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From transfer to co-creation: action research perspectives in knowledge transfer partnership (KTP) projects

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ABSTRACT

Action Research (AR) is about practitioners and academics interacting to generate knowledge. Using the University-Industry Collaboration (UIC) literature, we investigate the knowledge generation process through AR and whether this process can achieve the dual objective of practical relevance and theoretical novelty. Our study explores this through an examination of the utilisation of AR within UICs facilitated by the UK government's Knowledge Transfer Partnership (KTP) programme. Through an inductive, qualitative, multiple case study research design, we analysed three KTP projects, each lasting two years. We observed an evolution in the dynamics of the relationship between practitioners and academics, signifying a transition from mere knowledge transfer to a more participatory process of knowledge co-creation. We found that as the KTP project progresses through successive cycles of the AR spiral, there emerges a shift from single loop to double loop or multi loop learning, resulting in unplanned and emergent benefits and outcomes. This transition signifies a deeper exploration of underlying assumptions and strategies in AR projects, enabling the generation of novel knowledge. We offer a new framework by introducing the collaborative entanglement and linear knowledge enhancement arguments to explain the interaction patterns between researchers and practitioners in AR.

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1. Introduction

Can theoretical novelty, research rigour and practical relevance converge in business and management research (Alfaro-Tanco, Mediavilla, and Erro-Garcés 2023)? According to Van de Ven (2007), it is possible to achieve this delicate balance through the concept of 'engaged scholarship'. Engaged scholarship refers to an approach that emphasises active interaction between academic researchers and other stakeholders that exist outside of the academia. It extends beyond traditional scholarly activities by integrating academic knowledge with real-world challenges (Van de Ven 2007). This form of scholarship involves researchers engaging directly with individuals, communities, organisations, or inter-organisational contexts to co-create knowledge (D'Este and Perkmann 2011; De Silva, Al-Tabbaa, and Pinto 2023), and enact change through collaborative efforts.

Action Research (AR) is aligned with the concept of engaged scholarship and aims to implement change in real-life situations (Coughlan and Coghlan 2002; Erro-Garcés and Alfaro-Tanco 2020). AR represents a cooperative inquiry, a form of participative research 'with' organisations and people rather than 'on' them, where the roles of the researcher and subject are integrated (Heron and Reason 2006). These roles are integrated in a cyclical approach, defined in the late 1970s by Susman and Evered (1978) as five phases contained in a spiral of diagnosing, action planning, action taking, evaluating, and specifying learning.

The adoption of AR can be thought of as the product of three shifts. First, Bamberger and Schön (1983) suggested that practitioners can engage in reflective practice, effectively learning, reflecting and theory building by doing, which indicates that they can be active in developing new knowledge. Second, the epistemological shift known as the 'new scholarship' recognised that while practitioner and academic knowledge may be separate and different, labelled by Gibbons (1994) as Mode 1 (conceptual) and Mode 2 (practical), they are complimentary and of equal value (Avison, Davison, and Malaurent 2018). Third, the growing interest in the recognition of Polanyi's earlier characterisation of tacit knowledge (Oğuz and Elif Şengün 2011) and its acceptance as a legitimate form of knowledge. Tacit knowledge encompasses skills, intuitions, insights, and know-how that practitioners possess but does not transfer easily to others.

These three shifts position practitioners, as authentic holders of knowledge capable of working within groups comprised of other reflective practitioners and academics (Coghlan and Shani 2014). This brought practitioners' legitimacy as research collaborators and validated AR as an

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acceptable research methodology within academic and policy environments (McNiff 2013). Although the applicability of AR as a robust method in operations management research is now more widely acknowledged, it has been observed that few academic publications explicitly claim the use of AR (Avison, Davison, and Malaurent 2018; Lizarralde-Aiastui, Apaolaza-Perez de Eulate, and Mediavilla-Guisasola 2020). This lingering apprehension about its credibility may be because of AR's ongoing association with consultancy (Brown 1967; Alfaro-Tanco et al. 2021). This association may still pose a barrier to its recognition as a valid and rigorous research approach despite its potential to bridge the gap between theoretical advancement and practical application.

Consequently, it is important to understand the critical success factors (Alfaro-Tanco et al. 2021) and mechanisms for rigorous AR so its full potential to contribute to research, policy, and practice can be realised (White and Cooper 2022). Therefore, we seek to answer the following research question: *How should academics and practitioners interact to enable knowledge co-creation in action research projects?*

We will answer this question by conducting multiple case study research within the Knowledge Transfer Partnership (KTP) programme in the UK. KTPs are managed by Innovate UK, a government body promoting University-Industry Collaborations (UIC) (https://www.ktp-uk.org/). The KTP programme utilises an interpretation of AR to facilitate collaboration between academia and practice and it is increasingly deployed in operations management research (Alexander and Childe 2013; Manville et al. 2019; White et al. 2019; Tassabehji, Mishra, and Dominguez-Péry 2019). Hence, this contextual focus leads to the additional research question: *How do the features of 'Knowledge Transfer Partnership' programme enable co-creation of knowledge which brings both theoretical novelty and practical relevance in action research?*

This paper proceeds as follows. First, we conduct a review of the UIC literature to identify the knowledge enhancement archetypes. Second, we present our methodology and data narrative including our qualitative data collection and analysis methods through a multiple case study of three KTP projects in the UK. Lastly, we present our research findings and contributions by linking UICs, AR and the KTP programme.

2. Literature review

2.1. Academic-practitioner interactions in UICs

UIC refers to interactions between academic researchers and industry practitioners (Rossi, Rosli, and Yip 2017; Rybnicek and Königsgruber 2019; Thomas and Paul 2019). Research collaborations between academia and practice are not new. Abramo, D'Angelo, and Di Costa (2011) notes that in the 1980s, research studies began examining the mechanisms for technology transfer and the utilisation of research outcomes. Initially, these studies focused on national innovation systems before shifting in the 1990s towards regional innovation clusters and the Triple Helix Model (Etzkowitz and Leydesdorff 2000; Leydesdorff 2000). It was recognised that these mutually beneficial collaborations might foster innovation through the exchange of knowledge (Al-Tabbaa and Ankrah 2016). As a result, there has been a notable increase in literature focusing on such collaborations particularly within the domain of management research and practice (Hewitt-Dundas 2012; Rybnicek and Königsgruber 2019).

The literature identifies two types of interaction patterns that exist in these collaborations. These are knowledge transfer (Hewitt-Dundas 2012; Rossi et al. 2022; De Silva, Al-Tabbaa, and Pinto 2023) and knowledge co-creation (D'Este and Perkmann 2011; De Silva, Al-Tabbaa, and Pinto 2023). Knowledge transfer is associated with licencing, and selling of Intellectual Property, publications, and patents, whereas knowledge co-creation is linked with engagement-based, joint research projects between academia and non-academic partners (De Silva, Al-Tabbaa, and Pinto 2023).

In the knowledge transfer model, academics create knowledge and businesses receive it, and put it into practice. The defining features of this model are that the objectives are set clearly at the outset, the roles of academic knowledge creator and practice-based knowledge receiver are clear. The knowledge transfer activity tends to be carried out in a linear fashion. In the knowledge co-creation model, objectives may be less clearly defined at the outset and there are no predefined roles such as knowledge creator and receiver, here academics and businesses create new knowledge together. The defining feature here is that it operates in a cyclical manner akin to the AR framework (Barton, Stephens, and Haslett 2009).

While it is understood that knowledge transfer and knowledge co-creation are different in terms of their objectives and practice (Rossi et al. 2022), they are also different in their outcomes. The act of transferring knowledge as a resource (Peteraf 1993), with information passed in one direction, may lead to less ambiguous results compared to the act of co-creating knowledge, which involves entangling two knowledge bases, theoretical and practical, to create fresh insights (Grant and Baden-Fuller 2004; De Silva and Rossi 2018). These insights may themselves require a degree of interpretation. The differences between knowledge transfer and knowledge co-creation resonate with the concepts of single and double loop learning found in Argyris and Schön's Theory of Action (Argyris and Schön 1974), which posits that human agents function as architects of action. Based on this view, each type of interaction pattern offers different learning opportunities. The knowledge transfer model encompasses application of pre-developed knowledge in a linear fashion that results in single loop learning where the outcomes are planned, expected, and generally clear (Lant and Mezias 1992). Whereas the knowledge co-creation model includes experimentation and 'learning in doing' (Lave and Wenger 1991). This leads to double loop learning (Argyris 1977) where the collaboration can deliver outcomes that are transformational, unplanned, or emergent (Greenwood 1998; Argyris and Schön 1974).

As suggested by Argyris (2003), double loop learning brings solutions that do not come from established, pre-existing knowledge. This means the learning can be generated without the certainty of outcomes (Schön and Argyris 1996). Therefore, double loop learning underscores the

incorporation of an additional learning stage to augment knowledge or identify superior problem-solving approaches throughout the learning process (Barr and Tagg 1995; Tagg 2010). Finally, Rossi, Rosli, and Yip (2017) propose that the knowledge co-creation process impacts a surprisingly wide range of stakeholders as unforeseen circumstances and serendipitous events propagate in a 'rippling out' effect.

In conclusion, Table 1 outlines the differences between these two models and presents a useful conceptual framework for our empirical analysis.

2.2. AR as a method for facilitating UICs

UICs and AR are associated by their shared focus on addressing practical problems and applying knowledge to real-life situations. Kurt Lewin (1946) is often referred to as the originator of AR. Lewin and his colleagues applied their knowledge of social psychology in several areas to prove the utility of their ideas in practical settings. AR is an iterative process of inquiry designed to nurture solutions to organisational problems through a collaborative approach that immerses the researcher within the context of what is being researched (Coughlan and Coghlan 2002; Coghlan 2011). Using this iterative process, changes are implemented through AR cycles of diagnosing, planning action, taking action, evaluating action and specifying learning (Susman and Evered 1978; Thornhill, Lewis, and Saunders 1996).

In AR, the theory is generated from a changing social system (i.e. impact in knowledge exchange in UICs) through the researcher acting within the social system (White and Cooper 2022). The act itself is therefore both the mechanism of system change (i.e. impact) and of knowledge generation (Coughlan and Coghlan 2002). According to Rapoport (1970) and Eden and Huxham (1996), AR aims to simultaneously address the immediate practical issues encountered by individuals dealing with a particular problem and contribute to the broader academic objectives of social science. This is achieved through collaborative efforts applied within an agreed ethical framework. AR is, due to its cyclical nature, therefore closely associated with knowledge co-creation in UICs.

2.3. KTP as UIC in practice

The United States and Australia have well-established frameworks to facilitate collaborations between researchers and practitioners that date back over 50 years. European and Japanese models have more recently been developed creating formal frameworks for technology transfer and knowledge exchange, driven by changes in intellectual property ownership laws (Mowery 2011).

One framework employed to enhance the capabilities, capacities, and performance of businesses is the Knowledge Transfer Partnership (KTP) programme, which is offered by the UK government (Mowery 2011). KTPs are frequently utilised in operations management research, as demonstrated by studies such as those conducted by Martin et al. (2008), Rossi, Rosli, and Yip (2017), Wynn and Jones (2017, 2019), and White et al. (2019).

The KTP programme is a public-private collaborative initiative that was launched in 2003, replacing the Teaching Company Scheme formed in 1975 that was itself inspired by the practice-focused Teaching Hospitals concept (Senker and Senker 1997). It is one of several UIC initiatives in the UK sponsored by Innovate UK, an executive non-departmental public body that is part of the Department for Business, Energy & Industrial Strategy. The purpose of the KTP is to facilitate a triple helix of evolving and productive relationships with the goal of accelerating innovation as a mechanism for economic stimulus. The KTP programme facilitates the exchange of knowledge and the spread of technical and business skills and to stimulate and enhance business-

Table 1. Comparison of knowledge transfer and knowledge co-creation models.

Themes	Knowledge transfer	Knowledge co-creation
Business Challenge	• Clearly defined at the outset with distinctive objectives set.	• Complex and sometimes ambiguous at the outset with indistinct or no objectives set.

Roles and responsibilities	• Academics bring:
	  • theoretical knowledge
	  • knowledge of the problem-solving process
		• Academics bring:
		  • theoretical knowledge
		  • knowledge of the problem-solving process

	• Practitioners bring:
	  • tacit knowledge of the challenge
	  • domain knowledge
		• Practitioners bring:
		  • tacit knowledge of the challenge
		  • domain knowledge

	• The practitioner explains the challenge to the academic and the academic facilitates the linear process of problem solving while disseminating knowledge as a resource to the practitioner who implements it as a solution.	• The practitioner and the academic work together on defining the challenge before agreeing the cyclical process of problem solving. They then pursue a shared knowledge-building and solutionising approach.
Relationships	• Low levels of engagement and mainly transactional.	• High levels of engagement and very collaborative.
Knowledge Flows	• Linear knowledge flows. • Low complexity and unidirectional.	• Cyclical knowledge flows. • High complexity and bidirectional.
Outcomes	• Less complicated business challenge is addressed. • Established knowledge is conveyed from academics to practitioners. • Practitioner is more knowledgeable. • Redefining the proven knowledge that brings incremental change. • Single loop learning	• Complex challenge is addressed. • Practitioner and academic are more knowledgeable. • New knowledge is transformational. • New knowledge created that contributes to both practice and theory. • Double or multi loop learning

relevant and innovative research and training (Innovate UK 2023). To meet this objective each individual KTP project integrates agents from academia, government, and practice to form a team that operates within a structured framework to tackle a pre-determined industry problem, the solution of which is novel and of interest to all involved partners.

While initiated in the UK, the KTP programme has seen some international expansion with Sweden adopting the model (Innovate UK 2019) and more recently an expansion using African partner universities aimed at stimulating the African agricultural sector in Ghana, Nigeria, Kenya, and South Africa (UK Government 2023). At the outset, the KTP programme was focused on science and engineering. However, more recently, due mainly to its perceived economic success, the programme has seen generous increases in government funding (Innovate UK 2023) and an accompanying widening in scope with increasing numbers of KTPs initiated to tackle managerial and business-related problems in areas such as process or organisational innovation, operations management, and business improvement (i.e. management KTPs - mKTPs).

While all KTP projects are unique in their objectives, activities, and their outcomes, each is set up in the same way with an initial business challenge identified and associated objectives defined both industrially to lead to an economic, social, or environmental benefit and academically to lead to a contribution to knowledge. Each KTP has a core team comprising; an academic from a University named the knowledge base supervisor who contributes academic knowledge of the subject and of the research process; a practitioner from the company named the company supervisor who contributes tacit knowledge of the process and domain knowledge of the company; a KTP associate who is the embedded change agent; and a KTP advisor and admin support staff, the government representatives who implement the governance processes and ensures the integrity of the overall programme. These roles are complemented by other academics and company/industry representatives as required by the individual KTP project.

Therefore, the UK government's KTP programme is aimed at meeting the twin aims of developing new knowledge in a rigorous way that is both academically novel and practically relevant and is a useful vehicle to facilitate UIC and deploy AR. While other research has reported success in meeting these aims (Inns, Baxter, and Murphy 2006; Manville et al. 2019), the detail of how this was done remains under-researched. Therefore, the purpose of this study is to investigate how AR is enacted within KTPs to characterise the patterns of interaction between academics and practitioners for new knowledge generation that take place while ensuring its rigorous application.

3. Methods

This study adopts a multiple case study method (Eisenhardt and Graebner 2007; Yin 2009). Using an inductive approach (Glaser and Strauss., 2017), we have purposefully selected three illustrative case studies. We sampled organisations by applying two criteria: first, we focused on cases that were formally defined as KTP projects and second, these KTPs must address challenges in the management of the business operations.

To ensure consistency within our dataset, the case studies shared common characteristics. Specifically, all projects were led by the authors as academic supervisors within the KTP, each lasting a duration of two years. Each organisation was engaged in a KTP project with the same university located in Scotland. All members of the academic team had a background and expertise in operations and strategic technology management. All KTPs had the same KTP Advisor and employed a full-time KTP associate who worked on the project throughout the research period. All KTPs were perceived as successful, as indicated by high ratings (outstanding or very good) as assessed on completion by the funding body, Innovate UK.

Primary data was collected through direct observations, semi-structured interviews and project meetings that included local management committee meetings (LMCs) that took place every three to four months during each project. The KTP Associate was present in the company on a full-time basis. The team also had weekly meetings in the company premises to enact the AR cycles. Extensive field notes were taken and formal KTP reports were produced.

The empirical data gathered was analysed using qualitative techniques such as thematic analysis (Braun and Clarke 2013), and pattern searching across cases (Ketokivi and Choi 2014). Through research group discussions and retrospective observations, a consistent understanding of interaction patterns between academics and practitioners was built into a narrative.

4. Findings

Here, we will present each case study using the same structured approach. First, we will explain the practitioner's objective (business challenge), followed by providing details about the AR cycles (KTP project). We highlight the typology of benefits of applying AR in the Outcome section by dividing these benefits into academic outcomes (theoretical novelty) as well as planned and emergent outcomes for practice (impact). In doing so, we analyse the roles and responsibilities within the research team including researchers and practitioners while enacting AR to generate rigorous knowledge with practical relevance.

4.1. KTP a – FlowCo

4.1.1. Business challenge

FlowCo had built a strong reputation in providing gas measurement equipment to various clients in the oil & gas, food & drinks, and chemical industries. However, with technology changing and cost pressure increasing it needed to find a way to grow the business by offering new products and services. FlowCo faced various operational issues including operational process control issues and lack of expertise in the latest technology.

The key business challenge was to transition the business from an equipment supplier, in their terms a 'box shifter', to a high-value, technologically advanced gas measurement and data-focused enterprise. FlowCo's vision was to be at the forefront of technology in relation to data gathering, management and distribution in all its selected markets for process measurement applications. Therefore, the aim of this KTP at the outset was to develop the technological and operational capability to allow FlowCo to transition from selling hardware-based measurement products to offering software-based data and information solutions.

4.1.2. Project

This KTP began with diagnosis and direction-setting. A series of workshops were held over a 3-month period with the aim of defining the vision and objectives. This cycle included explicitly revisiting the purpose defined in the KTP application document, clarifying the situation, and sharing assumptions about the business challenge.

Then, a series of AR cycles were implemented that focused on explicitly building the new business model, defining the characteristics of the service solution, and designing the nature of the operational changes to be implemented. Throughout the project, senior management, including the business owner, were involved in shaping strategic direction and other members of the management team were involved discussing the operational issues.

During the later stages of the KTP, the operational processes were reworked, and a new Enterprise Resource Planning (ERP) system planned. Finally, the project was completed using a cycle of collaborative evaluation and reflection including intended and unintended outcomes and lessons learned.

4.1.3. Outcome

4.1.3.1. Planned practice-based outcome. FlowCo developed a new digital measurement platform that communicates with a cloud-based application which allows flow data to be gathered, displayed, and analysed in real time by the client. The organisation was redesigned to accommodate this business model and service delivery processes developed that allowed it to install digital process measurement equipment.

4.1.3.2. Emergent practice-based outcome. To support this servitised solution, the KTP also delivered enhanced management capability in two ways. First, it now operates within a product lifecycle model and uses project management to control the more complex solutions that it now delivers. And second it has built a software engineering capability which is now being used to develop other capabilities within the business. These capabilities were beyond those envisaged at the beginning of the KTP.

With these changes FlowCo began to expand their business in new sectors with new clients for this digitally servitised solution. For example, the Covid-19 pandemic highlighted several issues with the management of healthcare within the NHS (National Health Service in the UK). One of these issues was the discovery of deficiencies in how oxygen systems within hospitals were monitored in relation to capacity and flowrate. FlowCo installed a data solution within several hospitals across the country that allows clinicians to monitor the supply of oxygen to critical care wards in real-time. Additionally, their digital solution is now being used within water supply systems for domestic and commercial properties, where improved information provision will be a critical part of the drive towards improved water management and will therefore contribute to the sustainability agenda.

4.1.3.3. Academic outcome. The academic outcome was a contribution to the emerging body of literature which explores digital servitisation (Coreynen, Matthyssens, and Van Bockhaven 2017). This case study allowed the characterisation of the dynamics of change as this product-based company with a narrow industry focus transformed into a digital service provider with a more holistic ecosystems focus. It allowed the characterisation of ecosystems as nested systems of use where a hierarchy of servitised solutions can be implemented to resolve organisational problems.

4.2. KTP B – WaterCo

4.2.1. Business challenge

WaterCo had positioned itself as an own label manufacturer mainly supplying major supermarket chains. However, it was under constant pressure to cut costs that negatively affected the company's profitability and left little surplus to make investments for growth. WaterCo faced various operational issues including poor performance in its supply chain, lack of production capacity, and outdated operational control systems.

The key business challenge was to grow the business in a sustainable way and to address the key operational issues that were limiting growth. WaterCo's vision was to become the No 1 supplier of bottled water in the UK. Therefore, the aim of the KTP at the outset was to re-engineer the supply chain process through the implementation of a customised and integrated ERP solution.

4.2.2. Project

AR cycles started off with discussions between the academic lead and the senior management to identify the growth ambitions and the priorities based on the learning from the past. The management team was active in the project by reinforcing the project objectives throughout the organisation.

In this case study, there are AR cycles at two levels, macro, and micro levels. At a macro level, the overall trajectory of the company was reviewed, and decisions were made as to the key interventions necessary to move the company one step closer to its overall goal. This AR cycle was done collaboratively between the researchers and practitioners and was guided by the initial KTP proposal and the LMC meetings.

At a micro level, the KTP project focused on the delivery of one intervention at a time. As an example, the first intervention was to review and streamline all supply chain management processes including sales and operations planning, procurement, production planning and scheduling, materials management, finished goods warehouse management, logistics and customer service. Hence, this AR cycle included all critical business processes being mapped and analysed. Subsequent AR cycles created an integrated set of processes, selected, and implemented an ERP system to standardise, automate and further streamline these processes. To make this new system long-lasting and successful, the academic team delivered training on business process thinking and ERP system to all users in the company. They were also integral in the co-creation of innovations with the ERP system (further discussed under emergent outcomes below) that differentiated the company from its competitors.

4.2.3. Outcome

4.2.3.1. Planned practice-based outcome. WaterCo was transformed with reengineered operational processes and ICT systems which allowed- it to operate in a more integrated way both internally and externally within its supply chain. With improved supply chain management capability and increased production capacities, the company started to make new investment to improve its manufacturing facilities as well as acquiring new brands for growing the business. As the employees were included in this change process, process thinking become embedded in the organisation. Hence, the KTP significantly improved the business sustainability, enabling the company to invest in growth and building a strong brand.

4.2.3.2. Emergent practice-based outcome. Throughout the project it emerged that buying and implementing an off-the-shelf ERP system was only going to make the company as good as other companies with the same or similar ERP systems. In order to differentiate itself, WaterCo had to do something more innovative with its newly acquired ERP system. The KTP Associate employed as part of the KTP programme became central to development of innovative customised solutions that exploited the capabilities of the new system by integrating the deep operational knowledge which already existed within the business with the software capabilities and innovative ideas emerging from the team. These innovations allowed it to differentiate itself operationally from its competitors, securing significant new business that enabled it to make investments for further growth.

4.2.3.3. Academic outcome. There were two clear academic outcomes that emerged from this KTP project. First, related to management of change (Bititci 2015). Essentially any improvement project competes with the day-job for people's time. If you have two or more improvement projects at the same time, they compete with each other and also with the day-job, thus by focusing on only one-change project at a time, strategic change can be implemented faster and more effectively (Bititci 2015). The second academic outcome related to design and use of performance measurement data available from the new ERP systems and specifically the organisation of performance information to facilitate workforce engagement in the organisational performance narrative (Bititci et al. 2006).

4.3. KTP C – CleanCo

4.3.1. Business challenge

CleanCo had built a strong presence in the supply of reusable laundry products to the hospitality and tourism industry. However, while outsourced laundry service provision was for many years ignored as an 'invisible' operation, it is now viewed as vital to a hospitality provider's success. Additionally, with the recent rise of the sustainability agenda, inefficient provision of laundry services has not only negatively impact on business performance, but it also has negatively impact on the environment due to material waste and resource consumption. CleanCo faced various operational issues including cost pressure, stock losses and increased quality and sustainability requirements.

The key business challenge was therefore to import the latest technological solutions into this traditionally low-tech business in order to increase efficiency and effectivity. CleanCo's vision was to be the most efficient, highest quality and most sustainable and dependable supplier of laundry services.

The aim of this KTP at the outset was to improve service capability through digital transformation by using radio frequency identification (RFID) technology. The data produced by this system will help CleanCo to understand product flows better and provide industry leading levels of service.

4.3.2. Project

This KTP began with diagnosis and direction-setting in the first AR cycle. This was done with a series of strategy workshops facilitated by the academics. The practitioners were active in creating a story about their journey so far and in developing the future vision. CleanCo had previously attempted to build an RFID capability with only internal resource and had made little progress. The core senior management team had learned from this experience, and this was shared with the academic team.

Subsequently, the research had three AR cycles following the process of digital transformation: (1) Digitisation – implementing new technology (i.e. RFID) in the pilot factory, (2) Digitalisation – creating new knowledge and opportunities in the market, and (3) Digital Transformation – restructuring business and creating an enhanced value proposition to achieve competitive advantage.

Throughout the project, the CEO played an active role in shaping the KTP project with contributions to vision and strategy and the wider company team contributed with operational and domain knowledge of customer and community. The KTP associate ensured the changes were implemented, optimising the new system in collaboration with

ecosystem partners such as large hotel chains, suppliers, retailers, industry associations and technology providers. The knowledge base supervisors ensured that the latest models and concepts were considered and facilitated the learning and reflection process.

Using the structured two-year iterative process, the team worked on building the custom digital solution to allow CleanCo to keep track of its luxury textile products and use the data it generates to inform decision making at all points in the supply chain. Through the AR cycles, CleanCo have recognised the potential of this technology and the new operational models that it makes possible.

4.3.3. Outcome

4.3.3.1. Planned practice-based outcome. Clean Co successfully piloted and implemented the technology to enhance the current service offering with enhanced asset tracking capability, providing real-time visibility of high volumes of reusable stock. This has transformed the company's financial and operational performance.

4.3.3.2. Emergent practice-based outcome. The project also provided new opportunities for CleanCo. Using the current capability, data transparency and integrity allowed a closer relationship to be forged between the company and its customers. Their capability was extended to provide a lower volume model that would allow services to be offered to other types of customers such as Airbnb hosts, and boutique, and niche hotels. This would allow the benefits of economies of scale to be applied to a smaller-scale operation. This RFID tracking system could be extended to the laundry sector and used by hotels to track other high value assets such as electrical appliances in hotel rooms. Further, this KTP has resulted in positive environmental benefits by reducing process waste and rework and enhancing product recyclability. The operational system change has eliminated the necessity for plastic wrapping around clean linens, and the integration of RFID chips enables the monitoring of each garment's wear lifecycle, thereby minimising waste, and rework.

4.3.3.3. Academic outcome. The academic outcome was a better understanding of the dynamics of digital transformation in a traditionally low-tech industry, i.e. large scale laundry services. The study highlighted the salience of ecosystem readiness (Adner and Kapoor 2016), management of optimised big data and human aspects to make digital transformation happen. Next, we will present broader discussion of the findings across cases.

4.4. Cross-case analysis

The cases were analysed in relation to the five themes listed in Table 1. Cross-case analysis was carried out in two stages: pre-project (funding application) stage and project (live) stage.

4.4.1. Pre-project stage

Here, all KTP projects follow the same process as the application system is defined by the funding body, Innovate UK. This initial stage of building the application for KTP funding itself represents a simple form of knowledge transfer. All KTP projects are initiated when a company identifies a business challenge that they are facing and decide that they need help to address this challenge. The company is then matched with an academic team, and this might happen formally with the company approaching Innovate UK or a University, or informally through interpersonal or interorganisational networking activity.

As a result, practitioners, and academic team work collaboratively to define the challenge in more detail. The purpose of this pre-project stage is to characterise the business challenge in enough detail to allow the application for the KTP project to be written. At this stage while the business challenge may be complex, it must be defined as a set of clear and unambiguous objectives and a costed plan must be produced to address it. This plan is typically written as a linear activity sequence. At this stage, roles and relationships are clearly set by the KTP framework. Initially knowledge flows are expected to be linear with academic knowledge flowing from the academic team and practice/domain knowledge from the practitioner team. Expected outcomes are predicted and captured in relation to the stated objectives.

At this stage the key consideration is clarity. A clear understanding must be communicated to the KTP selection board to ensure they are equipped with the knowledge to decide on the validity and efficacy of the application as it is a critical part of the process of maintaining integrity in allocation of public funds.

The knowledge transfer at this stage includes the following activity. Explanation of the business challenge by practitioners to gain a shared understanding of it, the offering of some potential solutions by the academics to ensure that the knowledge base they have is relevant, generation of a plan to deal with the challenge and writing the application which is done in collaboration with the KTP adviser and the KTP admin staff. In all case study KTPs, the knowledge flows in this early stage were linear with each participant remaining within the roles and relationships defined by the KTP framework.

4.4.2. KTP project stage

On acceptance of the KTP project by Innovate UK work can begin. All three of our case study KTPs began by revisiting the plan included in the application. It is important to note that due to the timescales involved in the application assessment and Associate recruitment processes, as much as nine months may pass between submission of application and start of work.

In this initial stage, all KTPs reviewed the work as set out in the plan contained in their applications. This comprised an AR cycle where diagnosing meant revisiting the business challenge to gain a deeper understanding of the issue and of the changes that may have occurred since the writing of the application. Action planning included analysing the

validity of the content of the application, action taking involved revising the planning information, the integrity of the plan was then evaluated, and the learning recorded. Within all our case studies this cycle of AR built upon, but did not substantially change, the nature of the original objectives set. The changes included planning revisions to deal with how the business challenge had evolved over time. With a more current understanding of the situation gained, all case study KTPs then proceeded with their revised plans.

The KTP process incudes a mechanism for monitoring and reviewing progress termed the Local Management Committee (LMC) meeting. In all cases the LMC became the mechanism that punctuated the AR cycles providing a forum to evaluate what was achieved in the previous cycle, what was learned from it and what the next cycle would be. On completion of this cycle, subsequent cycles of AR were undertaken with durations of between three and four months beginning and ending with an LMC. As AR cycles progressed, several notable common themes emerged across the KTP projects.

4.4.2.1. Business challenge. As each AR cycle was undertaken the business challenge was revisited and while in all three cases it remained largely unchanged, greater understanding was gained as the complex nature of each challenge was slowly revealed. For example, in FlowCo it became clear that the deployment of the new digital product required a larger operational change beyond that initially envisaged. It was realised that an organisational redesign was needed including revisions to roles, responsibilities, and culture. Then later it was decided that a new ERP system would be required to fully exploit the potential of the new product.

In WaterCo, the first AR cycle resulted in the realisation that operating with an own-label product business model was not sustainable. This AR cycle involved a study of all the strategic options by the academic team and identification of the need for the company to build its future around its own brand to become #1 bottled water supplier in the UK. This led to identification of several constraints with the primary one being the companies end-to-end supply chain performance, which became the focus of the KTP project.

In CleanCo two things emerged; first, that the use of the RFID system would require a culture change within both CleanCo and the wider supply chain; and second, that implementation of an RFID system would create an opportunity to build a new business model for use within previously unexplored, new market segments.

While the nature of the business challenge is different in each KTP, the depth of understanding and consequent realisations only happened as the result of the cyclical nature of the AR process.

4.4.2.2. Roles and responsibilities. As each AR cycle played out, participant interaction became more fluid with role boundaries becoming less defined and responsibilities increasingly became shared. The facilitator of this change was the KTP Associate, part of this role is to work on the business challenge and part is to facilitate knowledge exchange. In all three cases, the Associate became expert in both the practice/domain knowledge bases and the academic knowledge base. Additionally, the Associates were critical to developing the solutions necessary which were the result of the combination of practice and academic knowledge.

For example, in FlowCo the Associate very quickly engaged with the engineering teams and became expert in the 'hands-on' installation work as well as the software design and business process reengineering work that was initially scoped as part of the KTP. This brought the academic team much closer to the business. Additionally, the Associate engaged with the academic knowledge bases including digital servitisation and business ecosystems which brought the practitioners within FlowCo closer to academia.

Within WaterCo the Associate was appointed to develop the operations and management aspects of the business. These roles were more intertwined as key business processes such as sales and operations planning often crossed functional boundaries. In this context, the Associate engaged with the functional teams and quickly became an expert in understanding the end-to-end business processes and the inefficiencies within these processes. These insights enabled them to work closely between the functional teams, the engineers from ERP system supplier as well as the academic team to develop innovative solutions that served to differentiate the company from its competitors. This dynamic allowed the academic team to observe and theorise the academic contributions identified above.

While in CleanCo the Associate became expert in the working of the industrial laundry as well as the RFID technology, as well as the decision support systems using the Microsoft BI, and the business process reengineering work required to support it. This proved invaluable as it highlighted gaps in the knowledge held by the practitioners within the KTP team and allowed the academic team to appreciate the nuances of the operational system that they were transforming.

4.4.2.3. Relationships and knowledge flows. Thirdly, because of the ongoing evolution of the business challenges and the merging of the roles and responsibilities, the nature of the knowledge flows changed within each KTP. This is most clearly seen by comparing the nature of the initial collaboration within the application phase, with no Associate and short-term relationships between academics and practitioners and the later stages where the Associate was well established, and trust between participants had been built.

While bilateral flows were a characteristic throughout the engagement with, in the application stage practitioners explaining the nature of the business and its challenge and the academics considering possible solutions, two changes emerged as the KTPs progressed. First, the content of the knowledge flow became much more fluid as both academics and practitioners began to gain an understanding and appreciation of the other's knowledge, the informal protocol

governing who could contribute what dissolved. And second, the frequency of the flows increased as academics and practitioners began to interact in a more informal and fluid way. Here, a form of resonance was achieved, and this speeded up the rate of interaction and increased the productivity of the KTP.

Finally, as a result of the merging of roles, the tightening of highly collaborative relationships and more frequent and fluid knowledge flows it became clear that knowledge transfer had given way to knowledge co-creation with single loop learning being replaced by double loop and even multi loop learning through feedback from each AR cycle. The teams in each case study were working together on not only dealing with the initial business challenge that had been set but on building wider understandings that unearthed further opportunities for the business while simultaneously pushing the boundary of knowledge in the respective academic areas.

4.4.2.4. Outcomes. As each KTP progressed to completion, the outcomes were assessed. While each KTP had achieved the objectives initially set, more significantly, each KTP has also gone beyond these through double loop learning. For instance, FlowCo had realised that competitive advantage might be gained by reconfiguration of their operational processes and upgrade of their ERP system to better support their new business model and had discovered novel applications within new markets for their new digital data service. WaterCo had identified how best to manage transformation by implementing one significant project at a time. Furthermore, they leveraged the capabilities offered by the new ERP systems to develop simple, visual, and interactive performance dashboards, which enabled them to engage people in a conversation about performance of the organisation to have a shared understanding. Moreover, CleanCo had revised their understanding of how their supply chains should be configured through digital transformation and developed a more sophisticated business model that facilitated the deployment of their RFID enabled service within new markets.

In conclusion, to capture our analysis, we offer a conceptual framework as presented in Figure 1. We identified two primary dimensions which characterise the progression in KTP as a UIC in practice, these are type of learning, single loop, double loop or multi loop, and type of knowledge exchange, transfer or co-creation. We identified the main differences between the linear and collaborative entanglement models based on the experience from three case studies. Figure 1 models the new view of AR from 'knowledge transfer' to 'co-creation' as the AR cycles evolve, the academic-practitioner role boundaries become increasingly blurred and more fluid. Next, we will discuss our empirical findings by revisiting the literature.

5. Discussion

AR encourages a collaborative investigation, characterised by participative research 'with' organisations and individuals rather than 'on' them (Erro-Garcés and Alfaro-Tanco 2020). As outlined by Heron and Reason (2006), it ultimately integrates the roles of the researcher and the practitioner. Therefore, from this perspective AR is as much about the socialisation of participants who take part in the research as it is about the process of doing the research. The findings gained from our case study KTPs resonate with this view and reveal several interesting points both about the KTP programme and about the practical use of AR within it as a mechanism to deliver useful and impactful UICs.

First, it is worth noting that this research indicates a departure from the KTP's apparent titular presumption of straightforward knowledge transfer from academia to businesses. Adopting the term 'transfer' is linguistic necessity as a labelling device, but it is also partially representative of the mode of activity at the outset. While it is true that the application stage of KTP projects is characterised as one-way knowledge transfer, it is also true that some collaborative activity is required. Practitioners and academics must gain a degree of familiarity with the other's knowledge base to allow effective matching to take place for knowledge exchange. While at this stage relationships are new, some cognitive proximity (De Silva, Al-Tabbaa, and Pinto 2023) is required to ensure enough of an understanding of the business challenge is reached to allow a useful partnership. A successful collaboration at this point is defined by the development of a clear business challenge and plan to resolve it that can be communicated to the reviewers who award the funding.

However, after award of funding, the flexibility inherent in the KTP programme, due to the light touch governance and the LMC meeting system, coupled with the willingness of those involved, provides the environment that facilitates the AR process. So, from this point instead of a linear problem-solving process with mainly unilateral knowledge flows that transfer knowledge from academic to practitioner, what unfolds is a spiral process using AR cycles to foster stronger relationships and more effective collaboration. This collaborative effort became more pronounced in each project as time passed, engagement became more meaningful, and relationships deepened. The critical factor in facilitating this was in all cases the KTP Associate, as these change agents became embedded in their roles, they facilitated greater cognitive proximity within the teams.

As the AR cycles progressed, knowledge transfer was replaced by knowledge co-creation with practitioner and academic contributing jointly to the process (Rossi et al. 2022). Initially knowledge generation was characterised by greater understanding of the business challenge which in all three cases required wider analysis of the business environment in relation to the dynamics of the market and the changing nature of technology. In particular, the challenges FlowCo and CleanCo faced, now operating in the digital servitisation space, were not easily solvable using current knowledge.

Second, we found that there were two types of learning evident in these case studies: single loop learning and double loop learning (Schön and Argyris 1996; Argyris 2003). Single loop learning is commonly observed in linear model of knowledge generation in AR, where pre-developed

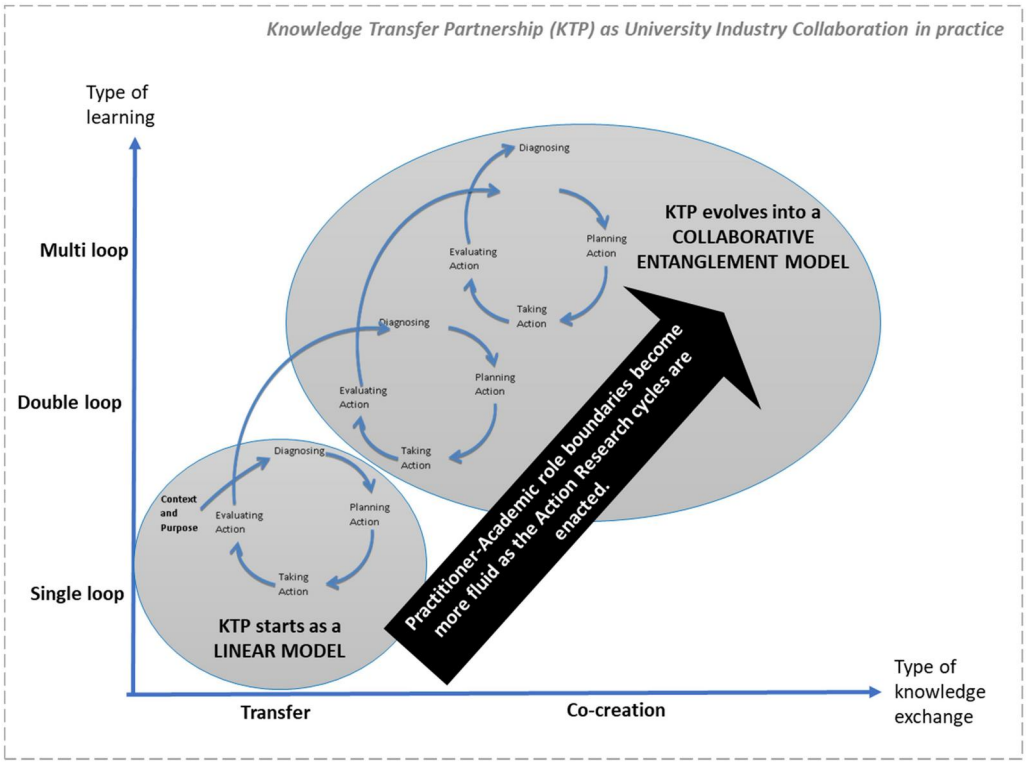

Figure 1. Interaction patterns.

knowledge is applied in practice and learning is derived from implementation of that knowledge. Single loop learning and its contribution to collaborative knowledge enhancement is limited as it only applies what was already known and planned (Blackman, Connelly, and Henderson 2004).

Schön and Argyris (1996) proposed the concept of double loop learning as a means of enhancing knowledge development in more complex situations. They observed that many organisations engage in single loop learning, which fails to address the underlying factors that shape strategic change and transformation. Consequently, they advocate for double loop learning, which encourages a process of inquiry that challenges underlying assumptions. This approach facilitates the emergence of new insights and knowledge.

Double loop learning has been identified previously within KTP projects. For example, Martin et al. (2008) studied the implementation of electronic supply chain solutions to enhance the quality of information within a manufacturing company. The team applied their knowledge, and this resulted in single loop learning regarding faster order fulfilment process implementation. However, this KTP project also delivered emergent double loop learning by finding that product pricing should also be connected to a comprehensive database containing materials, product details and pricing information.

Additionally, Manville et al. (2019) studied the implementation of balanced scorecard approach in small and medium enterprises (SMEs) within a KTP project. This research delivered single loop learning (Lant and Mezias 1992) in relation to the implementation of a balanced scorecard within SMEs. It also generated double loop learning by highlighting the salience of establishing pertinent knowledge infrastructures and fostering the interpretation of information from diverse viewpoints.

We observed similar patterns in our case studies. For example, in FlowCo, the potential to use a revised ERP system as a source of competitive advantage and the need for a new organisational design to facilitate the new business model emerged as the KTP progressed. These insights were not known or expected at the outset of the KTP. Instead, they surfaced and evolved via double loop learning as the AR cycles progressed.

We also argue that learning from experience, challenging established assumptions and going through multiple AR cycles may facilitate multi loop learning for managing effective change and transformation. In WaterCo, the KTP initially set out to develop a new service to be added to the current offerings and to reconfigure the existing business processes to deliver it. However, as the KTP progressed the team began to question the initial assumptions upon which the KTP was based. It became apparent that the entire business model needed to change. Instead of the new service being delivered as an add-on to the previous offerings, it became clear that the new service should form the basis of the new business model and all other offerings should be positioned in relation to it. Eventually, this meant the implementation of a new ERP system and a redesign of the organisational structure. Lastly, within CleanCo, it emerged that to optimise the use of the new RFID technology, a deeper change was required in relation to how the entire supply chain operated, but more significantly, insights identifying opportunities to improve sustainability of the entire operation also emerged.

5.1. Contribution to theory

From the academic perspective, we have identified the factors that should be present to achieve effective AR and contributed a model that characterises the interaction patterns that can take place to create the potential for rigorous generation of knowledge that is academically novel and at the same time is practically relevant.

Knowledge exchange encompasses the wide range of activities universities undertake with non-academic partners (UKRI England 2023; De Silva, Al-Tabbaa, and Pinto 2023). We identified that knowledge transfer and knowledge co-creation can be considered as subsets of the broader concept of knowledge exchange. Knowledge transfer is a one-way, purposeful transfer of knowledge whereas Knowledge co-creation is interactive and about unplanned emergence and discovery of new knowledge arising from a collaborative project.

Figure 1 therefore suggests two broad interaction patterns between action researchers and practitioners. We labelled these interaction patterns as 1) *the Linear Model* which is characterised by knowledge transfer and single loop learning and 2) *the Collaborative Entanglement Model* that is underpinned by knowledge co-creation and double or multi loop learning.

The Linear Model includes transferring established knowledge as a resource from a producer (university) to a receiver (industry) via mainly unidirectional knowledge flows. This process may follow a single AR cycle and results in single loop learning. For example, all our KTP projects identified changes within the organisations to improve efficiency and effectiveness through planned learning early in the proposal stages. However, the Collaborative Entanglement Model involves co-developing solutions to business challenges where both researchers and practitioners play an active role via deeper engagement and cyclic, iterative, and mainly bidirectional knowledge flows (D'Este and Perkmann 2011; Mejia-Villa and Alfaro-Tanco 2017). Knowledge co-creation requires a more collaborative approach since in these circumstances neither academic nor practitioner would be able to generate knowledge individually (Etzkowitz and Leydesdorff 2000). Hence, knowledge co-creation requires an engagement-based view (Fini and Toschi 2016; Balven et al. 2018).

5.2. Contribution to policy and practice

From the perspective of industry and government, our research suggests that defining precise outcomes at a KTP project's outset and assuming a linear model with a clear set of objectives and a step-by-step project plan might not always be feasible as business challenges are often too complex to be fully characterised. Only by approaching these collaboratively as a series of AR cycles can the full extent of the challenge be uncovered, and the solutions be found. In doing so, we found that both intended and unintended outcomes, lessons learned, and new knowledge emerged from the AR projects.

Second, our research suggests that as the AR cycles progressed in KTPs, knowledge transfer was replaced by knowledge co-creation with practitioners and academics contributing jointly to the process. Recognising this evaluation will enable better use of knowledge, technology and skills within the UK knowledge base including the practitioner communities to solve specific strategic innovation challenges businesses face. Based on this argument, we suggest that KTP programme can be better represented as Knowledge Transfer and Co-creation Partnerships.

6. Conclusions

Since Bamberger and Schön (1983) proposed that practitioners have the capacity and capability to contribute to the development of new knowledge, work has been ongoing to determine if it is possible to carry out collaborative research that contributes theoretical knowledge that is practically relevant. Our study sought to investigate this question by studying the use of AR within UICs facilitated by the UK governments KTP programme. Three KTP projects were used as case studies in this research and cross case analysis was carried out.

We conclude that AR is a useful method for simultaneously solving complex challenges in organisations and providing the potential for generating novel academic insight. The cyclical and iterative nature of AR creates the time and space for the reflexivity (Bamberger and Schön 1983; Ripamonti et al. 2016) that brings new knowledge. However, for AR to be successful in both these endeavours, there are critical factors that must also be present.

As an antecedent the challenge to be researched must be complex enough to require insight beyond what is known at present. The exploration of this complexity is itself a critical part of the AR as it provides the foundation upon which new knowledge can be built. Then during the AR, the interaction patterns which play out between participants are crucial. First, academics and practitioners must both bring relevant knowledge, and this knowledge must be considered of equal value. Then, the roles adopted by both sets of participants must be fluid enough to move beyond the traditional academic as transmitter and practitioner as receiver and allow this knowledge to be shared. Second, relationships must be strong enough to facilitate close cognitive engagement. The presence of a knowledge facilitator or change agent, here in the form of the KTP Associate, is critical to this. The fluidity of roles, the closeness of relationships and equality of knowledge is critical to creating the entanglement that is needed to allow novel and relevant knowledge co-creation to take place in AR. Finally, both practice-based and academic assumption must be challenged to allow the double or multi loop learning ((Schön and Argyris 1996; Argyris 2003) to take place.

Although our study includes three robust case studies, replicating this study in other KTPs or similar AR projects in various contexts will be useful to examine how AR can be carried out more effectively. Therefore, we suggest that our study has opened the doors to the scholarly community for

further research investigating the use of AR within the operations, business and management domain (Mediavilla, Errasti, and Mendibil 2015; Erro-Garcés and Alfaro-Tanco 2020; Mediavilla, Mendibil, and Bernardos 2021).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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