Fig. 1. Methodological pathway

facilities aiming for automatic and digital transformation. Semi-structured interviews were then conducted following the guidance of the above protocols. Both managers and R&D scientists related to MIF were approached for interviews in order to collect information of the research context and understand the research question from various angles. All the interviews were conducted by at least two professionally trained researchers from the research group, using interview protocols that were designed especially for interviews with managers and scientists.

The protocols act as guidelines of the interview and also give researches authority to vary and expand the conversation based on the interviewee's experience and responses. This allows the researcher to gather information from various perspectives and gain deeper understanding of research questions. Through interviews with managers and scientists with the two different sets of questions, the researchers were enabled a chance to understand the context of Unilever's digital strategy from a top-down perspective and to explore the conditions of acceptance and adoption of digital technologies from a bottom-up perspective. In total, 18 interviews were conducted from November 2017 to May 2018, including 5 interviews with senior and middle management, 7 interviews with team leader scientists and 6 interviews with scientists and technicians.

The analysis followed a mixed methods approach, where a qualitative thematic analysis established a number of relevant factors impacting attitudes and implementation of the digitalization process, and this was followed by quantitative analysis which aimed to profile concerns according to different types of stakeholders and to establish relationships between different factors and attitudes to technology uptake.

The qualitative analysis worked in inductive mode to extract the themes and subthemes discussed at interviews, then we proceeded in quantitative mode using clustering to profile concerns against stakeholder groups. This was followed by abductive qualitative analysis to align the derived codes with well-known factors from technology acceptance theories and finally we applied sequence analysis techniques to uncover any relationships between factors, and to map these to relationships from existing technology acceptance models.

The data collected via semi-structured interviews was analyzed using thematic analysis method, which is a well-used method in qualitative research focusing on examining themes, identifying, analyzing and reporting patterns based on interview data (Braun and Clarke 2006). Greg and Namey (2012) claim that thematic analysis goes beyond simply counting phrases or words in a text but moves on to identifying implicit and explicit ideas within data (Guest et al. 2012). The researchers start working on coding, which is the primary process for developing themes within raw data. Coding allows researchers to recognize important moments in the data and encode it prior to interpretation. In this research, all interview transcriptions were analyzed using thematic analysis and carefully coded by at least 2 researchers. AQ2

The thematic analysis of the semi-structured interview data strictly follows the standard process. For the first step, the researchers were assigned to read the transcriptions and note down the patterns shown in the data and potential themes emerged, when different researchers came up with an independent list of key themes that they picked up from the data. A discussion meeting was organized for all the researchers to explain the key theme list they generated for mutual understanding and therefore an integrated list of themes was agreed. The integrated list of themes was then used to analyze a few more interviews to test the robustness of the themes.

After continuous discussions and refinement, the coding system including the key themes and sub-themes was developed. The key themes emerged from the thematic analysis that indicating the conditions of the firm's digitalization process, includes characterization of digitalization, vision of the future, reasons for digitalization, attitude towards digitalization, impact on day to day work, behavioral influences on adoption, organizational influences and technological influences on adoption, and change management process. Within each theme, a series of subthemes are identified, illustrating in details how the key themes are constructed and represents the different thoughts among the informants.

4 Research Findings

4.1 Key Factors Influencing Digital Technology Adoption of Corporate R&D

The primary findings also show that there are several factors that could affect the introduction of digitalization into the R&D process, especially, behavioral, organizational and technological influences.

Vision, Understanding and Attitude of Digitalization. The analysis identifies although staff holding promising vision and understanding the reasons of digitalization, such as improving efficiency, creating new approach to research, utilizing big data and modelling, there are still different attitude towards the transformation from traditional approach to digital approach. While understanding the reason behind the introduction of digitalization, including growing competitive threats, developing better experimentation in terms of new possibilities improved efficiency, accuracy and standardization, as well as achieving better financial performance via better productivity, there are still mixed attitudes among the interviewed staff. While some staff are quite positive and highly engaged, there are a large number of employees who are hesitate and resistant to the change, or even fearful to the change. The reasons why there are these attitudes could be linked to the different aspects, for instance, the perceptions of how digitalization impacts on their work, the behavioral, organizational and technological factors.

Impact of Digitalization on Day to Day Work. Interviewee's perception of the actual or potential impact of digitalization on the content of her/his work, how s/he carries out that work, how and with whom s/he communicates, and her/his responsibilities (include here both formal and informal aspects) reflects on their attitudes towards the adoption of the digital technologies. For instance, some employees are concerned about the management of relationships with team members and the lost control of their work content, time and data generated from the new experimental approaches. They would also have to change work habits and change experimental methods to adapt to the change. These impacts of digitalization on day to day work have are mentioned as concerns in the process of digital technology adoption.

Organizational Influences of Technology Adoption. The organizational factors include elements like the organizational structure of Unilever, management style, global labs, prior experience of ICT implementation and MIF enabling networking, which represents what types of organizational structures and behaviors that could affect the digital technology adoption within the company. For instance, different categories and functions within the company might have different programs of the technology introduction, which could lead to different work progress and acceptance level among employees on using the new technologies. Another organizational factor is the networking effect within and across organizations that generated during digitalization. While utilizing digital tools, more opportunities for networking and sharing data/experimentation across research teams, as well as with collaborators outside the company, are generated. According to some informants, the benefit acquired from

networking encourages them to engage in the digitalization process and make them more likely to adopt digital technologies.

Technological Influences of Technology Adoption. The technological factors covers aspects such like commissioning and validating robots, data quality/trust in robot generated data, ICT infrastructure, inappropriate expectations of the technology, learning/new skill sets, perceived unreliability of the technology, etc. For instance, while the digital technology was introduced into the traditional system, it requires new working approaches which lead to learning of new techniques and new skills of employees. The new techniques learning is different from existing knowledge base and requires more effort, which is identified as an important factor that hinders the adoption of digital technology. Meanwhile, having been working on bench for decades, it is not easy for scientists and engineers to believe that the data produced from robot-run experiments are as solid as that from bench experiments. In the initial process of robot commissioning and validation, the perceived unreliability of the technology is also an important factor influencing the adoption. While the pressure of individual/team performance exists in the organization, it is essential that individual scientists and teams could get access to technologies that have been established and could produce trustful information.

Change Management and Management Commitment. Besides the above factors identified in the coding system from behavioral, organizational and technological perspectives, the thematic analysis also discovered impacts from firm change management activities, in terms of what has been done (or what is planned) to prepare and support individuals, teams, and the company as a whole in making the change towards digitalization. Within the change management scope, communication and consultation from management is identifies as a critical factor that influences the adoption process. Management commitment is another important factor. For instance, the interviews uncover the expectation from employees to receive strong and clear message from top management and middle management and to understand how the transformation could benefit their individual work. Otherwise, if the message is not conveyed effectively, it is hard for employees to figure out how the digital transformation relates to their individual and team work responsibilities. Financial compensation and incentives, trainings sessions and other supporting programs are identified as good approaches to facilitate the digital transformation process, as they could take out some obvious obstacles for some employees.

4.2 New Technology Acceptance Model for Corporate R&D Digitalization

In order to further identify the focal points of concern for different types of stakeholders and to identify relationships between the different factors, we have used a data mining technique, the sequence analysis. Before applying sequence analysis, the codes identified from the thematic analysis were reorganized into a new structure, which links to existing technology adoption theories. The codes are reclassified into different constructs according to the primary sequence analysis results and a reconsideration of the constructs relating to existing theories, a technique borrowed from the palette of

grounded theory analysis but fully aligned with the exploratory nature of our case study research. For instance, relative change management activities such as change in vision and language used to communicate and management communications are classified into the new group labelled as communication quality, while the change management activities such as financial compensation for extra travel and incentives are classified into the new group of facilitating conditions. Using the restructured codes, sequence analysis was applied to explore potential linkages among the constructs considering the order in which they appear in the text. The analysis was run on 1429 lines of codes.

Table 1 shows the association rules identified between the constructs Task Characteristics (TaC), Technology Characteristics (TeC), Perceived Compatibility (PC), Perceived Usefulness (PU), and Intention to Use (ItU). The results shows that TaC and PU appear together in 2/3rds of our interviews and that in 41.6% of the cases the mention of TaC is shortly followed by discussion of PU. Overall, the derived rules suggest that the characteristics of technology and task and how people perceive the compatibility of the technology to the task are very important for their perception of usefulness of the technology.

Table 1. Association rules related to perceived usefulness.

If antecedent then consequent	Support %	Confidence %
If task characteristics *then* perceived usefulness	66.6	41.6
If technology characteristics *then* perceived usefulness	100	38.8
If Perceived Compatibility *then* Perceived Usefulness	83.3	46.6
If Perceived Usefulness *then* Intention to use	94.4	23.5

Meanwhile, another rule identified in the analysis is the link between PU and ItU, which also appear frequently together. The result indicates that when our respondents discussed the usefulness of the technology, they also discussed their intention to use and adopt the technology. In the next section we describe how the association rules identified between the task and technology characteristics and perceived usefulness indicate the relevance of the Task-Technology fit model (Goodhue and Thompson 1995) and the process virtualization theory (Overby 2012) for our focal context of R&D digitalization.

Table 2 shows the association rules identified between the constructs Facilitating Conditions (FC), Perceived Ease of Use (PEoU) and Intention to Use (ItU). According to the sequence analysis, interview participants discuss frequently FC and PEoU in close sequence, and also PEoU and ItU are often discussed together. The results show that the facilitating conditions such as training and supports for adoption activities are essential for people's perception of ease of use of the technology and therefore affects people's intention of use and the technology adoption performance. In the next section we explain why the interplay between perceived ease of use, facilitating conditions and intention to use depicted in Table 8 is indicative of the relevance of the UTAUT (Venkatesh et al. 2016) to our focal context. AQ3 AQ4

Table 2. Association rules related to perceived ease of use.

If antecedent then consequent	Support %	Confidence %
If facilitating conditions *then* perceived ease of use	83.3	46.6
If perceived ease of use *then* intention to use	72.2	30.7

Table 3 shows the rules related to Resistance to Change (RtC) and some organizational characteristics, including Organizational Factors (OF), Communication Quality (CQ), Job Security (JS), and Employee-Management Relationships (EMR). The first a few rules shows that OF and CQ are linked to RtC, with RtC as consequent. The following rules shows that RtC is linked with PU, while RtC is identified as antecedent and PU is identified as consequent. The relationship shows that the organizational characteristics and communication between management and employees have influence on employee's resistant attitude to accept the change, which further impacts on their perception of usefulness of the technology. In the next section, we demonstrate how the links between constructs identified in Table 3 indicate the relevance of the Resistance to Change model (Amarantou et al. 2018) to our context and suggests ways in which its constructs interact with variables from the UTAUT (Venkatesh et al. 2016) and TTF (Goodhue and Thompson 1995).

Table 3. Association rules related to perceived usefulness.

If antecedent then consequent	Support %	Confidence %
If organizational factors *then* resistance to change	100	22.2
If communication quality *then* resistance to change	94.4	29.4
If (resistance to change > resistance to change) *then*	33.3	66.6
Perceived usefulness *If* job security *then* perceived usefulness	38.8	57.14
If employee-management relationship *then* perceived usefulness	38.8	57.14

5 Proposing a Technology Adoption Theory Within the Context of Digitizing Research and Development Activities

The results from our exploratory study of Unilever's digital technology transformation project provide a rich insight into factors which impact the digitalization of research and development work in corporate context. Considering the widely accepted models of technology adoption, we have found sufficient evidence to consider the following shortlist of models relevant to our focal context: UTAUT (Venkatesh et al. 2016), TTF (Goodhue and Thompson 1995) and Resistance to Change (Amarantou et al. 2018). The association rules also implicate specific ways of linking the elements of these three models.

First of all, the research results are aligned with conventional technology adoption models, by identifying that perceived usefulness and perceived ease of use are two main factors that affect user's intention to use and adopt the technology (see Tables 1 and 2 in the previous section). The Technology Acceptance Model (Davis 1989) extended the Theory of Planned Behavior by focusing particular attention on the role in adoption of the perceived usefulness and perceived ease of use of the innovation. Perceived usefulness is defined as the degree to which a person believes that using a particular innovation will enhance her or his job performance and perceived ease of use is defined as the degree to which a person believes that using a particular innovation would be free from effort. Our findings from the thematic analysis and sequence analysis are consistent with Yi et al. (2006) study of information technology acceptance in the US healthcare sector, demonstrating that perceived usefulness plays the most important role in determining physicians' intentions to accept a technology.

Furthermore, the analysis in the previous section also demonstrates the importance of antecedents of perceived usefulness and perceived ease of use found in the task-technology fit model (Goodhue and Thompson 1995), and, to a lesser extent, the process virtualization model (Overby 2012), with the key antecedents of perceived compatibility and task-technology fit (Table 1), and facilitating conditions (Table 2). Our association rules also identify how these constructs could be integrated into the traditional technology adoption model within our focal context. Facilitating conditions, which refer to the organizational and technological support that the organization provides to employees in to adopt the new technology, are identified as important antecedent of perceived ease of use. Agarwal and Prasad (2000) examined the adoption of new software development process innovations by systems developers and found that certain beliefs about the attributes of target technologies, including the perception of relative advantage, ease of use and compatibility, played a part as did external factors such as organizational tenure, prior technical knowledge, training experiences and perceived job insecurity (Agarwal and Prasad 2000). In addition, the research emphasizes that structured training is highly beneficial for professionals to integrate the new technology into their work.

The task characteristics and the technology characteristics are aligned with the task-technology fit model, which explains that when the capabilities of the technology match the tasks which users' perform, is this likely to have a positive impact on the performance of adopters (Goodhue and Thompson 1995). The task-technology fit model emphasizes that technology has to match tasks and the requirement of users. In this model, the research identifies that interviewees pay attention to the technology characteristics and how the adoption of certain technologies could support their achievement of every work and job tasks. In particular, this concern links to their perception of usefulness of the technology and leads to their different levels of intention to use the technology.

The perceived compatibility, which has been identified also as an antecedent of perceived usefulness (PU), could be sourced back to the process virtualization theory (Overby 2012). The process virtualization theory focuses on how the introduction of digital technology leads the transition of traditional physical activities into virtual processes. According to the interviews, the transition process from physical activities to automatic and digital techniques is sometimes questioned by employees since there might be missing parts/tacit knowledge/experience during the transition. Therefore, the

transformation from traditional working approaches to digital methods needs to concern the perceived compatibility and make sure that the new technologies comply with and represent the traditional approach in order to win user's trust and gain higher level of perceived usefulness.

Finally, the research results in Table 3 indicate that a set of organizational and psychological factors may also affect user's perception of technology usefulness and thus impact on user's intention to use. In particular, resisting change could be affected by the communication quality between management team and employees and a set of other organizational factors (see Table 3) which are not common in the technology acceptance literature. The resistance to change model (Amarantou et al. 2018) can thus act as a source of guidance towards reducing problems associated with organization change. This findings suggests that management team of an organization which seeks to achieve technology transition, should pay attention to the communication and language shared with employees to reduce their resistance attitude and increase their perceived usefulness of the technology.

6 Summary and Conclusion

This paper presents an exploratory case study capturing the digital transformation of Research and Development activities within a multi-national company, connected with a migration to a new facility and increased use of robots for experimentation and testing. We have used semi-structured interviews to gather detailed information about the considerations and perceptions of a number of experts and their managers regarding this transformation. We have analyzed the transcribed interviews to extract themes related to technology adoption using thematic analysis followed by sequence analysis. This resulted in a set of association rules between themes related to four existing technology adoption models. The association rules also indicated ways in which elements may interact within and between models. Thus our mixed methods study gave rise to an innovative emergent model of technology adoption in the context of digitalization of R&D activities in a multi-national corporation.

Appendix 1: Managerial Questions

Managerial questions (General questions to Managers to get context to unilever digitization/automation)
1. The term "digitization" is widely used today, both within Unilever and elsewhere. What does digitization mean to you? How do your colleagues interpret the term? Does their interpretation differ significantly from yours? If so, in what way?
2. In your opinion, what are the MAIN reasons UNILEVER is introducing digitization?
3. How far have you progressed with digitization?
4. What have been the challenges? What have been the challenges for others do you think?
5. Have the working practices of staff changed as a result of digitization?
6. How do you see the introduction of digitization in the near to medium future?

Appendix 2: Questions for MIF R&D Scientists

Managerial questions (General questions to Managers to get context to unilever digitization/automation)
1. What part does the MIF play in your role?
2. What were your expectations of the MIF before you began working here?
3. What does MIF mean for the way that you work?
4. What training have you received for MIF?
5. How long did it take you to feel mastery of the work process?
6. What are the main challenges that you've faced?
7. How has your experience compared to that of your colleagues?
8. More widely, do you have any views about the introduction of digitization in Unilever?

Appendix 3: Reclassification of Codes

Reclassification of codes	
Communication quality	Includes codes Change in vision and language used to communicate change Management commitment; Relationship management; Top management awareness
Employee-management relationship	Consultation; Management style; Performance measurement and Incentives
Facilitating Conditions	Financial compensation for extra travel; Support for adoption; Training; Incentives
Intention to use	Engaging; Excited; Positive
Job security	Fearful
Organizational factors	Differences between categories; Different levels of staff access to MIF; Lack of formal change management process; Role of champions; Resource allocation;
Perceived compatibility	Work habits; Inappropriate expectations of the technology; The need for new skill sets; Previous experience using robots

(*continued*)

(*continued*)

Reclassification of codes	
Perceived ease of use	Travel to work; Location change; Learning of new skills
Perceived usefulness	High expectation; Data sharing; Productivity; Better experimentation - data utilization; Better experimentation - new possibilities; Better experimentation - standardization; Collaboration; Competitive threats; Efficiency/accuracy/repeatability; Supplier specification; Disrupt through digital; Efficiency/added value; Global R&D/internal sharing; New approach to research
Resistance to change	Hesitate; Negative; Resistant; Sceptical; Established work habits
Task characteristics	Experimental methods; Time management
Technology characteristics	Logistics; Commissioning and validating robots; Data quality; ICT infrastructure; Perceived unreliability of the technology; Standardization; Technical limits of automation - measuring intangible aspects; Translating physical to automated processes; Trust in robot generated data

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