The X-ray Request: A Sociomaterial Inquiry into the Practices of X-ray Requests and Radiographers

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Declaration

I declare that this work is my own and where citations and acknowledgement to previous work are required, these have been included. The data collected and work undertaken are my own.

Signed,

Mark Widdowfield

Acknowledgements

I'd like to start my thanks with the *many* supervisors that have guided me on this journey. To my current (and final!) supervisory team Prof. John Fulton and Dr. Rekha Elaswarapu, thank you both for picking me up, dusting me off, and allowing me to continue after a considerable hiatus. Your input and sage advice has been invaluable to the development of the work. Thanks to Prof. Sharon Hamilton and Prof. Goisa Cieska for their patience in achieving ethical approval for the project and guiding me at the start of the data collection. Finally, to Prof. Rosemary Rushmer, who saw a kernel of an idea within my proposal and initially agreed to take me on as a PhD student. Thank you all so very much, not just for your guidance in this project, but for your influence upon my own teaching and supervision. It has genuinely been a fantastic learning experience.

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To my mam and brother, thank you for asking about the work and sitting patiently through my explanations, with everything that you have on in your lives, I'm so very grateful to you both. And finally, to my late father; I wish that you were able to share in more of the journey.

Short Note on Chapter Quotations

These quotations are all taken from the writings of Douglas Adams; specifically, *The Hitchhikers Guide to the Galaxy, The Restaurant at the End of the Universe,* and *Dirk Gently's Holistic Detective Agency*. The rationale for their inclusion is nothing more than a bit of fun. Adams appeared to enjoy poking fun at science and philosophy, but always (as it appeared to me) with a wry smile and kindly eye. I hope that you, dear reader, take it in the spirit in which it is meant.

"'I'd far rather be happy than right any day.'

'And are you?'

'No. That's where it all falls down, of course.'"

(Douglas Adams, *The Hitchhiker's Guide to the Galaxy,* 1979).

Abstract

The work of the radiographer is varied within clinical departments and involves organising and examining patients. Without the complex associations between the radiographer, X-ray machines, and X-ray request, none of this activity would take place. This thesis explores the role of the X-ray request in the practices that are used and develop within the radiography department. It utilises Actor-Network Theory as a framework through which to view the concept of noise in decision-making. This work highlights the role of the non-human and their agency in terms of the practices that are used to perform the X-ray examinations of patients.

This work took place within a district general hospital, and the data collection took the form of a focused ethnographic approach. Two weeks of observing radiographers took place within the viewing area of the X-ray department. Documents were also collected from the department; this included posters and the department's technique guide. Semi-structured interviews took place with seven participants. This also led to documentary data collection from other publicly available documents (such as legislation and professional and statutory regulatory body publications) where these were mentioned/used by the participants. Data analysis was performed using reflexive thematic analysis across all data. Documentary data was also subject to appropriate analysis in line with Actor-Network Theory. Actor-Network Theory and the concept of noise in decision making were integrated into the analysis through sensitization to the associations formed and the role of the non-human.

The findings from the research initially focus on the identification of entities that cause noise within the network. Level noise was initially identified as the radiographer being either *examine-focused* or *rule-focused*. This led to the identification of stable-pattern noise within the Actor-Network, contributed by clinical information, space and time, radiographs, referral source, and protocols and documents. These were then analysed as to their impact on the practices that occur in the justification process. A key finding is that noisy actors in the system lead to a series of practices that help maintain the dynamic stability of the assemblage. These practices included bespoke workarounds (*emergent practices* and *knowing-in-practice*), the interaction of the radiographers with other staff and systems (*historical and social practices*), and interactions within the physical environment (*embodied practices*).

These findings have implications in terms of how the practices that take place around the X-ray request can be conceptualised. The X-ray request is a boundary object around which boundary

work takes place. The noisy actors within the Actor-Network lead to practices around this boundary object that are *emergent*, in that they emerge out of the specific conditions of the patient, the contents of the X-ray request, historical and social experiences. These emergent practices indicate that the radiographer acts as practitioner and operator (i.e., justifying and authorising the X-ray exposure) but also as a *proxy-referrer* depending on the specific conditions of the referral. This finding has implications for how this process is performed within departments and how it can feed into education. The final finding relates to the changes in working practices over time, especially in relation to the apparent isolation of the radiographer and the potential effects of this isolation on the practises employed in the department in relation to X-ray requests. The isolation has the potential to impact sharing knowledge and practices, not just about the authorisation/justification of X-ray request, but of wider radiographic practices. This may have implications for the design of the working environment in which radiographers work, to further allow sharing and moderation of practices.

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Chapter 1: Who are Radiographers Anyway?

"He felt that his whole life was some kind of dream and he sometimes wondered whose it was and whether they were enjoying it."

(Douglas Adams, *The Hitchhikers Guide to the Galaxy*, 1979)

This thesis, when boiled down to its simplest context, is focused primarily upon the transfer of information in a specific context; from those who would like an X-ray examination to be performed, to those who undertake such examinations. That information is placed within a 'Request for Radiological Opinion', which is typically shortened to X-ray request, or as it is known colloquially within radiology departments, simply 'the request'. Prior to the widespread digitisation of radiographic practice in the late 2000s, this was a written request for a patient to undergo an X-ray examination, similar in some circumstances to a prescription. This process is now facilitated through electronic means (Royal College of Radiologists (RCR), 2022). This X-ray request is then used by a variety of healthcare professionals depending upon the examination that is being requested. For example, it is used by radiology support staff to ensure that the patient is correctly prepared; radiology nursing staff to pre-assess the patient for specific radiological examinations; by radiographers to ensure that the correct examination and projections are undertaken; and it is used by reporting radiographers and radiologists to provide an appropriate diagnostic assessment of the radiographs (i.e., images) that are produced (Royal College of Radiologists (RCR), 2021).

This chapter aims to introduce the roles performed by radiographers, radiologists, and X-ray requests as they form the basis for the discussions in this thesis. It aims to contextualise the discussions and to introduce the actors and agents (both human and non-human) that form this seemingly simple, but ultimately complex, network. The healthcare environment can be conceptualised as a wide ranging, integrated and relational landscape that is perhaps one of the most contested spaces within organisations. This complexity and contestation stem from the multitude of professionals working within a single space. Therefore, the resultant working relationships both between human beings and other objects are inherently complicated (Idema, 2007; Foronda, MacWilliams and McArthur, 2016). To aid in the communication of the disparate professional groups, organisations such as RCR and the National Institute for Health and Care Excellence (NICE), produce guidelines, protocols, and standard operating procedures in an attempt to control this space. These protocols and guidelines therefore increase the

number of relational aspects to this particular work. The production of guidance also means that, for those whose focus is in managing the healthcare environment, there is a potentially objective, if contested, approach to partially measuring the so-called 'quality' of healthcare services. For example, the interrogation, and assessment, of written policies and procedures by the Care Quality Commission (CQC) (2024) during assessment of health and care providers appears to give credence to the use of these policies and protocols in improving healthcare quality. Whilst protocols and procedures are an important aid in the running of these organisations, they are only efficient if they can be operationalised within the current system. Conversely, these documents can be sites of inefficiency if poorly designed and operationalised for the intended system in which they are to be applied. In the case of the latter, practitioners many find 'workarounds' for the perceived inefficiency (Grey, 2021; Fenwick, 2012).

Within the healthcare space, radiographers are required to make risk/benefit decisions with the use of these types of protocols. This thesis focuses upon the application of these protocols to assess the X-ray request (*Ionising Radiation (Medical Exposure) Regulations (IRMER) 2024*). They are used primarily to make decisions on whether a patient can (or cannot) be examined with ionising (in diagnostic procedures predominately X-ray[1]) radiation and which examination is to be undertaken. This chapter will provide the contextual information that is related to the development of the role of the radiographer, the legislative influence upon that role, and the context of the current working practices of radiographers and how they are perceived by other professionals.

Diagnostic radiographers are a professional group who use ionising radiation to diagnose, manage and treat patients who have been referred to the radiology department for an X-ray examination. Those who refer for X-ray examinations are the patient's current physician or another healthcare professional who is entitled by the X-ray department to do so (*IRMER 2024*). These diagnostic radiographers who undertake the examination are the human focus of this work. The latest statistical release from the diagnostic imaging dataset stated that over 22 million X-ray examinations took place within the NHS in England during 2023-24 (NHS England,

[1] There are contradictions within various style guides and online locations as to whether the X in X-ray should be capitalised. The *Chicago Manual of Style* (2024, 8.152) and *Radiopaedia* (Bell, 2022) advise non-capitalisation. However, *New Hart's Rules: The Oxford Style Guide* (2014) advocates consulting a reputable dictionary when preparing copy. Therefore, the *New Oxford Spelling Dictionary* (2014) was consulted as to the spelling for X-ray (and all other words) with the dominant variant being used. Therefore, X-ray will be used throughout the work.

2024a). This was out of a total of approximately 46 million examinations (if referrals for all radiological examinations such as CT, MRI, ultrasound, etc. are included). The Society of Radiographers (SoR) also estimates that 90% of hospital patients will encounter a radiographer during their stay (SoR, 2021). Yet, the role of the diagnostic radiographer is relatively poorly understood by other health professionals as well as the wider public (Stel, 2018; Lavaerts *et al.*, 2021). Whilst this study does not address these professional misconceptions *per se* it is appropriate to set the contextual information that will provide the background for this study. Therefore, the role of the radiographers within the imaging departments, as well as the other health professionals that work closely with the radiographer within these settings, will be explored in detail.

Before any X-ray examination can be undertaken, the X-ray request is required to undergo the process of justification and, when required, authorisation (*IRMER 2024*). Justification and authorisation are important aspects of the radiographers work and ensures that patients are kept safe from unnecessary exposure to ionising radiation. The radiographer should also ensure that the appropriate radiographs are acquired to aid in the diagnosis and management of the patient. The thesis focuses upon this everyday aspect and analyses the different facets of the decision-making processes, the potential actors that, both human and non-human, may influence the decisions made. There will also be a focus on the interactions that radiographers have with these different actors, the potential sources of noise within the decisions that are made, and the impact of changes in terms of legislation, operationalisation and the potential impact for the conceptualisation of the radiographer's role under that legislation. First, however, a discussion of the human actors within this system of work is required. The role of radiographers, the further development of that role, and their place within the healthcare system will now be outlined.

1.1 Professionals and Professionalisation

The term 'professional' can be seen as a contested sociological term, as what defines a profession (and therefore a professional) can be seen as changing and challenged. The term 'professional' is used in everyday language, generally in a positive frame, to identify those individuals undertaking a paid occupation in which enhanced education and training is required, along a level of autonomy in their actions (Hornby, 2020). It is useful to unpick the development of the term and the professionalisation of working practices that have not traditionally been seen

as being performed by professionals (Watson, 1995). Many perspectives can be used to interrogate what professionals are. Perhaps the most prominent is the 'trait' approach. The focus here is the characterisation of professions in terms of what they do. Flexner (2001; 1915) used a comparative approach when making the case for social work to be acknowledged as a profession; the comparison being to the three traditional Western professions; religious orders, medicine and the law. This type of debate was to echo through the ages, with Millerson discussing a similar approach in the 1960's (Millerson, 1964). These traits of a professional included claiming ownership of specialised 'esoteric' knowledge; self-regulation of members; a specialised code of conduct; and the existence of a professional body.

With the advent of post-modernism, other scholars became critical of this trait approach to classifying what a profession is (and is not) (e.g. Becker, 1971; Bureau and Suquet, 2009; Friedson, 1994). The post-modern approach sees professionalism as an honorific title, bestowed upon an occupational group by society. Abbot (1988) focuses on how society makes the professional, through the integration of professions, and therefore professionals, into society. Whilst this appears to be self-evident, it can lead to a view of professionalisation as one in which different groups/societies can bestow the title of professional. This may lead to the interpretation that the 'profession' is a societal entity in itself, with its own discourse. Therefore, if an individual is accepted as a member of a group, then they are a member of the social group, and therefore a professional. There is of course, a legislative element to this. The *Health Professions Order 2001*, discussed further below, recognises that the titles of Allied Health Professionals are protected. This means that in order to profess oneself a 'radiographer' for example, they must be entered onto the register of professionals (*Health Professions Order 2001*).

The concept of professional socialisation is therefore important to the work that will be conducted here, as the work focuses on knowledge sharing practices both inter- and intra-professionally. Recent literature has identified that a socialisation process may start to occur outside of the profession via media portrayal, previous personal encounters and what peers' experiences have been (MacLellan, Ly and Gingras 2011). This echoes Abbot (1988) and the theory that society makes the professional. It is difficult to see media having a considerable effect on the radiography profession, as generally they do not have a high media profile in the same way that medicine, nursing or even physiotherapy do (when was a radiographer last seen within a TV show for example) (Robson *et al.*, 2015). There is also evidence that medical and

nursing students have different attitudes towards the division of labour and what it means to work in healthcare prior to being socialised/accepted into their respective professional groups (Horsburgh *et al.*, 2006). The implication here is that professional socialisation is inherent within healthcare despite the move towards interprofessional learning within pre-registration curriculum. This interprofessional education may be already trying to change pre-conceived norms and personality traits that are inherent within individuals prior to training; pre-registration students are not perhaps the *tabula rasa* that one may expect (Horsburgh *et al.,* 2001; Visser *et al*., 2017). Indeed, there may be an element of potential individuals self-selecting themselves for each profession, via societal conceptions of that profession, leading to a self-fulfilling prophecy regarding how the profession is conceptualised, how their values develop, and the personality traits required to be received into, and succeed within, in such a profession.

Within this research, professional socialisation allows a starting point in which to view these interprofessional interactions. This will help in understanding the expectations and traditions that inform the socialisation process and shape what happens in practice settings. This may be seen as the first step towards some of the other themes within the literature review, such as challenges for professionals who work in teams, power, and professional boundaries. Professional socialisation may subsequently have an influence on the way that professionals perceive the work that they are doing, how they interact with and discuss their work with other professionals.

1.2 Radiology, Radiologists, Radiography, Radiographers: What is in a name?

Radiology is a branch of medicine that is concerned with the acquisition and interpretation of radiographic images to aid in the diagnosis, treatment, and management of patients' disease. Within the specialism there are primarily three professional groups that provide patient care. These are the medically trained doctors (radiologists), diagnostic radiographers[2], and nurses (radiology nursing) (Lohikoski, Roos, and Suominen, 2019). Regardless of the previous discussions around the designation of professions it may be useful to acknowledge at this point, that radiography perhaps meets both differing professional definitions previously discussed, particularly in terms of societal designation (as radiographer is now a protected title, see below).

[2] Henceforth, the term radiographers will be used to designate diagnostic radiographers. Therapy radiographers will be termed as such.

The radiographers' role is, primarily, to acquire diagnostic radiographic images (which are described as 'an X-ray[3]' by the wider public). Radiographers undertake the technical aspects of the patients X-ray examination (the actual role depends on the nature of the procedure and the modality (e.g., CT) that is used). When the radiographer is working within conventional radiography[4], which is the focus of this thesis, these tasks will include the assessment of the patient for suitability from both a practical and clinical perspective, the exposure of the patient to ionising radiation, the suitability of the resultant radiograph (X-ray) from a technical perspective, and the discharge of the patient back to another professionals care, along with other aspects of the role which may differ from working site to working site (Health and Care Professions Council (HCPC), 2023).

Whilst not forming a focus of this work, it is useful to at this juncture to also discuss the work of radiologists. Their role is, primarily, to interpret these radiographic images. Radiologists are qualified medical doctors who undertake (in the UK at least) five years of specialist training in radiology before sitting their consultant examinations (RCR, 2024). A radiologist's role is seen as looking after the medical aspects of the examination, including (but not limited to) the assessment of the patient from a medical perspective to undergo the examination and the subsequent interpretation of the results. The assessment of the patient is highlighted in the legislation, and this is discussed later as it forms a significant element of this thesis and may be seen as one of a number of spaces where the role of the radiographer and radiologist may overlap.

Over the past 20 years, there has been significant role development across these two professions, to the point at which the previous boundaries of action have, to a certain degree, moved. As medical imaging technology has advanced, so then has the skills required to use these new technologies, and the demand for them. For example, in an effort to 'free-up' radiologists' time for them to interpret the images from these new technologies (e.g. PET/CT[5], MRI[6], etc.) the radiographers' role has developed to allow the interpretation of projection

[3] The terminology generally understood by the public is that they are getting an X-ray rather than an X-ray examination, which is reflected by the various dictionaries (e.g., *Oxford English Dictionary*, 1970; 2023). However, to be scientifically correct, X-rays are a part of the electromagnetic spectrum. What is produced when X-rays interact with a patient and then a receptor is a radiograph or radiographic image.
[4] Conventional radiography is also termed 'protectional radiography' within the literature. This is the typical X-ray examination that most people imagine when they hear of someone having an X-ray. Both terms are used within this thesis to mean this.
[5] Positron Emission Tomography / Computed Tomography.
[6] Magnetic Resonance Imaging.

radiographs, as well as the resultant images from other imaging modalities such as ultrasound and MRI (Hardy and Snaith, 2006). The boundaries have moved, rather than being blurred, as the roles that have subsequently been developed have clearly defined boundaries. For example, the role of the reporting radiographers has seen a shift in the workload from radiologists to reporting radiographers. This shift appears to be more prominent across England than in other areas of the UK and internationally. This shift to reporting radiographers has not been replicated in other Western countries such as Australia and USA. The reality is that changing roles depend upon local clinical requirements (Booth, Henwood and Miller, 2017). This highlights that there is a contextual element to each clinical area. This is important to note in the context of this thesis, as reporting radiographers are also part of the sample population within the current study, bringing a unique UK perspective to the work because of this.

The change in roles, as well as being driven at least in part, by the increase in medical technology available to radiology departments, is also due to the increase in medical imaging referrals. Over the past 30 years there has been a significant increase in patient attendance at radiology departments, with the number of imaging examinations increasing year on year from ~26 million in 1995-6 to >43 million in 2022-3 (NHS England, 2024). This highlights the requirement for new ways of working, new roles, and streamlining of working practices from the mid-1990s to the present day. In part, the streamlining of work systems has led to the widening of roles across healthcare, and important for this context, this is apparent in the radiological division of labour (Thom, 2018). Prior to discussing these changes in roles and workflow, it is pertinent to recognise the impact of legislation within radiology.

1.3 The Legislative Landscape for Radiology

The medical professionals working within the radiology sphere have undergone further training which linked in with their regulation (e.g., achieving fellowship of the Royal College of Radiologists). However, following the high-profile failings across the health and care sector in the 1980s and 1990s from a regulatory perspective (examples include the inquiry into health outcomes for children undergoing heart surgery in Bristol (Dyer, 2001) and the failings at Alder Hey Children's hospital (Royal Liverpool Children's Inquiry, 2001)) the Health Act (1999) aimed to improve patient care and increase regulation across the healthcare provision. Part of this approach was to further regulate both nursing and the professions allied to medicine (as they were then termed). Prior to the Act, and the subsequent statutory instrument, radiographers

and other healthcare professions were managed by a combination of the Council for the Professions Supplementary to Medicine (CPSM) and the various professional bodies themselves. Through the *Health Act 1999* the *Health Professions Order 2001* brought into being the Health and Care Professions Council (HCPC, originally the Health Professions Council) which became, and is still, the single regulatory body for 15 Allied Health Professions including radiography in both its forms (diagnostic and therapeutic). The *Health Professions Order 2001* also provided protection of the titles, meaning that a person cannot legitimately call themselves a radiographer (or physiotherapist, etc.) without fulfilling the standards for entry onto, and remaining on, the register for that profession (HCPC, 2024). Prior to this, the use of the phrase 'state registered radiographer' was used to designate professional registration, as opposed to the occupational title (i.e., radiographer). This means that anyone could call themselves a radiographer, but they would not be able to designate themselves as 'state registered' (*Professions Supplementary to Medicine Act*, *1960*).

The 10 years prior to the move from CPSM to HCPC saw the introduction of the degree as a means of entry into radiography. By 1993 all radiographic qualifications for entry onto the state register were offered at an honour's degree level (Nixon, 2001). There was then a further move of regulatory power from the professional bodies to the national regulator as the standard setting for the individual professional groups now was under the banner of the HCPC. Therefore, the standards of proficiency, education and training, and conduct, performance and ethics were now administered and regulated by a single body, rather than residing within the professional bodies, such as the College of Radiographers (CoR) or the Chartered Society of Physiotherapists (Price, 2009; Payne and Nixon, 2001). This process also meant that there was a move away from the standardised examinations delivered by the professional bodies, to a more autonomous approach of assessment setting, delivered by individual higher education institutions who were approved by the regulator as providers of education (HCPC, 2017).

As the standards of proficiency for radiographers makes clear, radiographers work within specific legislation (over and above the usual workplace legislation such as *Health and Safety at Work Act 1974*). Both the standards of proficiency and the wider statutory instruments result in regulation of the work that is being undertaken within the radiology departments across England (and, to certain degree, the wider UK). The HCPC standards integrate the knowledge and skills required to use the legislation that governs the work as a radiographer (HCPC, 2023; 2.12, 2.13). The two that form the focus of the discussions, and the work investigated through this

thesis, are the *Ionising Radiation (Medical Exposure) Regulations 2017; 2024* (*IRMER 2017; 2024*) and the *Ionising Radiations Regulations 2017* (IRR). Between these two instruments, they provide the framework that govern the exposure of patients, carers (*IRMER 2017; 2024*), staff and the public (*IRR 2017*), in an attempt to ensure that no person is unnecessarily exposed to ionising radiation and those that are exposed either receive a benefit from that exposure (in terms of patients) or that they are adequately protected. Not all professions are aware of the dangers of ionising X-ray radiation, or for that matter the various regulations that govern its use and need to be adhered to (Williams, Widdowfield and Cosson, 2015). The isolation of radiographers (only working with other healthcare professions directly in specific circumstances, such as theatre work or portable examinations on a ward) adds to the challenge of effective communication and collaboration with other professions (Strudwick and Day, 2014) and ultimately an understanding of the role.

Whilst the standards of proficiency are important from a radiography perspective, the regulations affect the work being undertaken within the radiology department. In terms of the discussion throughout the thesis, it is useful to discuss the three underpinning concepts that inform these regulations. These are the concepts of justification, optimisation, and limitation. The International Commission on Radiological Protection (ICRP) (1974) defines these terms and these definitions are still the bedrock of medical exposures to ionising radiation today (which can be seen within *IRMER 2017; 2024*).

Justification is the process that is aimed at ensuring that the overall outcome of the action taken (i.e., exposure to ionising radiation will have a net benefit). In terms of medical exposures, this is the process of ensuring that the patient/society will benefit from the exposure (e.g., treatment/diagnosis influencing that patients' management). Optimisation is the process of ensuring that the exposure to ionising radiation is kept as low as is reasonably practicable (the so-called ALARP principle). From a radiographer's perspective this is using technical knowledge to ensure that the radiographs are produced using the lowest practicable amount of ionising radiation exposure for the patient (Welborn and Lockwood, 2022). Limitation is an extension of this, in terms of developing dose constraints to personnel and to patients and is not referred to in *IRMER 2017; 2024* but may be considered an interrelated concept to justification in this context. Limitation does, however, form part of the reduction of exposure of staff to ionising radiation within the *Ionising Radiation Regulations (IRR) 2017*.

The *IRR 2017* provide legislation that attempts to ensure the protection to everyone including members of the public and staff, regarding their exposure to ionising radiation. These regulations are wide ranging; for example, governing those who work within the nuclear energy sector, as well as those in healthcare. However, the principles highlighted above are enacted within the *IRR 2017* in a number of ways within the radiology department. As this statutory instrument sets the dose constraints for staff and the general public in terms of radiation exposure, this is translated within radiology in two main ways. Deriving from a limitation approach, dose monitoring of staff ensures that equivalent doses to staff in the course of their work does not exceed prescribed limits[7]. This is also operationalised using environmental protections, such as the identification of the controlled area, along with application of lead glass (*IRR 2017;* NHS Estates, 2000; RCR & CoR, 2022) and personal protective equipment (e.g., lead equivalent rubber aprons) (Murphy, 2020).

Whilst the *IRR 2017* regulations form part of the discussions within this research, the focus of this thesis is *IRMER 2017*;*2024*. *IRMER 2017* primarily governs the exposure of patients, who here can be defined as those people who may benefit from an exposure during the course of their diagnosis or treatment. The regulations also govern exposure of any person who may be exposed to ionising radiation as part of a piece of research, health screening programmes (such as Breast Cancer Screening Programme), those who may be defined as carers and comforters of those people who are exposed to ionising radiation, and those who may be exposed to medical imaging radiation where the purpose will have no medical benefit to them. Examples of these types of exposure include for forensic purposes, such as the identification of drugs packing or suspected physical abuse in children (*IRMER 2017*; McGregor, Brekon and Swainston, 2022). Furthermore, the regulations set out who can do what, in terms of exposing patients to ionising radiation. They set out specific roles within the regulation, which is worthwhile discussing here as the terms have specific meanings from a legislative perspective, and one of those terms (practitioner) has a specific meaning within *IRMER 2017*.

Referrers relate to the person who is requesting that a patient undergoes an X-ray examination (these people can be further split into medical and non-medical referrers). The practitioner[8] is

[7] An example of this is seen with monitoring the ionising radiation dose to eye of staff (equivalent dose of 15 mSv per annum) (*IRR 2017*).
[8] Note that the term practitioner has a very specific meaning within the regulations. This should not be confused with the more generic meaning of the term (i.e., someone who practices, for example, Advanced Clinical Practitioner).

the person responsible for justifying the exposure. The operator is the person(s) responsible for the technical aspects of the examination. Finally, there is the employer, who in the interpretation of the regulations are those who carry out the employer duties within the radiation facility (*IRMER, 2017*). Effectively, the employer is responsible for the implementation of the policies and procedures that operationalise the legislation. This will include ensuring that clinical audit is undertaken and that accidental or unintended exposures are investigated and reported to the appropriate authority under the regulations (i.e., Care Quality Commission (CQC) for patient exposures (CQC, 2023) and Health and Safety Executive (HSE) for staff and occupational exposure (HSE, 2024)). In the case of healthcare, the employer is usually NHS trust/private hospital group where the X-ray examinations will take place.

The operationalisation of *IRMER 2017, 2024* also employs the ICRP principles outlined above, with particular emphasis on justification and optimisation. Justification is performed on an exposure-by-exposure basis. What this means in principle is that each time a patient (or a person meeting the other categories identified above) undergoes an X-ray examination and is exposed to ionising radiation, a risk-benefit assessment is made prior to that person's exposure. This decision is made using clinical information about the patient and the clinical question (i.e., what does the referrer of the patient want to find out). The justification process is carried out normally by the practitioner or through guidance which has been produced by a practitioner. The processes of justification and authorisation must be outlined by the employer. The employer is responsible for all aspects of adhering to the *IRMER 2017; 2024* regulations, including the processes and the entitlement of the various roles as outlined above. This can lead to complications especially where there are referrers who have been entitled to refer by the employer but are not that employer's employees[9]. The process of authorisation is a separate but interrelated to process to justification. This is the process of checking that *justification has taken place* with reference to the referral and is seen as a practical process rather than an intellectual one (RCR, 2020) and can be performed either by the operator or the practitioner.

The justification and/or authorisation of an X-ray request (under the *IRMER 2017; 2024* regulations) is an important aspect of the radiographers' role, involving a risk assessment of radiation exposure against the examinations potential for influencing patient management (SoR,

[9] This can be confusing but is best explained by using a GP referral for a patient. The GP is employed by their practice, not by the hospital trust. However, the GP should comply with the processes set out by the hospital trust for their patient to have an X-ray examination.

2025). However, language can also be a cause of conflict within the interprofessional interactions. Some referrers may see their requests as 'X-ray orders' which gives an indication of an authoritarian approach to some or something; radiology professionals (i.e., both radiographers and radiologists) within the UK in particular, see these referrals as 'requests for radiological opinion' which may be open to questioning and further discussion rather than simply actioning them (Chakera and Mendelson, 2014).

All referring clinicians (whether medical doctor, nurse, physiotherapist, etc.) are required to complete a radiological request prior to any patient's exposure to ionising radiation, which identifies them as the referrer under *IRMER 2017; 2024* and allows for the required information to be made available to the practitioner and operator (Vom and Williams, 2017). Thus, the process is in place to ensure that the justification process takes place, a suitable imaging modality and/or examination is chosen, and a diagnostic image is produced, if required. These interactions take place within the medical imaging departments on a regular basis (RCR, 2021). Therefore, the request for radiological opinion may be 'rejected' or 'returned' should it be deemed that the exposure of the patient to ionising radiation will not result in a net benefit to the patient. The definition of this net clinical benefit to the patient is related to whether the report of the X-ray examination would in some way impact on the treatment of the patient (Clarke, Akudjedu and Salifu, 2023). An example of a request that may be returned is a referral for detecting the cause of plantar fasciitis as a calcaneal spur. As there is no relationship between calcaneal spur presence and plantar fasciitis, the likelihood is that the treatment for the patient would not change if there was (or was not) a calcaneal spur. Therefore, the clinical information and clinical question indicated in this request would normally be considered inappropriate as it does not change the treatment management of the patient (iRefer, no date).

There has been discussion and guidance on who is entitled to act within the specified roles of the *IRMER 2017; 2024* regulations. Entitlement is given by the employer and will vary within clinical situations. For example, the entitlement of the various roles will differ in the community dental practice from that of a tertiary referral centre with radiotherapy, even though both of these areas are governed by the same legislation (i.e., *IRMER 2017; 2024*). The entitlement to act within the roles specified in *IRMER 2017; 2024* will therefore change, depending on the employer and the nature of the work undertaken. Within the example above, a dentist may act as referrer, practitioner and operator; or they may delegate part of these roles to other workers (e.g., dental nurses or hygienists). It is the responsibility of the employer to ensure that any

person who is undertaking these roles under *IRMER 2017; 2024* are adequately trained to do so. *IRMER 2017; 2024* highlights the indicative content on any subsequent training and both RCR (2020) and CoR (2018) highlight the need for assessment of this content, within a given scope of practice. Degree programmes for diagnostic radiography usually encompass the content of the training highlighted within the *IRMER 2017; 2024* regulations, however, as previously stated it is the discretion of the employer to assess whether that the person has the ability to be entitled within that role as a practitioner.

1.3.1 A brief note on the Ionising Radiation (Medical Exposure) Regulations 2017; 2024

During the course of this research project *IRMER* changed three times (*2000; 2017; 2024*). The first change was anticipated and formed a rationale for the undertaking of the study. Previously, *IRMER 2000* had been in operation for 16 years at the start of the study and it was anticipated that these would change at the start of the data collection process. Therefore, it was felt that this was an opportune moment to investigate the operationalisation of the legislation. At the time of the data collection *IRMER 2017* had had time to become operationalised, even though data collection had started later than anticipated (collected during Spring 2019). Following the completion of the data collection there was a 3-year hiatus in the PhD process due to a lack of supervision throughout the COVID-19 pandemic. The PhD then moved to a new university and a supervisory team was able to be in place from February 2023. During the write up phase *IRMER* went through a further amendment to *IRMER 2024*. The changes to *IRMER 2017* by the 2024 amendments are highlighted below.

The impact of the amendments to *IRMER 2017* may indeed be minimal in terms of the outcomes and findings within this thesis. The amendments relate primarily to clarifications within the text. However, a significant change that may have an impact upon further investigations into the operationalisation of *IRMER 2017; 2024* is in relation to the roles. The roles of the referrer, practitioner and operator remain similar and broadly unchanged. The biggest impact is the explicit mention of the referrer in terms of compliance with the employer's guidance (*IRMER, 2024,* 10 (1)). This was not explicitly stated in the previous iterations of *IRMER*. This may have an impact upon the quality of the referrals received in time, but this would require some further investigation.

1.4 Teamworking and the Historical Context within the NHS

The radiographers' role may be seen as that of a contractor, asked to perform imaging examinations on patients who are then referred back to their respective consultant for further treatment or diagnostics (Tannenbaum *et al.*, 2015). Within radiographic practice the radiographer can at times feel a little isolated, captured in the silo of the radiology department (Strudwick and Day, 2014). To understand these different processes and conceptualisations of teamwork, a further interrogation of the issues that surround teamwork and interprofessional working within the context of the NHS is useful. This will provide a background to the similarities within the current state of working within the wider healthcare system of today's hospitals.

The care of the patient within healthcare is inherently complex within the modern world (Gawande, 2011; Braithwaite *et al.,* 2017). It has become more complicated since Arthur Blenkinsop discussed the role of health visitors and their work with general practitioners (GP) in a House of Commons debate in 1956 (House of Commons, 1956). Interprofessional working has always been inherent within the NHS. What has changed are a number of different facets: the influence of new medical technology (this is particularly pertinent concerning medical imaging), the complexity of the patients that are coming through the healthcare system and how they are managed. This background sets out the historical context of the division of labour and teamwork within healthcare along with the role of the radiographer.

In the discussions surrounding health visitors' roles in the 1950s, the main themes centred on matters such as to whom they should be responsible and their professional remit. The key theme however was where the boundaries of their role should lie. Historically, team working was intimated as early as the 1920's, with specific reference to healthcare teams within the community setting. Whilst the idea of general practitioners (GPs) working within teams from health centres did not move forward at that time (Milne, 1980) it was in the 1960s that GPs and community staff were brought together to coordinate the immunisation of the population and look after the health of the elderly and children (Pinsent, Pike, Morgan and Mansell, 1961). This was not explicitly defined as 'teamwork' or interprofessional working, however it did include some processes that are now recognised as being part of interprofessional working. This included interaction with colleagues from within and outside the service, professional staff ranging from medical doctors to Mother Superiors. This type of working clearly required some form of collaboration and coordination between different groups.

In the 1970's there was a move towards a 'primary health care team' (Elwyn, Rapport and Kinnersley, 1998). It was felt that this team working would produce benefits for the patient, such as patients being treated by the right clinician at the right time. The Cumberledge report (DHSS, 1986) into neighbourhood nursing services stated that some of the primary health care teams were not working as a team. Several issues were hypothesised as to the reason why this was the case including poor interaction between professions and skill-mix problems. The report stated that the poor skill-mix was seemingly exacerbated through poor planning, specifically that the provision was based on geographic and demographic data rather than specific healthcare needs of the population.

By the 1980's there was a move towards what may termed as marketisation and the implementation of a managerialist approach into the NHS. Resource management was piloted following the Griffiths Report (MacFarlane, Exworthy and Willmott, 2012). Prior to the report, doctors were seen as a 'professional monopolists' (Williamson, 2008) with contemporary comments on the report (e.g. Day and Kelin, 1989) describing the NHS as a feudal society. It was felt that influence and power resided with mainly one professional group, the medical profession. The Griffiths report attempted to offer accountability and responsibility of management. Keen and Malby (1992) note that some nursing staff felt that their influence and power had been curtailed by these changes. However, resource management was introduced to move the decision making to the point of contact, rather than at the top level. Griffiths envisaged that the physicians and nursing staff would move across into clinical management (Gorsky, 2013), but this was not the case. Due to the addition of a new layer of management, this therefore required a certain amount of collaboration between managers, physicians, nursing and other allied health professionals (Keen and Malby, 1992, p. 864) to allow resource management decisions to be devolved to the front line. Conflicts were noted due to confusion of roles or unwanted imposition of systems. Keen and Malby (1992) also note that there was no evidence that nursing practice had changed on the wards, just that nurses had become more aware to make the best use of available resources. If this research is taken to its logical conclusion, then it may be intimated that resource management at this level had little discernible effect on patient care. Building on this report Griffiths' 1988 report on community care and the subsequent white paper published by the then Conservative government (DHSS, 1989) had a number of outcomes intended to improve the quality of community care. This included the

proper assessment of cases and case management and the development of accountability for the performance of services.

The move towards a managerialist approach has been described by Fournier (2000) as the end of the 'labour of division' and the advent of 'the logic of the market' citing such developments as the blurring of professional boundaries and the ability to work in a more fluid manner, as a way of managing performance. This need for flexibility appears to have started with the Griffiths' report above but was continued into the 1990s by the new Labour government as well. The '*New NHS: Modern, Dependable'* (1997) describe the use of teams and team working '…within and across organisational boundaries' (p. 55). The question to be asked here then, is did this improve the service and outcomes for patients? Two independent audits conducted by the London School of Economics (Vizard and Obolenskaya, 2013) and the King's Fund (Appleby, 2005) were positive, although the outcome of public satisfaction appears to have been the main measure, along with some proxy targets (such as reduction in waiting lists). Further issues were highlighted, such as the so-called 'post-code lottery' leading to general health inequalities, but whether these could be attributed to teamworking specifically is debatable.

Following this into the 2000s and to now, the landscape of professional division and interprofessional working throughout the NHS has changed. The introduction of apprenticeships was highlighted as a way of increasing the number of health professionals in the workforce, along with changing the nature of the healthcare delivery with other professionals such as physician associates and Enhanced Clinical Practitioners. However, the nature of teamwork within the multidisciplinary team has remained constant throughout the period. The delivery of interprofessional learning and leadership has come under criticism for not being cognisant of the various socio-cultural and contextual factors that play a part in the relationship between the individual practitioners and the patient (Samuriwo, 2022).

However, the position of radiography as a profession and radiology as a specialism within the wider healthcare setting still appears to be positioned in a similar place. Radiographers work primarily with colleagues within radiology department (e.g., radiologists and radiology nurses) within intermittent interactions with other healthcare professionals on an *ad hoc* basis or within highly specialised roles (e.g., Strudwick and Day, 2014; Williams, Widdowfield and Cosson, 2016; North and Holmes, 2023). The relationship between radiologists and radiographers can be categorised as hierarchical, with the traditional dominance of the medical professions seen in

other healthcare relationships (see for example, RCR, 2022). Radiologist opinion regarding radiographers' work is also a point for discussion at higher levels (such as at the level of the professional bodies). For example, previous publications from the RCR indicated that radiographers did not possess the skills, knowledge or training to produce a radiological report to the same standard as a radiologist (RCR, 2010) which prompted a riposte from the Society and College of Radiographers, leading the production of the '*Teamworking in Clinical Imaging'* joint publication (RCR & CoR, 2012). On the point of radiographer reporting, the opinion appears still to be prevalent, with some studies citing teamworking issues with radiologists in this particular role; however, the consensus across the literature is more harmonious (Wood, 2022).

The issue of justification of requests has had less of a focus within the literature until recently. As described in this literature review (chapter 2), there has been an increase in the focus around this area since 2019. Whilst it is tempting to think that this increase is related to the further embedding of *IRMER 2017*, as much of this research has been conducted in Norway it may be assumed that this is not the case.

There is a wider discussion to be had here in terms of how the work is conceptualised and how this thesis sees the work of the radiographer. Both the work being undertaken within the radiology department and within the wider healthcare setting may be conceptualised as interprofessional. However, there is a wider debate to be had over the meaning of these terms and the verbs that are associated with them (working, collaboration, learning, etc.). This has been described by some academics as being a 'semantic quagmire' where the seemingly endless addition of prefixes (e.g., inter-) along with nouns (e.g., profession) and then verbs (e.g., collaboration) give rise to a body of work where it becomes difficult to unpick the nature of the work, question, or findings (Perrier, Adhihetty & Soobiah, 2016). Whilst there are issues that surround this on both a theoretical and practical level, the discussions within the thesis that surround the nature of the work and the interpretations used, will be outlined in the literature review but can be summarised here as being one of interprofessional collaboration (many professions, working together to affect an outcome).

Schot, Tummers & Noordegraaf (2020) identified interprofessional collaboration as '…an ideal typical way of working together that can occur within multiple settings in different ways' (p. 333). The key perhaps to understanding this particular conceptualisation is that this is seen as an

ideal way – not perhaps the way in which most interactions occur. The argument being made within this work is that there is no typical way of an interaction to occur, as all interactions may be seen as being *contextual* in nature (Samuriwo, 2022). The contextual nature of the interactions is a particular key for the work being undertaken by radiographers here. Often the interprofessional collaboration in the manner defined above is missing. This is because the radiographers and the referrers (normally, but not always, medical professionals) are temporally or spatially separated from one another (or often both). The object that is used to cross this particular boundary of time and space is the X-ray request. This is generated through the interaction of the referrer and the patient's symptoms or disease.

As the request is then seen as the boundary object it is then useful to articulate at this stage what this boundary is and where it can be found. In chapter two, the literature review highlights the many ways that teamworking and interprofessional collaboration is considered in the literature. Tannenbaum *et al.* (2015) make the point that in the current organisations, teams need to adapt and change the way in which they work. They also describe that often teams have a group of core members and transient members. Taken in the context of the wider healthcare system, radiology may be viewed through this lens as being an outer core or, perhaps more radically, an outside contractor. The patient is handed to radiology for the specific task of producing a radiological report and then the patient and the report are handed back to the referrer.

1.5 Decision Making for Radiographers

The role of the radiographer as described above, as with any professional role, concerns a number of decisions that a radiographer must make when they care for the patient. These decisions can be around the examination that needs to be undertaken, how to adapt the radiographic technique to produce a diagnostic image, whether to immobilise a patient, or whether the examination is justified as per the local technique guide/protocol guide (Diaby, Debess and Teli 2024). The Society and College of Radiographers (SCoR) (2019) produced a *'Paused and Check'* document which highlights the tasks to be undertaken during an examination. This document identifies 26 nominally discrete tasks that need to be performed in relation to the X-ray examination. These are a simplification of the processes but could be seen as being broad categories in which a series of more interrelated and fundamental tasks can be performed. For example, the statement 'Evaluate images, confirm necessity for repeat or

addition views [sic]…' contains within it a series of independent decisions. These decisions require information from the X-ray request (what is the clinical question and clinical information), identification of a pathology (which may require extra projections to be undertaken), identification of anatomy and if that anatomy is correctly visualised, if it is not correctly visualised then a decision needs to be made if that radiographer could improve through undertaking another projection (i.e., changing the position and/or X-ray exposure factor settings) and would the patient be able to maintain this position (Seo *et al.*, 2022; Decoster *et al.*, 2022; Kjelle and Chilanga, 2022; Talevski, Kilgour, and Spuur, 2023). Therefore, as demonstrated here, an ostensibly single task has several parts within it. These parts may be present on every projection undertaken, or only parts of the questions highlighted above may be present. There are a number of different non-human, human, and intra-human elements that may influence the decisions made by radiographers in this instance.

Given the number of questions and decisions a radiographer makes during the day and that these decisions can be multiple even when observing a single radiographic exposure, then it appears to make sense to focus the research on a particular part of the radiographic process. In this case, the decision of whether an examination is, or is not, justified. This decision making is an interaction with the material world. The X-ray request, the X-ray machinery, and the patient, referrer and other radiographers can be seen to form an assemblage or network of 'things' or entities (Law, 2004). These decision-making processes and interactions form the nucleus of a discussion of the sociomaterial, which informs the approach taken within the thesis.

1.6 The Potential Impact of the Sociomaterial

As identified above, as the X-ray request is the focus of this work. Further to this, within this thesis the request is conceptually defined as a sociomaterial product. It therefore makes sense that the inquiry outlined is engaged with through a sociomaterial lens. Sociomateriality is a suite of theoretical approaches which highlight the role of material things (books, documents, technologies, etc.) within society and the impact that they have (de Moura and Bispo, 2019). Using a sociomaterial approach it becomes apparent that the X-ray request has agency as the boundary between the referrer and radiographer is crossed. As context is important, so then is the environment and connection within it. This will be further elucidated within the current thesis through the application of sociomaterial approaches, predominately Actor-Network Theory and other theories that stem from it. The use of Actor-Network Theory within the research is

discussed in further detail in chapter three; however, a brief overview is provided here prior to discussing the general overview and significance of this thesis.

Actor-Network Theory is not a theory *per se* but a sensibility or wider approach to research. The purpose of it is to attune the researcher to the connection or associations that make situations unique or give them context. Latour (2004) describes Actor-Network Theory as being almost a third way in research; one that can be removed from the micro/macro dichotomy of structures and interactions, through tracing the associations of actors. This means that this approach gives equal actor status to both the human and non-human entities within the networks which are being investigated. This does not mean that they are treated the same, but that they require equal attention within the network (Michaels, 2017). They (things within the network) are primarily seen as both being able to have agency within a network or to enrol others into it.

1.7 Study Overview

This study is an ethnographic account of the everyday work that is undertaken by radiographers within a district general hospital. The focus of the ethnographic approach is the justification and authorisation of the X-ray request for conventional X-ray examinations. For a 3-month period in the spring of 2019 time was spent within the X-ray department watching radiographers undertake their work as a 'fly on the wall' for a total of 72 hours. This was combined with a series of semi-structured interviews with participants. Further data was collected through various documentation related to the process of authorisation and justification from the department. Thus, the data collected were field notes from ethnographic observations, verbatim transcripts of semi-structured interviews, and documents collected. All were subjected to reflexive thematic analysis. There were 8 radiographers who consented to participating within this study; 7 out of 8 participants were able to be observed within the practice setting with one participant unable to be observed due to shift patterns. One of the eight radiographers also was unable to be interviewed but was happy to be observed.

The research is primarily concerned with the *practices* of the radiographer and the *practices* of the materials that influence the radiographers work (whether knowingly or unknowingly). Scoles (2018) discusses the link between knowing and doing stating that 'knowing is inextricably linked to doing' (p. 10). However, a counterpoint to this is that often people *do without knowing*.

Therefore, it is not useful to assume that the two (learning and doing) are inevitable or are inexorably linked. However, practice may be conceived of as a proxy indicator of knowing, and therefore the focus on the practice of the radiographers seems to be a more appropriate focus of research than on their knowledge alone. Therefore, *knowing in practice* as a concept (Reich and Hager, 2014) would appear to be a useful way to interpret the work of the radiographer in this context. The interviews that were undertaken often used the field notes as a starting point for the discussions.

This leads the reader into the next significant part of the work, which is the use of noise as a conceptual entity to understand the variation in the work of the radiographer. As noise appears to consist of non-human entities, the linking of this concept with Actor-Network Theory appears to have face validity. Actor-Network Theory's sensibilities sensitise the researcher to conceive of the research landscape as an inherently complex series of associations between the human and non-human. This will therefore allow the researcher to be aware of the different entities within the network and how they influence the network. Whilst the effect may not be that of noise, this allows the researcher a meaningful concept with which to explain the action and agency of these non-human entities within the work and practices being undertaken and enacted by the radiographer.

1.7.1 Research Questions

- What are the associations within the X-ray request network that make it durable?
- What happens when disturbances occur and how does this affect the work of the X-ray request?
- Can the radiographers' work be more effectively conceptualised in terms of the non-human entities around them?
- Does the physical environment, technology, patient, and departmental protocols play a role in the development of noise and the practices of radiographers?

1.7.2 Study Significance

This study contributes to the growing field of research that focuses on the Actor-Network Theory, and its development within the field of healthcare organisations and interprofessional working. It further develops the previous work of scholars who have investigated the decisions that radiographers make in terms of the X-ray examination request (e.g., Diaby, Debess, and Teli,

2024; Chilanga, Olerud and Lysdhal, 2022a; Reitan, Sanderud and Mussmann, 2024). It has taken a currently novel approach, as the focus is upon what the radiographer is doing at the 'coalface' of their work, with non-participant observations within the real world. The decisions that professionals make are inherently complex and the thesis makes this point. The work also highlights the fundamental interconnectedness of the radiographer with the material objects all around them and contends that some that are labelled as un-important are perhaps exerting agency because of this.

There are three major findings within this work that can have an impact upon the training, education, and workplace organisation of the radiology department and therefore the work of the radiographers within them. The first finding is that radiographer's use *emergent practices* to ensure that the patient's, mainly diagnostic, journey through the department is as efficient as possible. When an actor introduces noise into the network these emergent practices evolve to work around the potential barriers within the system. An example being that where elements of the work fall outside of the protocol or of their current practices, workarounds and other actors are enrolled into the network to ensure that the patient is afforded the most appropriate diagnostic journey possible.

The second finding is that one of the results of the *emergent practices* that the radiographer can be conceptualised as a 'proxy-referrer' to counteract the introduction of noise into the system. The further conceptualisation of this role within this thesis is that the radiographer here is performing boundary work with the boundary object (i.e., the X-ray request). This boundary work is described within this thesis as being pragmatic in that the work undertaken by the radiographer is not a synchronous collaboration with the referrer (which has been previously described at 'collaborative boundary work') but without the referrer's knowledge or any indication that the radiographer wants to fully undertake the referral role. It is pragmatically used when the radiographer is unable to undertake the collaboration with the referrer.

The third major finding of the work is the impact of the environment in which radiography now takes place and the potential impact of this upon both the profession as a whole and the training and education of the wider radiographic workforce. The discussions within the thesis regard the sharing of knowledge and practices that are attributed to the authorisation and justification of the X-ray request. However, it is apparent from the data that the siloed working within radiography appears to have been exacerbated by technological innovation. The move from daylight and

computerised image processors towards direct digital has removed the viewing area as a sharing space for practice and knowledge. The radiographer now works within a room as the image production is instantly available to them. The potential implication for practice is that this may be a factor for noise, and the lack of sharing may indeed be impacting the development and moderation of practices within the department.

The original contribution to scholarship provided within this thesis is two-fold. Firstly, the use of Actor-Network Theory *and* teaming this with the concept of noise is a useful way to operationalise Actor-Network Theory and to ensure that the noise being elucidated within the research is meaningful and the endpoint. Furthermore, this thesis highlights the work that radiographers do to maintain the assemblage of actors together, to ensure that the patient receives a timely diagnosis ensuring that all actors within the network are accounted for, gives a fuller picture of the complex work. This has implications for further research in terms of the working practices that radiographers are required to engage in, further noise audits of the activities that radiographers engage with, and acknowledgement that radiographers have the training, ability, and currently undertake justification, within the limits of the *IRMER 2017; 2024* legislation.

1.8 Summary

The first chapter of this thesis gives an overview of the work of the radiographer as a professional within the healthcare setting. It is important to note the overarching impact of the legislation upon the work of the radiographer. Whilst there are legislations that govern all work undertake by anyone in a workplace (such as the *Health and Safety at Work Act 1974* or the *Control of Substances Hazardous to Health Regulations 2002*) the impact of *IRMER 2017*; *2024* should be seen as having a crucial role in governing patients' exposure to ionising radiation within a healthcare setting.

This chapter also highlights some further conceptual discussions that take place within the literature review; important to note here for context is the interpretation of the type of interprofessional work that is being undertaken by the radiographer. The context in which radiology, as a healthcare specialty, operates is subjectively different to the wider healthcare system, being organised around modalities rather than patients' disease. This chapter has also identified the current work that has been undertaken within the radiography literature around

radiographers' decision making, which will be further explored within the literature review, along with the concept of noise within context.

Actor-Network Theory has been highlighted as the theoretical framework and sensibility that has informed the analysis of this work. This approach is rooted in the sociomaterial and Actor-Network Theory's specific interpretations of this will be further explored in chapter three. An overview of the methods employed within this work has also been outlined within this chapter, highlighting the unique approach to radiographer decision making, incorporating an ethnographic data collection method, including documents, field notes and semi-structured interviews.

The significance of this work and an overview of the major findings have also been indicated within this chapter. This work will have an impact on the education and training of radiographers in terms of helping them to further conceptualise the work being undertaken and how the non-human can have an impact upon the decisions made. There are also implications for radiology managers and team leaders in terms of recognising how the work of the radiographer has changed and what may be done to further help in terms of practice and knowledge sharing in the era of direct digital technology.

Chapter 2: Teamworking, Protocols, Power and Decision-making in Healthcare and Radiography

"'But look, you found the notice, didn't you?'

'Yes,' said Arthur, 'yes I did. It was on display in the bottom of a locked filing cabinet stuck in a disused lavatory with a sign on the door saying, 'Beware of the Leopard.'"

Douglas Adams, *The Hitchhikers Guide to the Galaxy*, (1979)

This chapter aims to further expand the introduction through discussion of the key themes and directions of the research, adding further context to the discussion of Actor-Network Theory in chapter three and to the discussions surrounding the overarching methodology employed within chapter four. The chapter begins with some contextualisation of the work undertaken within the radiology department and how this this sited within the wider discussions of the healthcare systems. There is a focus on teamwork, to showcase the somewhat unique position that radiography in particular has within the health service organisation.

Following this discussion there is a further focus on the development of protocols and guidance within healthcare. This is from a general perspective before the focus is narrowed down to types of interactions that are undertaken within the radiology department and how these interactions fit with conception of professionalism and interprofessional working in radiology. Prior to discussing decision-making in radiography, a discussion of wider decision-making literature relating to heuristics and noise will be undertaken, as this will form a key element of the data analysis (see chapter five in particular). From this, an overview of the current literature on decision making and radiographers is discussed, highlighting that the current published research does not focus on unpicking the practices of radiography within a department. The research methodologies employed in previous research predominately use a survey methodology, rather than observing radiographers within their day-to-day work, which is the method employed in this work.

The hospital environment is inherently complex due to a number of issues. This includes the healthcare professionals that work within it; the technologies and medical equipment that are used; the type of patients accessing the system and their needs; and the historico-political discourse that has shaped the healthcare sector (Iedema, 2007). Davies, Nutley and Mannion (2000) cite that in the past reform to working practices had pursued a 'Taylorism' approach,

based around a mechanistic and process driven development of the hospital labour force (essentially a modernist or scientific management approach). This involves the imposition of regulation, targets, clinical governance, and changing the 'organisational culture' (which Davies and colleagues question the existence of). So, it appears that the reorganisations that were introduced by 'New NHS: Modern, Dependable' (1997), as well as previous reforms stemming from the Griffiths' report, may have led to this increase in the complexity of the health system.

As the idea of teamwork has grown within the political consciousness in the forms of white papers and guidance, so has the literature around teamwork in healthcare. This literature can be seen to be largely focused on various clinical contexts; however, there are certain themes that run through the research. These are the socialization of professional groups; what interprofessional working is and how it has been conceptualised; how professionals communicate with other professionals; and the influence of protocol development and professional power. These are discussed in turn below in order to develop working definitions of certain concepts (such as interprofessional working) and analyse their potential impact on the interpretation of interprofessional working in radiology.

2.1 Interprofessional Working: Working Definition for Thesis

Interprofessional working, multidisciplinary working, interprofessional collaboration, collaborative teamworking (and others) are all terms that are often used interchangeably within the common discourses of everyday practitioners and also within the academic literature (Bleakley 2013; Hall 2005). However, these terms require some discussion in order to elucidate what is meant by them. Through this, it is possible to arrive at a working definition that will inform the thesis.

The health and social care literature also has issues in defining what a team is and what a team does. For example, Payne (2000) offers many different definitions of a team (and teamwork) within the health and social care setting, as do West (2012), West and Lyubovnikova (2012). When interrogated further similar concepts begin to emerge from the different definitions across wide ranging literature. These can be distilled into three common themes that appear in all of the definitions: the drive towards a common goal; shared mental models (potentially of that goal); and members of the team having complementary competencies that contribute towards reaching that goal (Payne, 2000, p.6-7). West (2012) further describes some of the features that are required for the formation of a team including: shared responsibility, a budget, and size

(in particular more than two but no more than 10 members). This appears quite a restricted perception of what a team is. If professionals have the same goals and a shared responsibility, then it would appear remiss to dismiss a group of people as a team if they do not have a budget that they control. There is also something implicit within these definitions; they are context dependent.

This context dependence can be seen in West (2012); he states that '…there are certain tasks that are best performed by teams and others that are best performed by individuals or groups of individuals working serially or in parallel' (p.29). Here the task appears to define whether those people working on it are a team or a group. Other definitions can also be interpreted in a similar manner. These differences between the definitions are perhaps indicative of the setting or audience for which the teamwork definition is derived. It appears that the task and the context can inform the team and teamwork, and therefore, the team/teamwork takes on a different form in different contexts. Thus, it appears to be a link between how a team is defined and the decision of what tasks that team should be doing. This interpretation can, however, lead to a circular argument. Is it the task that defines the team or does the team define the tasks?

The difference between these separate definitions is also of interest, as this gives an insight into the ideological background of the researcher. For example, some of the definitions appear to be rather utilitarian in their nature (e.g. Katzenbach and Smith, 1993; McIntosh-Fletcher, 1996) in that they are extremely succinct and do not address the complexities of teams and teamwork. Some of the other definitions are more nuanced particularly those that take into account the diverse requirements of interprofessional working in healthcare (Rosen *et al.*, 2018). However, the management literature has seen further debate concerning what teams are and how they are structured in the modern, dynamic and complex organisational environment. Tannenbaum *et al.,* (2015) postulate that in modern organisations, teams in all sectors (including healthcare) are adapting the way in which they work to manage this complexity. Of the descriptions given of these new ways of working, they can easily be applied to healthcare settings. For example, they describe a 'flash team' (p. 5), which is a team made of individuals who come together and disperse quickly for a single task. This can be viewed as a transient team, a role with which many radiographers would be familiar (e.g. within the emergency theatre environment). They also discuss the concepts of teams having an inner and outer core. These are defined as permanent members (inner core) and transient members (outer core). Radiographers may feel familiar with both of these viewpoints through interactions within surgical teams and as

members of their own ‘radiological’ teams (Williams, Widdowfield and Cosson, 2015; Woznitza *et al*., 2014). Although Tannenbaum *et al*., (2015) state that the outer circle may exist outside of the organization; however, given the disparate professions involved within the healthcare environment, it is possible to have teams within inner and outer core within a single healthcare organisation.

For this thesis, care should be taken to choose a definition of interprofessional working that will suit the professional groups involved. As there are a number of themes that run through teamwork. This study will utilise the approach taken by Tannenbaum *et al.* (2015) outlined above, in particular the ‘inner’ and ‘outer’ core model. This will mean that ‘true team membership’ is membership of a group that has a shared mental model, interdependency and all roles within the group specified. When attempting to apply this to radiographers working practices, it is useful to consider the notion that the radiographer belongs to a multi-professional team that resides *within the radiological department* – this team consists of radiographers, radiologists, radiology nursing, and radiology department assistants. Perhaps this is better codified as belonging to a ‘specialism’ rather than a ‘team’. Taken to a logical conclusion, this has an interesting supposition for radiography as a profession. A radiographer may be seen as belonging to their specialism solely (i.e. the speciality is the profession), whereas a doctor may be a radiologist or surgeon (specialism) but also a medical practitioner (profession).

This alternate interpretation has some face validity with the discussions of Powell and Davies (2012) who have stated that healthcare is becoming segmented by speciality, rather than by profession. Therefore, the interaction that occurs during the requesting of X-ray examinations, the radiographers are not true members of the specialism requesting the examination, but rather part of an outer core. Here the work has been ‘contracted out’ to a different speciality (in this example, radiology) rather than being undertaken by that specialism. Therefore, the patients do not enter a radiology department defined by their illness (respiratory, cardiac, musculoskeletal, etc.) but defined by the radiological modality (X-ray, Computed Tomography (CT), etc.) and see a radiographer who is an expert in the modality (not the disease).

2.2 Interprofessional Communication

Communication is a very wide-ranging term, and it is difficult to elucidate exactly what is meant or indeed measured, when it is used. Effective communication is often cited as being essential

to teamwork (Carrizales and Clark, 2015) but the type and nature of communication is sometimes missing from research that makes communication its focus. Wheeler's (2014) discussions around patient handoff indicate, if implicitly, that effective communication is essential to good teamwork. It identifies different communication strategies intended to enhance the patient journey through the healthcare system, thus ensuring that disparate teams communicate all relevant information concerning the patient being discharged from their care. Therefore, effective communication can be seen as the transfer of timely, specific and relevant information from one party to another (Leonard *et al*., 2004). Some studies suggest that poor communication is often the result of emotional outbursts (Matziou *et al*., 2014). Other research has suggested that interactions between physicians and nurses/allied health professionals are at times, terse and short (Zwarenstein *et al.,* 2013) and that interactions would benefit from the introduction of a structured communication tool (Mackintosh and Sandall, 2010; Cornell *et al.,* 2014; Blom *et al.,* 2015). Effective communication can be seen as having a number of overlapping and integrating attributes, including open communication channels and a non-punitive environment (Kulkarni, 2025). Various tools and models have been developed or adapted to help facilitate these communicative interactions including crew resource management and structured communication tools such as SBAR (Situation, Background, Assessment, and Recommendation) (Gluyas, 2015).

There has even been randomized controlled trials (RCT) attempting to assess the nature of interventions to improve communication between healthcare professionals in certain situations (e.g. Crofts *et al.,* 2007; Robertson *et al.* 2014). This literature is generally based on Crew Resource Management (CRM) which was developed within the civil aviation industry to prevent the role of human error within aircraft disasters. The focus within research is often on so-called 'glitches' within a procedure or situation. These 'glitches' are defined as when something happened within the procedure that may be described as an avoidable error in communication or where something happens that is outside of normal working practices (e.g. diathermy not being turned on). Thus, the intervention within the studies tended to focus on crew resource management training. In some studies, as the communication scores increased, so did these 'glitches' (e.g., Morgan *et al.*, 2015). This is an interesting point, as this may have been due to the opportunity to communicate when a 'glitch' occurs which means that measuring 'glitches' may be an invalid measure of how well the communication intervention strategy worked.

These pieces of research are very much focused on immediate communication strategies (which is what is required within that particular clinical environment), and whilst communication within surgery or the emergency context is important, some of these studies seem to neglect other important aspects of teamwork. These include aspects such as planning prior to the surgery within a multi-disciplinary team meeting (RCS, 2014). McCulloch, Rathbone and Catchpole (2011) also cite the problem that many of the tools that can be used to measure communication (such as the Oxford NOTECHS II scoring system) are inherently flawed as they '…attempt to quantify concepts for which objective measures do not exist' (p. 477).

The RCT studies may not address some of the extraneous factors that may have an effect upon communication outside of the operating theatre environment. Some of these factors include role ambiguity and power differentials, which are not discussed within the RCT-style studies. Rydenfält *et al.* (2012) intimated that communication can also be affected by the activity that is being undertaken. For example, if there is a shared understanding of the tasks being undertaken but there are faults in the systems of work, it may mean that effective communication may be compromised. Rydenfält *et al.* (2012) also makes an astute observation, that communication failures may arise from the differing interpretation that each professional group has of the task being undertaken. Studies such as Jefferies, Johnson and Nicholls (2011) also look into the written word and how medical notes are interpreted, thus bringing into question differing interpretations of some of the acronyms used by different professionals. This informs the current thesis through the use of X-ray requests and how radiographers interpret the clinical information provided and the tasks they are undertaking.

An important facet of work within radiography is the operationalisation of the protocols, or technique guides within the departments. As these are used widely to manage the process of justification through *IRMER 2017* the literature around protocols and their use must be discussed to further conceptualise the thesis.

2.3 Protocols and Power: The Mediation of Professional Boundaries

Protocols and policies offer the standardization of processes (including communication processes and job roles) within the clinical environment. Protocols are useful for the relay of specific, patient related information and therefore, the ability to enhance timely, accurate and specific communication between practitioners. There are often used in patient handovers (Tibbs and Moss, 2014; Wheeler, 2014) and are used in radiology to manage the process of

justification and examination selection by the radiographer. The directive nature of protocols can be seen as defining an aspect of a particular practitioner's role (*IRMER 2017*). Within other healthcare professional settings, they can be used to undertake a number of different roles. Roth *et al.* (2014) describe the use of protocols in managing risk and responding to specific emergencies. Their use here is to ensure that a specific course of action is undertaken by members of an emergency response team. This attempts to ensure that every eventuality is covered by assigning certain actions to members of the team. Protocols may be developed from guidance and may be seen as a way in which 'evidence-based practice' may be implemented.

Goldman *et al.* (2010) interestingly noted that whilst 'teamworking' is globally being delivered in healthcare, interprofessional collaboration remains difficult to operationalize via the types of protocols discussed above. They cite a 'mismatch' between the aims of the teams and that the process of work. The process of a team approach to producing protocols also appears to enhance the 'shared goals' of the team. For example, Goldman *et al.* (2010) stated that the teams had to develop protocols that targeted '… the FHT [family health team] needs' (p.658). This allowed the FHT to discuss what their needs were, explore their (and others) practices, and come to a group decision. This is essentially the team agreeing to terms and conditions that they place upon their work, via the implementation of a protocol. This also appears congruent with Xyrichis and Lowton (2008) findings of their literature review that noted that teams performed better with regular team meetings. It may be that this is a way that teams regulate their own work and, consequently, their roles.

The use of protocols within the healthcare setting has been linked with increased job satisfaction and a lessened intent to leave, usually by providing structure and clarity to roles and actions (Metcalf *et al.*, 2015; Olson-sitki, Kirkbride and Forbes, 2015). However, they are not always seen as empowering and some practitioners find that protocols are too restrictive and prevent creative thinking (Tume, Scally and Carter, 2014). Nurses who undertook role advancement in Emergency Care stated that whilst protocols defined their role, some of them felt that they did not let them treat the patient 'individually' (McConnell, Slevin and McIlfatrick, 2013). This is also echoed by Barrow *et al.* (2015) who have a telling quote from their study:

"Doctors recognized protocols' value when nurses delivered care in a doctor's absence (which may also suggest that protocols limit nurses' authority; creating a form of control-at-a-distance)." (p. 5).

The rationale given by the authors is that this is a form of medical control of nursing, at a distance. In fact, it is apparent that nurses 'own' and develop the protocol (p.4). This may be where power is being enacted by the doctors over the nurses, during the protocol development, rather than explicitly via the protocol itself. It may also be about risk aversion; this form of control may allow doctors to be called upon when things go wrong but ensure the status quo if the risk of injury to the patient is not too great. It may be dependent upon who takes authority/responsibility of the protocol. For example, the nurses produce the protocol and take ownership of it, then it may not be limiting their professional autonomy; in contrast, it could be enhancing and guiding it, whilst ensuring that they act within a defined scope of practice. There also appears to be differences within how the different professional groups interpret what protocols are for, which is not discussed by the authors. For example, one of their participants is dismissive in one sense "[leaders]…acknowledge that nothing follows protocol" whilst enthusing that they are "…bloody great…" (p.4). There is an apparent dichotomy happening here, as protocols themselves are seen as both enabling and restrictive in terms of practice. Therefore, it would appear that adherence and utilisation with protocols requires a level of engagement in the design of them. Within the current work, this required the identification of those who are involved in their production.

One reason may be exercise of power by the different professions involved in the care of the patient. Power here being the ability of one professional or professional group to dominate and control the other (Haugaard, 2021; Russell, 1932). The consensus of the literature is that power in healthcare is generally enacted by the medical profession over others, including staff and patients (Mammen, Hills and Lamb, 2023). However, there are examples within the literature of this concept being overturned somewhat. Examples such as Salhani and Coulter's (2009) research regarding Canadian mental health nurses and how they gained autonomy over the medical profession and Nugus *et al.* (2010) and their discussions regarding community interprofessional working. What these studies fail to address is why the medical profession has yielded power to other professional groups in this instance. There may be an element of the non-urgent nature of the work being undertaken. The power of the practitioner over the patient and other professionals is not required as the perceived risk of patient harm from the other

professionals is not great. Within the acute/sub-acute settings it appears that the medical profession is less inclined to give up this power (Kuijper *et al.*, 2024) than they are in the chronic or community setting (Franzén and Nilsson, 2024). This resonates with the discussions surrounding the development of protocols in Barrow *et al.* (2015) and the use of the protocol. It should be noted that radiographers work almost exclusively within the acute setting, and where patients are referred from the community, they may be sent to the hospital for the X-ray examinations.

Protocols and professional boundaries (and by extension, perhaps even identities) may be mediated by protocols, as they may be used in the setting of clear roles and scopes of practice. This can be seen as enhancing the ability of practitioners to work together within an interprofessional setting. Rushmer (2005) argues that definitive roles are not a barrier to effective interprofessional working but are, in fact, essential. In a healthcare system where, advanced practice is becoming more integrated into everyday healthcare (Fotsch, 2016; McDevitt and Melby, 2015) there is a need for boundaries to be visible, negotiated, and agreed upon. Protocols and procedures are a tool (but not by any means the only tool) which may be used to ensure that 'blurred boundaries' do not occur and create a potential for aggravation and mistrust in interprofessional working (Khan *et al.*, 2022).

A number of early papers discussed empowerment of all members of the collaborative partnership (see Lindeke and Block, 1998). This is also linked with what D'Amour *et al.* (2005) called 'interdependency' (p. 119). Perhaps for true collaboration to occur the power differentials need to be addressed, as without this, interdependency cannot emerge. However, the supposition that a '…collaborative process requires that professional boundaries be transcended…' (p.119) is perhaps slightly misleading. This is often cited in the literature without any real evidence that this way of working is necessary or effective within interprofessional scenarios, or without the discussion that there is a potential for conflict within this area. There is perhaps more pertinently the need for specific tasks and competencies from team members; people need to know what their roles are (Manser, 2009). It should, however, be noted that Manser (2009) is looking specifically at the dynamic domains of healthcare (theatre, critical care etc.). There is also the supposition that if these boundaries are transcended and normalised, does this not simply become another role in its entirety. This has perhaps been seen recently within the healthcare system in the UK as the role of the Enhanced Clinical Practitioner has emerged. It is worth highlighting within this discussion that the teamwork dynamic is perhaps

under-researched within the radiographic context. Possibly because of the conception of teamwork highlighted above, as them being transient members or sub-contractors, rather than a constant presence across the healthcare system.

2.4 Decision Making and Noise

Research on decision making has traditionally been focused on the decision-making process that binds individuals together. That is to say that the research focused on the similarities between individuals in the decisions that they make and the way in which they can (commonly) be wrong. There is now a large body of work that focuses on heuristics and bias. The term heuristic is commonly referred to as the 'shortcuts' that human beings make to reduce the cognitive load and come to a decision that is broadly correct or accurate (Kahneman, 2011). This has been previously described as system-one thinking. This can (and does) lead to bias being introduced into the decision-making process. The famous example of this psychological bias is that of being given a list of attributes for a particular individual and being asked which is the most likely to be true about that person. The most famous example of this is the 'Linda problem' and the modified version of this is outlined below:

"Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice and also participated in anti-nuclear demonstrations…Which alternative is more probable?

1. Linda is a bank teller.
2. Linda is a bank teller and is active in the feminist movement." (Kahneman, 2011, pp. 156-158).

In Tversky and Kahneman's (1983) original study there were originally a number of different options, but the above option was given to fully explore whether the participants in the study would apply probability logic. However, they found that people were more likely to choose option 2 over option 1. The cohort of people did not matter, students, medical professionals and statisticians all preferred option 2. As explained, by Kahneman, (2011) and following on from categories that are apparent in analytic philosophy, all feminist bank tellers are bank tellers; therefore, option 1 is the most likely, as conjoining the two above will always make this option less likely (because not all bank tellers are feminists).

A number of things are happening here. People assume that Linda is active due to her former credentials. However, they do not follow the question and think about probability in the wider sense – that it is more likely for one thing to be true, than for two things to happen simultaneously. The 'Linda Problem' has of course drawn criticisms from journalists, philosophers and psychologists in terms of the way in which the question is presented to individuals (Morse, 2014). Reverse this the other way round and most people would reply that 1 is more probable (e.g., Linda is active in the feminist movement' than both things being together). Scholars of analytical philosophy have also chosen to discuss the various probabilities that Linda is indeed both and that this is most likely logically (e.g., Olszewski, 2017). The statement of 'Linda must be a feminist' described as being true is discussed using Grice's four maxims[10]. This does, however, have the appearance of creative accounting rather than simply recognising that two things simultaneously being true is less likely than one thing being true. Perhaps such criticisms are missing the point; such presentations are not how they would occur to someone in a real-life situation. For example, a person can notice a few elements of another person or thing and then make a judgment based on those. It is those judgments, based upon very little information, that are prone to introduce bias into decision making. This is Kahneman's point - it is not that heuristics are inherently bad, but that they can introduce bias into thinking, and that those biases may indeed prove themselves to be correct at that moment in time. If they do so, they then reinforce a potentially erroneous element into thinking (Kahneman, 2011). Studies have highlighted that heuristics, particularly when used in clinical decision making, may indeed help through removal of extraneous factors and the reduction of cognitive load (Marewski and Gigerenzer, 2022). There have also been criticisms on the type of research that has been undertaken in this area, in particular the focus on vignettes in highlighting the issues that surround these mental shortcuts (Blumenthal-Barby and Krieger, 2014). Whilst there is agreement that further work needs to be performed from an empirical position, such papers miss a key aspect; that of knowing which information to ignore and which to put into the heuristic. It is this that is required to further change a person's thinking and to remove bias from decision making (Hughes *et al.*, 2020).

Heuristics can be classified into several different categories. Availability heuristic is a form of psychological bias where people perceive uncommon events (such as plane crashes) as being

[10] Grice's cooperative principle has four maxims for conversational communication – quantity (not too much or too little information), quality (not using deliberate falsehoods), relation (the information provided is relevant), and manner (be clear, brief and orderly). Of course, these maxims are often broken.

risky in the immediate aftermath of media coverage. This may be seen across the professions and has been investigated within healthcare. Previous studies in physicians have shown that when doctors come across a rare (but significant) case, their interpretation and integration of the information affect how they subsequently treat patients with similar symptoms. This happens regardless of whether the symptoms that the patients now present with are indicative of the previous significant disease (e.g., Ly, 2021; Redelmeier and Ng, 2020). In a similar manner, representativeness heuristic appeals to the apparent likelihood of something being true based on the individual similarity with a particular population (Minué *et al.*, 2014). This is sometimes referred to in the literature as 'gut-feeling' or something akin to intuition (Kostopoulou *et al.,* 2016). Previous research has shown that these two heuristic processes may make up the majority of bias within the clinical decision-making process (Fernández-Aguilar *et al.,* 2022); however, as discussed previously, the use of heuristics within clinical decision making is not necessarily something which may lead to incorrect decisions and may have the effect of reducing the cognitive load in complex decisions (e.g., Norman and Eva, 2010).

Whilst heuristics may indeed be useful, research in this area and that cited previously focuses on the introduction of bias into decision-making. Whilst bias introduction may form part of the process, there is also another element to the discussion that is required – that of noise. Noise is the result of inconsistent decision-making and is therefore separate to heuristics. Mental shortcuts may play a part in the development, but if a mental shortcut, or bias was consistently applied, then there would be no noise within the decisions being made, but they would still be biased (Kahneman, Sibony, and Sunstein, 2021). This is part of what makes noise a useful interpretation for the work of the radiographer. In essence, it is not possible to know whether the outcome of a radiographic examination was correct or incorrect. As an example, if a patient was to require an X-ray examination which did not adhere to the guidance, yet an abnormality was found on the radiograph that altered patient management, it may not be a clear 'correct' or 'incorrect' outcome (which would relate to accuracy). However, it may be possible to observe the noise within the system, based on whether two (or more) radiographers would have made the same decision. The reality is in fact more complicated that simply identifying the noise in the system. Prior to discussing this, a working definition of noise is required for the purposes of this thesis.

2.4.1 A working definition of noise

When any decision requires human judgment, there is a potential for noise (or variation) in the decisions being made. The working definition for noise within this thesis is derived from that developed by Kahneman, Sibony, and Sunstein (2021). However, before discussing noise it is prudent to focus on the ideal and identify the other (perhaps more identified) factor in decision making, bias. There are a number of different elements to decision making that can be further focused in on, particularly around clinical decision making and diagnosis. These may include accuracy, bias, and noise; accuracy and bias in particular are common measures within the decision making. To be clear accuracy refers to the number of decisions that may be labelled correct (e.g., X-ray report which identified correctly whether the patient has an X-ray identifiable pathology, or not) (Bland, 2015). Bias may be described within this context as being a decision that is systematically wrong in a consistent manner. For example, where the demographic information given to admission tutors influence their judgements made on the suitability of candidates (Axt and Lai, 2019).

Noise has traditionally been seen as a partial player within these decisions; however, it can have a significant influence. Noise within this thesis is seen as the differences between decision makers, both inter-individual and intra-individual. This variation may be due in part to bias, but not necessarily so (i.e., decisions can be biased *and* noisy). Noisy decision-making systems allow for considerable variation between different decision makers and at different points within the system. An extreme example of this noise can be seen when judges make sentencing decisions. It has been identified that as outdoor temperature increases the favourability of the sentencing towards a defendant decreases (Heyes and Saberian, 2019). Furthermore, within the legal research literature variation in the decisions made by judges in sentences may be influenced by other factors not related to the case such as the local college American Football team results and the previous case that the judge may have heard (Ludwig and Mullainathan, 2021). Noise then, by its very definition is not systematic and repeatable[11]. It is not systematic in nature and there are different categories of noise that may be useful to focus in on (Hicklin *et al.*, 2022).

[11] An example given in Kahneman, Sibony, and Sunstein (2021) is being asked to stop a stopwatch consistently on 10 seconds. It is not possible to get the time on 10 seconds exactly every time. There is very little noise within the system (within a standard deviations of a few ms) but noise is still present.

Within the literature there are different types of noise within a particular system (from now on the noise within a particular decision-making system will be termed system noise). System noise is identified as primarily consisting of level noise and pattern noise. Level noise is that noise which may be interpreted as the degree to which the decision maker is inherently predisposed to a particular decision. This is seen in some radiology literature on decision making as being able to identify those who are 'doves' (cautious decision makers) and those who are 'eagles' (able to make immediate intuitive decisions). Kahneman, Sibony, and Sunstein use 'hanging judges' and 'bleeding heart' judges to identify their predisposition to make harsher or lenient sentences (2021, p. 73). This therefore sets the 'level' of potential noise within the system (a type of 'background' noise).

Pattern noise is slightly different in that it is in some cases the changes in variation within the decision-making process. For example, a healthcare professional sees two patients with identical symptoms, age, etc. however, they then move on to approach the treatment of the two patients differently. This may be due to previous experience that the healthcare professional has had a with a particular sub-group of patients to which one of the patients belongs. This can be seen as stable pattern noise, in that the professional will always treat the sub-group in that particular manner (Mullins and Coughlan, 2023). It can then be further split into 'stable pattern noise' and 'occasion noise'. Stable pattern noise may be interpreted as the noise that occurs within an individual's judgment. In the example above, the stable pattern noise would arise from the health professional treating the similar sub-groups the same on a regular basis. This would be seen when the sub-group identified above was treated the same every time. This is sometimes seen in judge's decision making when they may routinely give lesser sentences to females.

There are examples within the literature of where guidelines and protocols reduce noise within decision making. Examples of these include clearly defined diagnostic criteria for physiological ailment (e.g., Centor/FeverPAIN scores for Strep throat; BI-RADS reporting guidelines for mammography). In these instances, the noise has the potential to be reduced within the procedures that health professionals undertake. These guidelines are developed in that they 'breakdown' the judgments being undertaken by the professional into manageable chunks.

To give an illustrated example, the FeverPAIN scores are divided into specific areas: fever within 24 hours; purulence (from the tonsils); presents to healthcare rapidly (within 3 days); inflamed

tonsils; and no cough. Whilst there may be judgments to made in terms of these criteria, there are also objective elements that are placed into the criteria. For example, purulence from the tonsils is a medical judgment (i.e., the physician has to make a decision whether they can observe this) whereas fever can be seen to an objective assessment (i.e., undertaken using a thermometer). The National Institute for Health and Care Excellence (NICE) also indicate in their guidance that whilst scoring systems/criteria have not fully evaluated within a UK context they are preferential to not using a scoring system to decide whether a patient requires antibiotics for a sore throat (NICE, 2023).

There may also be a certain utility in removing some information from those who are making the decisions. Axt and Lai (2019) have shown that removing demographic information from interviewers reduces the errors being made. There is also an assumption within their research that participants may not want to fully engage with *all of the information* that is available to them. This is possibly more to do with wanting to make a decision, whilst keeping the cognitive load low. An argument may be made that the judgment being made in terms of an X-ray examination, justification is a rule-based decision and therefore would be in the same area as the previous examples. Whilst an X-ray request is required to meet certain criteria, they may not be as straightforward as scoring criteria such as the FeverPAIN example that has been given above (i.e., not typically objective binary questions). Typically, and within this study, most radiology departments' protocols in the UK are derived from the Royal College of Radiology's iRefer Guidance (RCR, 2023). This guidance consists of clinical indications (clinical reasons why an X-ray examination needs to be undertaken) and the radiographic examinations and/or projections that are required to be undertaken for a potential diagnosis to take place. However, where the clinical information, clinical question and patient's symptoms, etc. fall outside of the guidance, this is where potential noise may be introduced into the decision making for the radiographer (or person who is acting as the designated practitioner) turning a thinking decision (based upon guidance) into an evaluative one (a judgment based on the evidence). This can be defined as a professional judgment made with the aim of accuracy (i.e., making the most appropriate decision for the patient). However, there will be an element of inconsistency across the judgements being made, for various reasons. This will include differences between and within professionals making evaluative decisions (Kahneman, Sibony, and Sunstein, 2021). The variation across the professionals and within them can be described as the potential noise within a particular system. The noise is particularly important when thinking about decisions that are made within the clinical arena.

The discussion of the impact of noise in decision making within the authorisation/justification of the X-ray examination request is perhaps pertinent to be clear about the nature of the activity that is taking place when a decision is made for the patient. An approach to the work of justifying/authorising the X-ray request may be seen as being protocol or rule governed in the first instance, as it is a requirement that protocols/guidance is in place under the legislations that guide the exposure of patients to X-rays (*IRMER, 2017*).

Therefore, the decision to make the X-ray request itself the focus of this research is useful. This showcases the important impact that the X-ray request has on the decisions being made by radiographers within the clinical setting. Decision making in has been explored in some areas of radiology previously (such as mammography reporting e.g., Clerkin *et al.,* 2024) has not been explored in the realm of clinical decision making and the authorisation and justification of the X-ray request.

2.5 Current Research on Decision-Making and the X-ray request

A scoping review process was employed to find and analyse the current research around decision-making within the radiographic context. The review as initially undertaken in 2017 and has been subsequently updated through to the completion of the thesis. The approach used the Population, Concept, Context approach as defined by the Joanna Briggs Institute (JBI) (Peters *et al.*, 2024). Search terms were developed from the initial completion of the framework and are identified in table 1. It was important to fully outline the different conceptions of the radiographer therefore various regional terms were used to expand the search. The databases to be searched were based upon the most appropriate of the institutional access and related to medicine/healthcare. Therefore, the most appropriate to be searched for this context were CINAHL Ultimate, MEDLINE, Behavioral Sciences Collection and PubMed.

Once the search terms were decided upon the JBI scoping review template was employed to outline the inclusion/exclusion criteria (Peters *et al.*, 2024). The criteria related to diagnostic radiographers in terms of population (therefore excluding therapy radiographers); the concept of decision-making was kept reasonably wide to ensure a higher sensitivity (given the expected paucity of research); and the context for the X-ray request was also kept broad. Decision making that related to system wide patient journey (for example, as part of a wider service

redesign were not included). The inclusion of all X-ray modalities was considered appropriate. Again, this was due in part to ensure that a full overview of the current evidence was able to be performed from this review. Snowball sampling also took place, whereby the literature from the 11 papers that were included in the full-text review were also used to identify any further pertinent literature (Chudyk *et al.*, 2018). This yielded a further 11 papers which went through the assessment process. One article was excluded as it was not in the English language (Norwegian) and one other was not included as it related to a wider patient process design, rather than to decisions made within the clinical environment. A PRISMA flowchart (Page *et al.*, 2021) is given below outlining the process (figure 1).

Table 1: Search terms employed and the use of Boolean operators.

Population	**Combined using AND**	**Concept**	**Combined using AND**	**Context**
Radiographer* OR radiologic technologist* OR medical radiation technologist*		Decision making OR decision-making OR clinical reasoning OR thinking		Justification OR order* OR request* OR examination*

What is apparent from the literature is that decision making in radiology is a relatively under-explored concept, and the decisions made with regards to the indications for imaging and the role of the X-ray request are even more explicitly so. Whilst, as with all professional roles, decision making has been an important part of the professional landscape since time immemorial, the investigation of decision making from the radiographer's perspective has been under-researched until relatively recently, with just over half of the 20 papers included in the review published since 2022 (n = 11).

A study characteristics table for the papers has been included (table 2, pp. 43-44). This shows the broad findings of the studies included, their geographical location, and a brief overview of some of the limitations of the works. Included within these studies were two recent scoping reviews. Diaby, Debess, and Teli (2024) attempted to pull together the literature around radiographer decision making as a whole, finding that clinical decision making was not a well-defined concept within radiology. Research focusing on the wider decisions made by radiographers appears to have increased within this area from 2016 onwards. Whilst Diaby, Debess and Teli (2024) overlaps with this literature review, the focus on the X-ray request

identified here included three further papers which add further to the discussions around radiographer justification of the X-ray request.

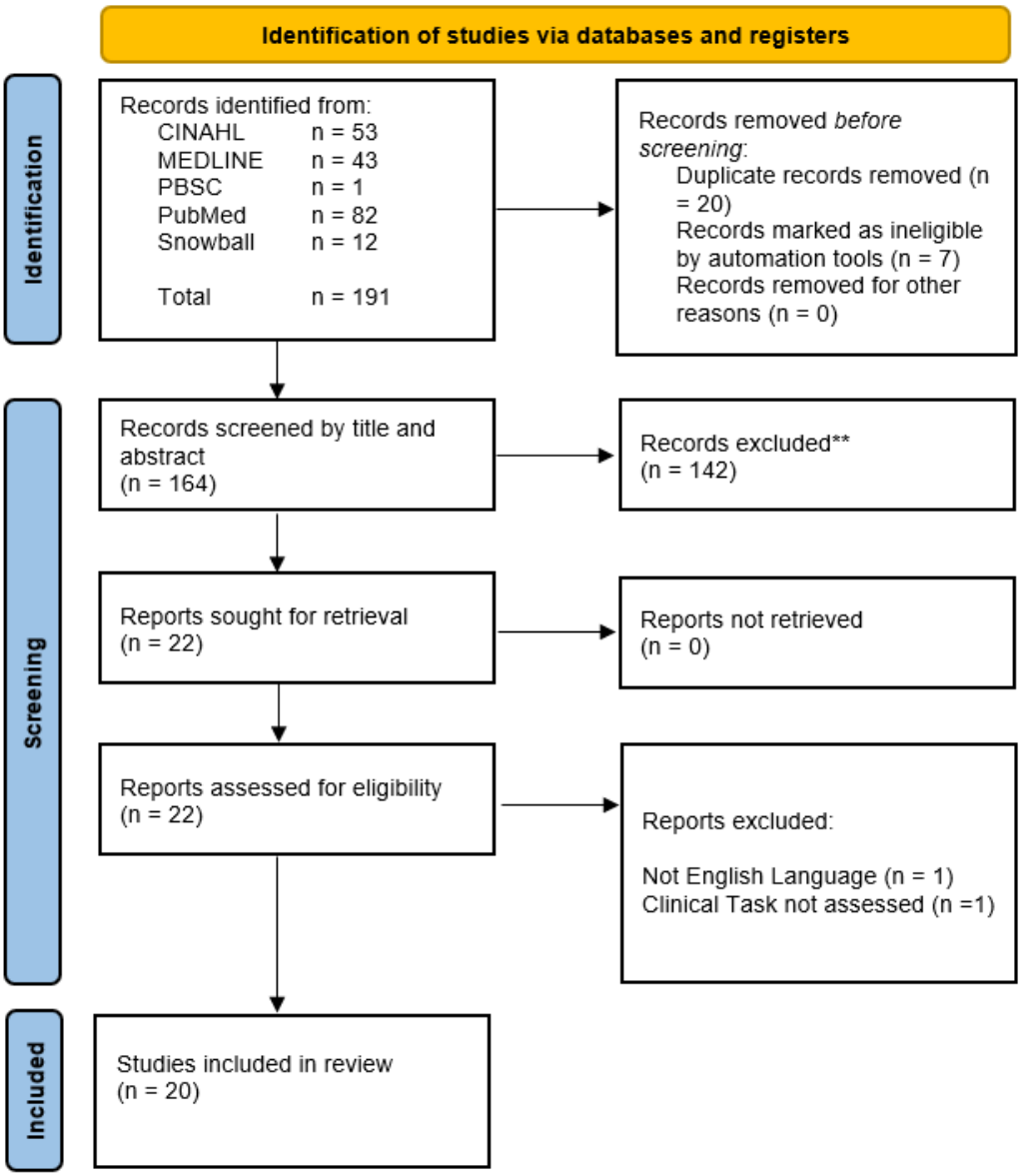

Figure 1: PRISMA flow chart showing process for scoping review.

The oldest paper included in this review Duszak and Berlin (2010) highlight some important differences in the approach taken between the UK and USA in terms of the radiographer's role within the assessment of X-ray requests. The paper focuses on a legal case of a patient suing a gynaecologist, radiologist and hospital due to a delay in cancer diagnosis, with a focus on the

Table 2: Study Characteristics of papers related to radiographer decision-making.

Author	Paper Type	Country	Findings	Contextual Limitations
Duszak & Berlin (2010)	Case Review	USA	Medical Hierarchy still at play in USA; communication between referrer and radiologist more important than between radiographer	Single case study
Malone *et al.* (2012)	Professional Report	Global	Implementation of protocols and guidelines advised for inappropriate referral management.	Expert opinion only
Makanjee (2014)	Qualitative	South Africa	Nurses sometimes fill in the request, and this can lead to inaccurate referrals; interprofessional communication can be an issue.	Primary focus on nursing
Borgen & Stranden (2014)	Questionnaire	Norway	Radiographers perceive that imaging referral is inappropriate; clinical referrers and radiologists do not.	Perceptions of practice.
Darcy *et al.* (2015)	Experimental (quants)	Canada	Eye tracking employed to see how radiographers made decisions on radiation exposure factors based on body habitus, which varied with age/experience.	Sampling issues, unclear as to eye tracking.
Vom & Williams (2017)	Review	Australia	Issues around medical hierarchy not letting radiographers' vet/justify requests.	Position paper
Villar-Palop, *et al.* (2018)	Quantitative	Spain	Half of all requests deemed appropriate; clinical presentation and referrer status influence this	Focus on referral rather than individual process
Chilanga *et al.* (2020)	Quantitative	European	58-57% of radiographers tested showed answers that aligned with guidance in CT/MRI.	Not undertaken in clinical environment
Ebdon-Jackson & Frija (2021)	Review	European	Computerised support system implementation may remove clinical decision making; problems with population-based decisions on an individual level	Professional guidance paper.
The Royal College of Radiologists (2021)	Professional Guidance	UK	Radiologists and some radiographers can vet/justify.	Professional guidance paper.

Chilanga & Lysdhal (2022)	Review	Norway	Radiographer and other professions should act as gatekeeper, use shared decision making, interprofessional communication.	Not empirical research
Chilanga, Olerud & Lysdhal (2022a)	Questionnaire (quants)	Global	Radiographers use referral information for a variety of purposes	Perceptions only; sampling issues.
Chilanga, Olerud & Lysdhal (2022b)	Questionnaire (quants)	Global	Radiographers discuss things with patients, radiologists and referrers.	Perceptions only; sampling issues.
Moore (2022)	Quantitative	USA	Radiographers perceive that majority of imaging is inappropriate.	Perceptions of practice; not in clinical environment.
Ooi *et al.* (2023)	Service Evaluation	Thailand	Radiographers may be able to undertake vetting for CT examinations	Service evaluation limiting wider applicability.
Sitareni *et al.* (2023)	Qualitative Interviews	Namibia	Vetting enhances patient care, but communication issues exist between radiographers and referrers.	Service evaluation limiting wider applicability
Clarke, Akudjedu, & Salifu (2023)	Scoping Review	Global	Radiographers currently vet in a wide variety of contexts.	Scoping review focused on expansion of radiographers' role
Diaby, Debess & Teli (2024)	Scoping Review	Global	Clinical information is used on the X-ray request to inform decision making	Not focused on the decisions made on the X-ray request.
Chilanga & Lysdhal (2024)	Questionnaire (quals)	Global	Five themes: Opportunity, competency, work environment, role perception and significance	Qualitative interpretation of free text comments; sampling issues.
Reitan, Sanderud, & Mussmann (2024)	Questionnaire (quants)	Global	Radiographers who engage in justification perceive it as a duty, think it is important, and perceive that they have the knowledge to undertake this role	Perceptions only; sampling issues.

impact of Medicare and protocols for ordering a mammogram. In short and for context, the paper describes a 58-year-old patient who goes to the gynaecologist as she has felt a lump in her breast. The gynaecologist performs a breast examination and cannot feel a lump but orders a screening mammogram (X-ray of breast) which does not show any lump. One year later the patient returns to the gynaecologist complaining of a lump in the same area, the patient receives a mammogram and then is subsequently diagnosed with cancer.

The use of the term 'ordering' should also be focused on, as this language in particular is unusual in terms of the UK context. Ordering indicates something that must be done, rather than a request for imaging, which is the usual term used in the UK (Remedios, France and Alexander, 2017). Whilst Duszak and Berlin (2010) focus on the appropriate application of Medicare legislation within the context of the United States, it does provide an insight into the radiographer's[12] processes when patient information is added to a request. In this particular case, the patient complained to the radiographer that she felt a lump in her breast. As this would mean different projections would need to be undertaken for a patient who is symptomatic (rather than a screening protocol) the radiographer communicated this with the ordering physician. Within the discussion, the hierarchical nature of healthcare becomes evident. Within the depositions reported within the paper the referring gynaecologist stated that if the radiologist (rather than the radiographer) had written to ask if the order could be changed the answer would have been yes. What is interesting also within this paper, is that essentially the patient should have been able to self-present for diagnostic mammograms, a practice explicitly stated as problematic and poor practice by International Atomic Energy Agency (2007). This paper therefore highlights the differences in practice between different geographical and legislative contexts.

The geographic, legislative and cultural implications are perhaps less explicit, but certainly present, within the antipodean context. Whilst not empirical research, Voss and Williams (2017) give useful overview in terms of justification of X-ray requests from an Australian context. However, even within this context, though perhaps for different reasons, the hierarchical nature of the delivery of radiology services appears to be apparent, with radiological bodies such as Royal Australian and New Zealand College of Radiologists (RANZCR) explicitly did not support the premise that radiographers can justify X-ray requests (RANZCR, 2019). Whilst not

[12] In the United States of America, the term radiologic technologist is used for radiographer. With Australia and Aotearoa/New Zealand the term medical radiation technician is also used.

providing any evidence that radiographers can, and do, justify X-ray requests the discussions within the paper highlight the importance of radiation protection and the need for justification of X-ray exposure (as outlined in *IRMER 2000* at the time, and *IRMER 2017* and amendments subsequently) should form the first step in terms of protecting patients from ionising radiation.

The importance of radiation protection from all aspects cannot be understated, especially in terms from the ethical perspective. Chilanga and Lysdahl (2022) pick up on the ethical implications for the patient utilising Beauchamp and Childress' (2019) four ethical principles. However, the discussion around the role of the radiographer implementing a system that operates ethically is quite brief. They highlight that sharing tasks such as referral vetting could help in terms of providing a service that operates on an ethical level. Again, like the previous work there is no link to empirical research that states that radiographers can, or have the capacity to, engage in such activity sharing. The research in this area appears limited with a single study within this review demonstrating that within a specific modality (i.e., Computed Tomography) that radiographer led vetting processes appear to improve the service through enhancing the CT service being provided (Ooi *et al.*, 2022). That said, a single centre service evaluation does not necessarily provide the level of evidence required to fully infer an improvement in terms of the resource allocation. Various issues with the study included the retrospective nature of the data collection, limited sampling, and absence of a control/usual practice group to view an enhancement, or indeed whether the service had a significant change in either direction during the radiographer led period (Howorth *et al.*, 2016).

The request form and the work that surrounds it does however, form part of empirical research. The role of healthcare professionals around the request is acknowledged to be confusing to those who do not sit within radiology departments and may, at times, present a potential source for interprofessional conflict. This conflict, however, appears to be more of a bureaucratic nature, than a clinical one (Makanjee *et al.*, 2014). Geographic location and local rules do, however, appear to play a part in the role of the imaging request. Within the United States, whilst the X-ray request did not appear to be a source of conflict *per se* a recent study demonstrated that over 90% of respondents perceived the imaging being undertaken as having no discernible effect on patients' management, with more than 50% of imaging being undertaken perceived by the radiographer as being inappropriate (Moore, 2022). This is at odds with the UK perceptions of imaging appropriateness for CT and MRI scans as these have

been reported as being as high as 93-95% across the two modalities respectively (Remedios, Drinkwater and Warwick, 2014). The discrepancy between these two findings is perhaps more easily explained. Moore (2022) focused on radiographers' interpretations of the request and Remedios, Drinkwater and Warwick (2014) survey departments in an audit capacity. Differences in perception of the work being undertaken, the questions asked in the respective questionnaire and differing professional education and values (Thomson *et al.*, 2015; Goldman *et al.*, 2016) are all variables that can play into the differences observed.

The justification of X-ray request s is an area that appears has been explored most from a Scandinavian context. The previous research also appears to be focused on decision-making in a wider professional context, often categorising the work into various phases. Previous research such as Lundvall, Abrandt-Dhalgren, and Wirell (2014) examined the professional role of radiographers identifying three phases which were adaptation of technique, responsibility for the patient and the quality of the image. This research did not focus explicitly on conventional radiography, nor was there a particular focus on the X-ray request, other than an acknowledgement that understanding the request was important. The lack of focus on the imaging request itself was similar to other studies undertaken where the focus was on different aspects of the radiographic examination, for example, Seo *et al.* (2022) and Darcy *et al.* (2015) focused on exposure factor selection; Sitareni *et al.* (2023) focused on computed tomography; Newton-Hughes (2016) and Talevski *et al.*, (2023) focused on appendicular trauma patients.

Two pieces of research from Chilanga and Lysdahl (2022 and 2024) and Chilanga, Olerud and Lysdahl (2022a) specifically focus upon radiographers' opinions surrounding the assessment of X-ray requests and therefore requires some further unpicking than perhaps the other papers in this review which do not focus solely upon the process of referral assessment, seeing this as part of the wider processes. The approach taken from these authors is a widely circulated questionnaire to members of the International Society of Radiographers and Radiological Technologists (ISSRT). Reitan, Sanderud and Mussmann (2024) also undertook a similar approach with questionnaires being distributed to Norwegian and Danish radiographers.

The findings of Chilanga, Olerud and Lysdhal (2022a) show that radiographers sampled with the questionnaire stated that they utilised the patient, fellow radiographer, and fellow consultant colleagues in the justification process, to ensure that the imaging was appropriately undertaken. Reitan, Sanderud and Mussmann (2024) findings indicate that the majority of radiographers

who responded to the survey indicated that justification is an important part of the work of the radiographer; with similar findings to Chilanga, Olerud and Lysdhal (2022a; 2022b) in terms of the approach to justification (confer with radiologists, referrers, and other radiographers). Within the later work (Chilanga and Lysdhal, 2024) discussed free-text responses which were provided by n = 81 of the respondents to the questionnaire. Here they identified a number of different themes across the responses (opportunities, competencies, work environment, role perception and significance). This paper highlights even more the wide geographical and cultural disparities between the respondents with some comments regarding training, work processes, medical hierarchy, and the lack of experience of some junior members of the medical profession.

There have been two published scoping reviews within this field during the write up of this thesis. Diaby, Debess and Teli (2024) scoping review focused on the wider decisions made by radiographers whilst Clarke, Akudjedu and Salifu (2023) appeared to take a slightly different interpretation. The PICO approach taken by the authors here to their scoping review compares radiographer-led vetting and radiologist-led vetting. This gives the review the implicit focus on the extension of radiographer justification into the advanced modalities (e.g., CT and MRI) rather than focusing on the approach in terms of conventional or projection radiography. The findings of both reviews place justification as being high on the radiographer's agenda, whilst Clarke, Akudjedu and Salifu (2023) highlight that there is a need for further training, predominately because these modalities are not normally radiographer-led in terms of vetting. This is highlighted through the work of Chilanga *et al.* (2020) who demonstrated that radiographers justification decisions in CT and MRI were appropriate around 50% of the time. However, Chilanga *et al.* (2020) was not performed within the clinical environment and used a test/experiment situation.

It does appear that the decisions made by radiographers in this conventional radiological setting varied widely based on the individual decisions that radiographers make, ranging from the engagement with advanced technologies (e.g., Ooi *et al.*, 2023; Sitareni *et al.*, 2023) through to the daily and more mundane decisions such as setting of exposure factors and communication with patients (Diaby, Debess and Teli, 2024; Clarke, Akudjedu and Salifu, 2023). However, both scoping reviews do underpin the importance of the clinical request in identifying the way the decisions are made, making it an important element of the clinical decision-making process (i.e., a something that lends the radiographer the information required to make decisions about the

patient journey) both in terms of the X-ray request's assessment and within their wider clinical decision making.

Recent radiographer specific research highlighted above has focused on the decisions made by radiographers, however, at the time of writing, none of these have focused on collecting data within the radiographers' workplace. The majority of research has been via questionnaires, with a focus on gathering their opinions and perceptions of the processes (Chilanga, Olerud and Lysdhal 2022a, 2022b; Reitan, Sanderud and Mussmann, 2024; Chilanga and Lysdhal 2024) and a single piece of research which focused on their experiences (Sitareni *et al.*, 2023). These pieces of research have not focused on what the radiographer does within the department when a request is received and all of the research concerns either a Scandinavian perspective (Chilanga, Olerud and Lysdhal 2022a, 2022b; Reitan, Sanderud and Mussmann, 2024; Chilanga and Lysdhal 2024) or Namibian (Sitareni *et al.*, 2023). There appears therefore to be a gap within the literature for a situated exploration of the actions, activities and external factors to be explored further within the process of justification of the X-ray request.

2.6 Summary

The current literature has unpicked different aspects of the research landscape within the realm of both healthcare generally and radiographic research in particular. The broader research around protocols and teamwork have provided an insight into the organisation of labour within the radiology context. Decision-making has also been discussed, providing the reader with an overview of the current radiographic literature that is focussed on the clinical decision making of radiographers in general, and the current gap in the literature around the interplay between teamwork, knowledge, protocols, and the decision-making that takes place when authorising/justifying requests for X-ray examinations within the conventional radiographic setting. The identification of heuristics and noise in terms of decision making is an important element to bring into the discussions. Noise can be seen as being something that is a non-human influence upon the decisions that are being made. This is an important element of current research.

The current thesis effectively focuses on a single aspect of this professional role, that of the justification of the request. As previously discussed, and further elaborated within the data analysis and interpretations, within the UK context it is important to bear in mind that this current

PhD study took place following the implementation of the *IRMER 2017* regulations and newly introduced professional guidance from the Society and College of Radiographers on the justification of radiographic examinations (SCoR, 2018). Whilst there has been previous research in this area, this has been on a global perspective and has not taken place within the clinical environment. The changes in the legislation and the evidence of a wide variety of geographical and cultural practices within the wider radiographic community focused on the assessment of X-ray requests, means that a more focused, empirical, and situated approach to this process is appropriate to enhance the understanding of what happens to an X-ray request *in situ*. Investigating the X-ray request poses some challenges. The following chapter will attempt to further explore how this non-human object may be interrogated. Within the thesis this will be through Actor-Network Theory (Latour, 2005) as a way of approaching the research to sensitise the researcher to the non-human, its potential agency, and how they are involved in the maintenance of practices (Reich and Hager, 2014).

Chapter 3: Sociomaterial Theories: Actor-Network Theory, Boundary Work, and Threads of Professional Practice

"…what we are concerned with here is the fundamental interconnectedness of all things…"

(Douglas Adams, *Dirk Gently's Holistic Detective Agency*, 1987)

This chapter introduces sociomateriality as a broad collection of interconnected theories that focus on the associations between the social and material worlds with special attention paid to Actor-Network Theory specifically, as the approach that underpins this work. The historical development of Actor-Network Theory will be discussed, with its beginnings in the sociology of science and technology, through the development of a post-Actor-Network Theory (post-ANT), and finally to Modes of Existence, Bruno Latour's final, ongoing project. Actor Network Theory as an approach to research will be critically analysed with reference to the shortcomings identified by its own proponents, as well as those of differing ontological and epistemological positions. These questions of Actor-Network Theory will be brought to the forefront of the discussion, along with critical analysis of those alternate approaches that are perhaps most critical of Actor-Network Theory. Following the discussion of Actor-Network Theory there will also be a discussion of other analytical frameworks which have informed this work. These are Reich and Hagar's (2014) six threads of professional practice and Star and Griesmer's (1989) boundary objects. These will be discussed in terms of their compatibility with Actor-Network and how they will further inform the work, and the data analysis is particular.

3.1 Overview of Sociomateriality

Prior to discussing Actor-Network Theory a brief overview of sociomateriality is required in order to properly situate Actor-Network Theory within this broader theoretical landscape. Sociomateriality is a collection of theories that ascribe to the perspective that society is not just the bringing together of people but is made through the interaction of human and non-human (i.e., material) entities (de Moura and Bispo, 2019). The definition of the term material is key to understanding the theories that constitute sociomaterial approaches. Fenwick (2014) provides an appropriate definition of materials within the approach as being '…the everyday stuff of our lives that is both organic and inorganic, technological and natural: flesh and blood; forms and checklists; diagnostic machines and databases; furniture and passcodes; snowstorms and dead

cell zones, and so forth…' (p. 47). Fenwick also highlights that there are many theories that sit under the banner of the sociomaterial including Actor-Network Theory, but also Activity Theory (Engeström, 2001), complexity theory (Fenwick and Dahlgren, 2015), the new materialisms (Fox and Alldred, 2016), etc. There is perhaps agreement between many on Fenwick's definition of the material whilst others would see the social as the summation of the interactions between human and non-human (or material) elements. Others eschew the symbolic nature of the interactions, specifically from a symbolic interactionism perspective (Latour, 2005) whilst other scholars may see no compunction in bringing together symbolic interactionism and sociomateriality (for example, Clarke, Friese and Washburn, 2018). Sociomateriality can therefore be viewed as a collective of theories which have, as a thread that binds them, a wider interpretation of the importance that the material has within society.

There is some debate about where Actor-Network Theory sits within the broader approach of sociomateriality. For example, there is criticisms of sociomaterial approaches more broadly that question the philosophical underpinning, particularly in terms of ontological application and neglect of social structures (Mutch, 2013). However, further critiques of sociomaterial theories have sought to place Actor-Network Theory outside of this banner (Mutch, 2013). There is also a broad application of theorists who cite Actor-Network Theory as being within the sociomaterial family (Leonardi, 2013; Fenwick, 2014). Given the unresolved nature of the debate, and Latour's (1999, 2005) aim of Actor-Network Theory being to disrupt the tension by not using society as an explanatory mechanism but rather the result of the associations between all entities within it (i.e., human and material things), it was deemed appropriate to place Actor-Network Theory within this broad theoretical amalgamation of linked theories. Therefore, a discussion of Actor-Network Theory is now required, to further explore the sociomaterial nature of the approach and its application to the current thesis.

3.2 Defining Actor-Network Theory

Actor-Network Theory is not an easy thing to provide a definitive definition of; both those initial proponents of the approach and those who seek to fully understand it often struggle with the underpinning elements of the approach. An example of Actor-Network Theory's resistance to definitive definitions and categorisation can be seen in the introduction to Michaels' (2017) work on Actor-Network Theory. Here the introductory chapter begins through outlining the situations that led to the book (post-graduate seminars), the number of citations associated with Actor-

Network Theory within various academic disciplines, and an introductory discussion that surrounds different *types* of Actor-Network Theory. The final part of the introduction contains a discussion that exemplifies Actor-Network Theory in terms of the difficulty of its conceptualisation:

"…ANT [Actor-Network Theory] cannot be easily packaged…it might once…have been reduced to an analytic recipe, this is certainly no longer the case…Rather it is a complex, oftentimes disparate resource (closely aligned with a particular, evolving, set of sensibilities) that opens up a space for asking certain sorts of methodological, empirical, analytical and political questions about the processes of a (more-than-) social world." (p. 2-3).

Therefore, Actor-Network Theory may be conceptualised as an approach to reality, and research, that forces researchers to ask questions of that reality, in terms of its construction and constituent parts. In essence, Actor-Network Theory is a set of sensibilities that are applied to research, rather than a *bona fide* theory that can used. There are, of course, certain ontological and epistemological underpinnings, and the application of these will be discussed further within the methodology chapter (chapter 4), but there is a requirement also to discuss some of the underpinning elements in this chapter as well. These underpinning epistemological and ontological assumptions are fundamental to the understanding of Actor-Network Theory and its utilisation within this thesis.

Bruno Latour is regarded as one of the principal founders of Actor-Network Theory along with colleagues such as Michel Callon and John Law. Latour (2005) perceives Actor-Network Theory as a way of approaching society (or, as he describes it, 'the social') and how it is constructed (i.e., put together) through tracing associations between entities (i.e., subjects and objects). To ensure that no association is left un-explored Actor-Network Theory requires the application of material semiotics[13] and relational materiality[14] (de Camargo Florini *et al.*, 2018). In a sense these are the terms that, when understood, are the keys that unlock the understanding in terms of using the approach to understand the social. Both terms are discussed below, so that it is possible to understand how the approach differs to more traditional interpretations of how social interactions are investigated. However, these are not the only elements that are integrated into the Actor-Network Theory approach. It is effectively a series of

[13] The meanings that are assigned to material things.
[14] The associations between material things.

approaches (or sensibilities) that can be used by researchers to invigorate research into social phenomena (Latour, 2005; Michaels, 2017). Through the analysis a network of associations is built. A further element that makes Actor-Network Theory unique is the focus on what the elements in the network *do*, including those that are non-human; that is to say that it is not only human beings that are actors within the network, but other material things can also be seen as actors (hence the term actant[15] which is sometimes used within Actor-Network Theory).

Actor-Network Theory is primarily an inductive approach; an approach which is rooted in the empirical, and it may be seen in this regard as being similar to a grounded theory style, particularly in terms of analysis (Zimmermann, 2008). Latour (1999) described the Actor-Network as an approach that is unconcerned with what has gone before, describing it as an attempt to break out of the structural hierarchies that dominate the social sciences and to move back towards the data (the data here being what is being performed by the entities within a network). Latour (2005) asks the social scientist to move towards a description so rich that no explanation is required. If any further explanation is required, then that description is simply not good enough. This may be seen as a move away from abstractions and abductions and a concentration on the observable associations that can be empirically delineated within reality. The use of 'the social' or society to be able to explain what is happening within society does not sit well with Latour, hence the requirement to *reassemble the social* i.e., to move away from using society as the explainer for the things that happen, but rather regard it (that is, society) as the product of when things happen (Latour, 2005).

To perform an effective explanation and critique of Actor-Network Theory it is first useful to unpick the terms used in the definition above. Semiotics can be seen as the study of order building. This can, at first glance (as can a lot of the discussions around Actor-Network Theory) appear counterintuitive; especially given the Actor-Network Theory assumption that hierarchy and order are abstract concepts that hinder the explanation of the (more-than-) social world. Therefore, material semiotics is perhaps better rendered as the meaning-making that includes material objects (Law, 2023). The application of material semiotics within Actor-Network Theory can be seen to have developed from the writings of various philosophers, including Albert North Whitehead and Michel Serres (Michaels, 2017). An example of this application can be seen

[15] Actant is a term periodically applied to actors within a network to note the categories of human/non-human do not apply (actor being typically associated with human agency). Within this thesis the term actor will be used, but this does not designate humanity, nor cognition, to any actor.

most obviously in the work of Serres (for an in-depth discussion see Serres with Latour, 1995). Latour and Serres discuss the notion of relations using the game of rugby as an analogy. During the discussion, Serres intimates that what makes meaning is not objects and subjects in and of themselves, but the relationship between them. Here, the notion of the 'quasi-object' becomes of importance and for Serres this quasi-object is the 'true subject' (p. 108). Rugby as the analogy here works, as it is that it is the ball that dictates what the players do (e.g., where they go; where they look; how they are organised); the ball can be slippery, and the fall or the bounce of the ball is uncontrollable. Serres also discusses Hermes, the Greek messenger of the gods, stating that, whilst the true subject may indeed provide the meaning, that meaning is often not faithfully transmitted[16]. The relation of material in the definition given above is that it can be applied to settings, machines, bodies, and languages, such material objects are the backbone of healthcare in general and radiography in particular, for example, radiographs, reports, protocols, patients, symptoms, etc. are all material objects.

Performativity is also part of the vocabulary of Actor-Network Theory but not perhaps in the way in which this is typically discussed in the social science (i.e., Goffman, 1971). The performativity with Actor-Network Theory is different to the common Goffman interpretations (e.g., Diedrich *et al.*, 2013). In the Actor-Network Theory or Latourian sensibility, the idea of backstage and front stage does not describe something that is real or truth. It is, in fact, a different reality; that is to say that they are both real. Therefore, performativity is what happens when a reality is performed. There is an element of the spatial, temporal, situation and a multitude of other factors that will affect how a practice creates objects and reality (Urry, 2004; Greco, 2012).

Latour (2005) discussed that the network is made up of associations, and those associations can be defined via intermediaries (those objects or entities which translate meaning faithfully) and mediators (those which do not transfer meaning faithfully). The difference between intermediaries and mediators may be usefully illustrated by an example through the distinctions that can be made between nylon and silk. Traditionally, silk has been seen as a highbrow material (for the upper class) and nylon as a lowbrow material (for the lower classes). However, traditional sociological analysis may interpret this as being due to a small number of mediators and come to the conclusion that this difference between the two materials is a representation of,

[16] An excellent example is that the above discussion is often stated as being related to association football (e.g., Michaels 2017) when in fact, the discussion between Latour and Serres is about rugby –the content is different, but the meaning remains the same (in my humble opinion rugby is perhaps a better analogy as the ball bounce is more unreliable in comparison to a football).

for example, class struggle. However, this does not take into the chemical differences between the materials and how these influence the touch and the aesthetic. These are examples of potential mediators. Perhaps without them, there would be no difference between them at all (Handley, 1999). It is important to recognise that mediators may be transformed or changed into intermediaries, but this is not the norm. This may occur only with association and enrolment of other mediators to the actor-network (Latour, 2005).

There is a certain intellectual flexibility within the approach that gives an Actor-Network Theory a wide applicability, outside its original application in the social studies of science. As such, Actor-Network Theory views social interaction (or social associations) and society not as a static edifice but as a set of inter-connected relations between actors. Actor-Network Theory has a focus not just on the human relations that lead to action but also that of non-human entities, drawn from the work of Serres discussed above. This set of practical approaches allows these relations, their meanings and their translations to be traced through a series of mediations. These terms (translation, intermediary, mediators) can be seen as problematic and will be further discussed below. These sensibilities can be described as the following: neutral vocabulary, a focus on relations, topography of the interactions, empiricism, and the reflexivity of the researcher (Michael, 2017). These orientations may appear at first disparate, but through interrogating them further, in relation to the proposed study, the rationale for making Actor-Network Theory the overarching conceptual framework underpinning the analysis will become clear.

3.3 The Development of Actor-Network Theory

In the late 1970's there were developments within the social science of knowledge that can be described as fore-runners to Actor-Network Theory. Pinch and Bijker (1984) outline a useful overview of the differing approaches within the sociology of science and the sociology of technology and highlight where the two different approaches may be able to learn from one another in their application of social constructivist approaches. Within the work of Pinch and Bijker (1984) there is perhaps too narrow a view of the seminal work of Latour and Woolgar (1979; 1985) '*Laboratory Life'.* Latour and Woolgar's (1986) work is primarily an in-depth ethnographic study of the work and practices that took place within the Salk Institute over a 2-year period, seeking to describe, explain, and understand the approaches taken by scientists to undertake and disseminate their work. It effectively illuminates the subtle processes and actors

that are involved in the *construction* of science and scientific facts. Lezaun (2017) draws attention to the key phrase within the findings (and the subtitle) of the work – that of *construction*. Latour and Woolgar here highlight that there is more to scientific facts becoming accepted than assumed at first glance. There are a number of objects that hold together the loose network of things that make up a scientific 'fact'. Pinch and Bijker (1984) are perhaps a little too dismissive of Latour and Woolgar's work as being 'at the laboratory bench'. The discussions within *Laboratory Life* are much wider and included not just the laboratory work performed at the laboratory bench (which of course, includes test tubes, pipettes, analysers, etc.) but the arguments and discussions about scientific papers, resourcing, and other organisational issues. The work stands out for its situated and contextual findings about how science is constructed at the coalface, rather than solely at the laboratory bench.

Following on from this there is a departure of Actor-Network Theory (at this point occasionally termed the 'Paris School') from the Strong Programme. Whilst being aligned with the Bath School in terms of the approach's foci being on the micro-level interactions of human, there appeared differences in approaches. These differences were driven in part by the influence of continental philosophy (in particular Michel Serres and Michel Foucault) on Latour and other practitioners of the approach. This led to oppositional discussions from Callon and Latour (1992) in particular in terms of the relationship to the Strong Programme. This was a colourful exchange in which Callon and Latour accused the Bath School of xenophobia[17] (though perhaps, this should be taken as tongue-in-cheek!). A major difference between the two approaches is found in the interpretation of what symmetry and impartiality means within each approach. This is exemplified (and partly alluded to previously) through the treatment of the nature of human agency, and crucially the agency of non-human entities. The Strong Programme position was that the durability of facts (regardless of truth or falsity) was due, in part, to hegemonic structures (notions such as social mores or shared understandings). This is rejected by those practising Actor-Network Theory as making social abstractions the explanatory mechanism (Callon and Latour, 1992, p. 348). This is a key aspect of Latour's work; that hierarchical structures are the causes of sociological phenomena is not a full explanation, rather the result of association/connections/power struggles within a network of

[17] Callon and Latour put words into Collins and Yearly's mouths describing themselves as '…bloody foreigners…' who were now interfering in a field of study that '…the British have been firmly in command for many years…' (p. 343).

things. This led to a turning point within Actor-Network Theory, that of the sociology of associations, rather than the 'sociology of the social' (Latour, 2005).

Following these explorations Actor-Network Theory emerged from them changed from the original prepositions discussed above. Part of the reason for this was that there were accusations from those critical of Actor-Network Theory that it had become an enabler of normative explanations. For example, Callon's work within economics was criticised by social theorists for focusing in on normative economic theory and not engaging with those economists of a more critical and/or radical stance (Bryan *et al.*, 2012). Similarly, Latour's in-depth analysis of the French legal system was criticised for being too in awe of the lawyer and the language of the law (Pottage, 2012). But perhaps these criticisms miss the point of Actor-Network Theory as an exploratory approach. The purpose is to describe a reality that has *become*, rather than ascribing truth to a particular account of reality. This leads the reader towards the other criticisms of Actor-Network and whether this approach is as radical as those who practise it think.

3.4 Criticisms of Actor-Network Theory

Perhaps the starting point for a critique of Actor-Network Theory is to begin with the criticisms made by its main protagonists! For example, Latour (1999; 2005) is often quoted as stating that there are four problems with Actor-Network Theory. The words actor, network, theory, and the hyphen[18]. Callon (1999) also explained that a shortcoming of the use of the term 'Actor-Network Theory' was it was everything *but* a theory. Callon and Latour (1992) were also critical of their own position in that they wanted to '…go on looking for alternatives, original methods…radical definition of the field…' (1992, p. 344).

One of the issues that many who begin on a journey with Actor-Network Theory find is that the terminology used within it can seem obtuse, even deliberately so. This is due to the deliberate attempts of early Actor-Network Theory scholars, not to obfuscate, but to provide an alternative to traditional sociological research (i.e., what they saw as using the 'social' or society as an explanation for phenomena). As previously discussed and worth bearing in mind here is that Actor-Network Theory scholars prefer to view the social or society as an outcome, rather than an explanation. Latour (1999; 2005) and Law (1999) both regarded traditional sociology as

[18] Latour also described these as 'Four nails in the coffin.' (Latour, 1999, p. 15).

being stuck in a never-ending cycle of two interrelated research paradigms. One focusing on individual interactions and the other focusing on abstract concepts such as culture, norms, values, etc. For example, as Latour states:

> ‘‘… [Actor-Network Theory] is simply a way of paying attention to these two dissatisfactions, not again to overcome them or to solve the problem, but to follow them elsewhere and to try to explore the very conditions that make these two opposite disappointments possible.’ (Latour, 1999, p.17).

As early Actor-Network Theory scholars wanted to remove some of the inherent biases that reside within the traditional sociological approaches, they therefore developed terminology that attempted to remove some of these biases. Callon (1999) has an interesting take on Actor-Network Theory’s inability (and indeed its refusal) to adequately define and delineate what an actor is. Callon is unequivocal in his response, stating that this very refusal to be specific about what an actor is or does is exactly what makes Actor-Network Theory so unique. In fact, when discussing actors and intermediaries it can be difficult to see the difference between the two. Callon (1991) defines the actor as having the ability for authorship and change. Therefore, something can be an actor or an intermediary but only an actor can put other intermediaries into the network. To further muddy the waters, Latour (2005) introduced the concept of the mediator. Again, this is similar to an intermediary, but a mediator may distort meaning, whereas the intermediary translates meaning faithfully and other entities act upon the actor, making it do something or react to something. Therefore, an actor can be a non-human entity, and it can also be an intermediary or mediator as well. What *it is*, will depend on a specific context and the associations that are made between them (Latour, 2005).

The underpinning philosophy of the approach has its roots mainly in the post-modernist and post-structuralist continental philosophers of the late 20th Century, such as Foucault, Deleuze, and Serres. As stated previously, it should also be acknowledged that there are also echoes of the philosophy in the Sociology of Scientific Knowledge (SSK), often seen as a forerunner of Actor-Network Theory. What links the philosophical approaches here is that they are, essentially contingent. There appears to be an element of Foucauldian influence here as knowledge is seen to be confined to a specific episteme (Foucault, 1970; 2002) and is informed through the practises (i.e., the ‘doing’) of that particular time and place. For example, post-structuralism rejects the assumption that discourse (as a means of constituting knowledge) can

be pinned to any one ontological theory. Knowledge of the world is therefore not a static, solid edifice. It is contingent. This is perhaps best exemplified by Foucault's preface to 'The Order of Things' (1970; 2002); his description of the 'certain Chinese encyclopaedia' where the taxonomy of the animals (both real and imagined) at first reading appears rather eccentric to modern sensibilities:

'a) belonging to the Emperor, b) embalmed, … e) sirens, f) fabulous, … m) having just broke the water pitcher, n) that from a long way off look like flies' (p. xvi).

This is important as it demonstrates that knowledge is embedded within the historical context. To build on the above, society's current preferred biological taxonomy is rather different but can still be said to be contingent. That is to say that it is heavily influenced by a particular approach to animal classification (current classifications includes mother producing infant milk, presence of a backbone, ability to regulate body temperature, etc.). It is preferential *at this time* to have such a taxonomy of animals, as the repercussions of touching 'the Emperor's' animals are not of immediate concern now. This aligns with Latour (1993) and his work within the field of the science and technology studies. His analysis of pasteurisation, seen as a classic within the field, stated that the reality of bacteria did not exist prior to its discovery. Foucault's influence on Latour can be seen here – essentially drawing attention to the notion that the classification of bacteria as an entity did not empirically exist until its creation for the purposes of science. This is consistently misinterpreted in popular critiques of Actor-Network Theory (e.g., Latour, 2005), that Latour is denying the existence of bacteria prior to Pasteur's discovery under the microscope. What he means is that the *scientific construction* of bacteria did not exist until this point and that this was the result of the enrolment of materials into the network that bacteria, in the scientific sense, came into being. There is no denial of science, or of the scientific process (Latour, 2005). Occasionally, this commitment to redefining the language used is perhaps what leads towards criticism of the approach.

This also brings the reader back to the Latourian interpretation of the point of Actor-Network Theory. In the interlude of *Reassembling the Social*, Latour provides a fictional dialogue between a post-graduate PhD student in organisational studies and a professor of Actor-

Network Theory[19]. In their discussions the 'professor' makes an interesting point, that of Actor-Network Theory being a new perspective on the sociological world. An opportunity to, just as science has done, change perspectives and the interpretation of the social (Latour, 2005, p. 141-156). This can be seen as Latour indicating that Actor-Network Theory's *raison d'etre* is not ontological in nature, but to challenge prevailing perception of what counts as knowledge (i.e., epistemological). This relates to the earlier discussions of *Laboratory Life* in that the major influence of that work was to change the view of how knowledge is constructed.

There are less populist but more academic critical analyses of Latour and other proponents such as Michel Callon and John Law. These criticisms have however, further shaped what Actor-Network Theory has become of the intervening years. During the so-called Strong Programme that was developed within the Sociology of Scientific Knowledge there were opinions expressed that Actor-Network Theory's approach to symmetry was not appropriate and a significant barrier to meaning interpretation of data (Lezaun, 2017). This was because it was felt that the Actor-Network Theory focus on the non-human was leading to an elevation of the scientific method within the work (Collins and Yearly, 1992) and that this subsequently reinforced the interpretation of the 'strong-man' of science, allowing Latour (1994) and Callon (1986) to show that human beings were in charge of ordering and organising these elements rather than specifically emphasising the role of the non-human. Latour's work on Louis Pasteur (Latour, 1993) was perceived as elevating Pasteur to a god-like status (Shaeffer, 1991). Some of these criticisms were seen as being fundamentally an ontological issue, with the different interpretation of what symmetry is from a methodological perspective. However, both Latour (1999; 2005; 2013) and Law (2004; Law and Lein, 2012) have further developed the approach. Both authors have made statements that theories within any field should remain open and contested; the only thing that should be constant is the changing of face of Actor-Network Theory (i.e., that this approach should adapt and change). Latour even likened himself to Victor Frankenstein and Actor-Network Theory as a monster that he had created, and that he should go '…all the way in developing its [Actor-Network Theory's] strange potential…' (Latour, 1999, p. 24). The manner of the change becomes evident in Latour's *Reassembling the Social* (2005) whereby he introduces the concept of mediation alongside that of the intermediary (as discussed above). This is essentially where meaning is changed or adapted in the association

[19] This section is particularly enjoyable as it shows some of Latour's humour and playfulness. It also accurately characterises the frustration of a student who would like a 'straight answer' but then realises that the world is far more complex than they first think…

between two objects within the assemblage or network, giving greater focus on the way in which the interactions occur, rather than ascribing power to a certain object (whether human or non-human).

The post-structuralist narrative is therefore useful for interrogating those issues that have traditionally not been part of society or 'the social' (Latour, 2005). Foucault's analysis disregards the 'knowing subject' allowing material things to have action or agency properties. But what are regarded as material things? Objects can be placed into one of three categories, namely physical, social, and abstract (Bulmer, 1969). The philosophical perspective used within this thesis is one that includes all of these as actors within the work that is undertaken within the radiological context. The evidence exists within the radiographic literature that abstract concepts such as professionalism and culture exist within radiographers' work (e.g., Strudwick and Day, 2012). It would therefore appear prudent to re-interpret what this means 'at the coal face' and how such objects mould the work that is undertaken. Clarke, Friese and Washburn (2017) also indicate that objects are central to collective identities. It therefore follows that the collective identity of those undertaking the work will also have an effect on the how the work is undertaken, given the influence of these objects. This interpretation of the material or non-human world as potential actors is a very useful device, allowing the researcher to problematize the traditional view of the social world (Hiba, 2025). Through this lens, it is possible to stop seeing social interactions as being merely about how *people* interact together, but about how interactions with objects and subjects (whether human or non-human) can shape the production of society. It is therefore possible to trace the influence that these entities have in these interactions (Schatzki, 2001). That being said, it is possible to lay a significant criticism at the door of this approach. Many of these objects are created by human endeavour, therefore human-made objects are influencing humans in the workplace. This be resolved through the integration and development of the concept of hybrids, which are discussed further below.

Ontologically Actor-Network theory can allow the expansion of the interpretation of reality and what, materially, renders reality visible. This thesis takes the view that a revised interpretation of ontology can be implemented, in the manner of Mol's (2002) work *'The Body Multiple'*. In Mol's work there is a focus on how *practice* enacted on *objects* makes *reality* and that *different practices* can make *different realities*. Mol describes how ontology can be '…more than one, but less than many' (2002, p. 151). The rationale for this approach in the current thesis is that when discussing many different professions and many different patients, with many different

extraneous variables impacting their (individual and group) thought processes, what is required is not to view ontology as a static edifice, but to recognise that this mess, in Mol's words, can create multiple ontologies. To achieve this, it has been put forward that the standard methods and methodologies employed in social science research are too normative to be able to cope with all of the extraneous variables, in effect being blinkered to 'the whole messy picture' (Law, 2004; p.24). Therefore, the goal is not to explain or derive a preference for one constructed truth over and above others, but to discuss how objects are handled in the practices that are being undertaken (Mol, 2002). Action is what makes objects real (bringing to the fore again, the work of Serres). It is action that leads to the bringing together of objects, discourses, and knowledge that gives rise to the emergence of the Actor-Network (or assemblage) (Michael, 2017). Some may state that when objects and people are brought together that a goal must be coherent for action to happen. It is often not, which is what can lead to divergent practices being employed (e.g., Law and Lien, 2012) which has further utility when used within a healthcare perspective.

Critical Realists have been predominant in the critique of the theoretical underpinnings, and application, of Actor-Network Theory (e.g., Elder-Vass, 2015; Elder-Vass, 2019; Mills, 2018), despite, or indeed possibly because of, close theoretical ties. There are those that see critical realism as being a predominantly quantitative methodology (Bleiker *et al.*, 2019). However, this is not the case (Bryne and Ragin, 2009); whilst critical realism has a focus on the empirical, the nature of the data does not necessarily lead directly to quantitative investigations, but rather, a focus on all data. There has also been some criticism that Actor-Network Theory offers nothing that critical realism does not already do or draw upon and it is in fact not what it purports to be (Elder-Vass, 2015; Elder-Vass, 2019). This criticism is partly due to Latour's previous refusal to explicitly engage with such ontological and epistemological discussion. However, Latour in his later work began to engage with these discussions through the concept of 'modes of existence' (see below, and Latour, 2013). Critical Realist had previously stated that the ontological underpinning of Actor-Network Theory can be interpreted as being shallow (acceptance of only the empirical and actual data) whilst the critical realist position is that in applying critical realism there is engagement in a deep ontology and that Actor-Network Theory cannot access. It is described as deep as it tends to infer the existence of causal relationships (Byrne 2009; Brennan *et al.* 2017). However, this deep/shallow interpretation is not strictly speaking as dichotomous as it first appears. There are those within Actor-Network Theory who advocate an alternate ontology, that of fractal realities, as discussed above with regards to Mol's (2002) work

(e.g., Law and Lien, 2012; Law, 2004). These alternate ontological positions seek to change the focus of explanation from the abstract and towards the multiple, through a focus on what is done (i.e. practised) rather than how to find a particular 'truth' (Mol, 2002). This also deals, in part, with Baskar's epistemic fallacy, that is to say that what is known of something is not the same as the thing itself (Farasoo, 2024). However, the integration of practice within this (Mol, 2002; Schatzki, 2012) gives an insight into the creation of reality through practice, as opposed to the different domains of reality (see Bhaskar, 2016) which, arguably, can only be inferred and by Bhaskar's own admission, abducted from the reality that is perceived. Without tracing the wider impact of the associations within society, can it be ensured that the abduction is warranted.

This criticism of the critical realists of Actor-Network Theory not taking into account the three domains of reality, and also structure more widely, leads into an exploration of structure and agency within Actor-Network Theory. Traditionally, this has been the preserve of structuration theory[20] and the predominant tool within the social sciences as a way of explaining social phenomena (Canary and Tarin, 2017). Actor-Network Theory has effectively removed the societal structures from the equation through the advocation of a flat ontology. Therefore, appeals to the actions of traditional structures or hierarchies is not of concern to Actor-Network Theory. However, to some of its critics, this is Actor-Network Theory's biggest failing (e.g., Alcadipani and Hassard, 2010). Unsurprisingly, the main these criticisms come from the use of other theories where structure and agency are interlinked, and structures form the basis of analysis.

Structure is inherent with the analytical framework, being interpreted as relationships that exist at different positions within a social sphere (Jones and Bradbury, 2018; Modell, 2020). There is an interplay between society and action that occurs within critical realism, whereby the two are inexorably linked (Bhaskar, 1979). This interplay is denied by to a certain degree by Actor-Network Theory scholars. Not to the degree that there is no structure to society, but rather that structure cannot be used as the explanatory framework or mechanism (i.e., to explain why things happen in the manner that they do). The social (as Latour (2005) describes it) is a series of connections, and the focus of Actor-Network Theory is to trace those associations. Whilst simplicity of analysis is often levelled at Actor-Network Theory, the same can be said for the

[20] This interpretation of structure is different from the aforementioned critical realist view of reality and relates to the more traditional sociological view of the organisation of society (e.g., institutions such as government, etc.)

criticisms that the framework elicits. For example, it has been said that Actor-Network Theory and other post-structuralist methods have a focus on 'verbs rather than nouns' (Reed, 1997, p. 26). As the focus is on empiricism within Actor-Network Theory, this criticism is essentially true, as what it is possible to trace (empirically) is what things do, not what things are. This seems akin to stating that the only thing being studies is what happens. Reed (1997) also states that:

'We are left with an entirely process-driven conception of organisation in which any, even residual, sense of social structures …dissolves away in the analytical fascination with the local, contingent and indeterminant' (p. 26).

This is not surprising given that Actor-Network Theory denies the explanatory mechanism of such structures and perceives the overall importance of the local. However, for those undertaking Actor-Network Theory analysis, it is how actors are enrolled into the network that is the cause for study, rather than the use of power of one actor over another.

Criticisms of Actor-Network Theory have attempted to unpick the proposed ontological and epistemological assumptions made by this 'theory' as it is argued that those that are proposed are often at odds with the reality of the method employed, data collected, and its interpretation (Whittle and Spicer, 2008; Elder-Vass, 2015; Modell, 2020). Actor-Network Theory can be seen to take an ontological anti-performative stance, through a reinterpretation of power relations. There is a criticism that Actor-Network Theory is, in fact, not critical enough to take this anti-performative stance. For example, Walsham (1997) has stated that there is limited analysis of social structures within the Actor-Network Theory literature and therefore it cannot adequately be used within an anti-performative critique. This can be explained through the philosophical viewpoint of Actor-Network Theory of that there is no structure to society, only associations within the network. Within this view, how could Actor-Network Theory critique social structures if a core tenet of the approach is that those structures are not the explanatory mechanism for action, but rather the result of them. To focus analysis on structure (or structural forces) moves into realm of that structure being the explanation of what is happening, rather than the outcome (Latour, 1999; Latour, 2005).

A similar discussion is apparent with the accusation of an *under-powered* Actor-Network Theory specifically when focusing on its anti-dualist stance. Anti-dualism within Actor-Network Theory allows a return to a discussion of symmetry. Actor-Network Theory does not associate action

with only humans but also with non-human objects. A criticism of Actor-Network Theory is that through using it, a distinction has already been made between human and non-human actors. This means that there is already a dualist position being undertaken by using Actor-Network Theory (Whittle and Spicer, 2008). At first glance this appears to have merit; by using the phrase human and non-human a dualist distinction has already been made, of that there is no question. There are, however, dangers with this particular stance on the perspective of these objects within Actor-Network Theory. There is a danger of entering into an *ad absurdum* dialogue where researchers end up having to interview scallops or fuel cells (Law, 2004) to ensure that human/non-human entities are treated the same, therefore employing no distinction between the two. Whilst the dangers of anthropomorphising non-human entities should be kept in mind, this particular argument is perhaps too simplistic an interpretation of symmetry. The interpretation within this thesis (and within Actor-Network Theory generally) is that the focus should be on ensuring that proper currency is given to the boundaries of *action* that exist, not to the cognitive existence of non-human entities. Therefore, whilst the focus in this research is upon the X-ray request, the purpose is not to give (human) cognition to the X-ray request, but the assumption is made that it has the potential capacity to *act* within the network, as much as a radiographer does. It is also not the assumption that the X-ray request (or any other entity within realm of the study) is acting in the way that it was *designed* or *intended* to do.

Actor-Network Theory does provide the researcher with a way in which to pay attention to the role of non-human entities. The criticisms that have been laid at the door of Actor-Network Theory are often not of its own making *per se*. The engagement in fruitless arguments regarding the nature of the anti-dualism being practised does not make sense on a practical level, as a circular, irreducible argument would then ensue with no possibility of resolution (unless all non-human entities suddenly develop cognition). The majority of criticism really lies at the feet of those who have been practising an ineffective application of Actor-Network Theory or the limitations of research in general (see Whittle and Spicer (2008) for a good example of this). In reality, this means that the researcher needs to be aware of the potential for moving away from a successful application of Actor-Network Theory. There are some caveats attached to the application of Actor-Network Theory, but these should be overcome as long as the researcher is engaging in effective reflexivity.

A particular interpretation of human and non-human is that of the existence of hybrid entities (as briefly mentioned previously). The existence of hybrid entities is also acknowledged by those

within different methodological fields who have drawn upon all or part of Actor-Network to inform analysis (e.g., Clarke, Friese and Washburn, 2018; Hurlbert and Akpan, 2022). Clarke and colleagues (2018) define the boundaries between the human and non-human as 'leaky' meaning that there is an element of cross-over between where a human being stops, and technology starts. This has gained currency in recent years, with the advent of information technology in particular. However, the concept of hybridization is not new. Both Latour (1994) and Law (1994) both intimated that if professions are stripped of the technology (whether 'high' e.g. computer, projector; or 'low' e.g. desks, lamps, etc.) then it becomes impossible or extremely difficult for those people to undertake their roles. This is explained with Latour's example of the *citizen-gun*. Rather than subscribing to the left-leaning political viewpoint of 'guns that kill people' and that of the right-leaning alternative ('people kill people') Latour asks for a switch in understanding. He states that the real culprit is the citizen-gun. Both the gun and the person holding it have become a new, conjoined entity. Therefore, it is the citizen-gun that requires further exploration, not the separate entities (Latour, 1999). This is important when conceptualising and thinking about healthcare. What is the surgeon without the technology that is used within surgery, or in this particular instance, what is the radiographer without the X-ray machine, the symptoms of the patient, or more specifically, the X-ray request or *IRMER 2017*. In essence actions are being interpreted differently, for example, the radiographer cannot act without the X-ray request, and the X-ray request cannot act without the radiographer.

Actor-Network Theory offers the researcher the opportunity to trace associations and interactions within the network. These interactions allow the researcher to build up a picture of what is unfolding before them. These associations are being constantly produced and reproduced, they are constantly in flux and are therefore heterogeneous in nature. This heterogeneity requires unpicking as these interactions will almost certainly be context specific. This is an issue with regards to some of the criticism laid at the door of Actor-Network Theory. However, empiricism is key to understanding these relationships. As Latour (2005) alludes to, one must allow the actants to speak for themselves and to tell their own story – not that of the researcher (whilst of course acknowledging that the researcher, by their very presence, is part of what makes the network exist). One must resist the temptation to make assumptions. This also underscores the commitment to neutral language of Actor-Network Theory. This empiricism allows the researcher to trace the interactions to wherever they take them. Actor-Network Theory does not subscribe to the micro/meso/macro interpretation of interactions and assumes a certain 'flatness' to the world. This is an important facet of the thesis, as it clearly

informs the use of an ethnographically informed approach to the work (see 4.3 for in-depth discussion). The use of ethnographic methods is appropriate in the operationalisation of Actor-Network Theory informed approaches (MacLeod *et al.,* 2017) through enabling the collection of empirical data at a particular site. The use of Actor-Network within the analysis is also important, as it allows the training of actions (and associations) of both human and non-human actors to further observe their actions within the chosen context. To further bring this to the fore, the integration of Latour's (2013) later work (*An Inquiry into Modes of Existence* or *AIME*) can also be drawn upon within the analytical frame as this is an extension of Latour's previous ideas and his extension into ontological work.

3.5 The Inquiry into Modes of Existence Project (AIME)

Given the criticisms and rebuttals of Actor-Network Theory over the years Latour appeared to have one further turn within this sociomaterial project that began within Salk Institute. Whilst some of Latour's later writings were much focused upon climate change and the politics surround this (e.g., Latour, 2017; Latour 2018) the overarching framework for this project can be seen to be based upon *An Inquiry into Modes of Existence* (Latour, 2013; henceforth *AIME*). This was conceived, perhaps in part, to address some of the issues that surrounded the application of Actor-Network Theory, but also as an amassing all of Latour's work into an inquiry of the 'different ontological conditions that co-exist to describe contemporary ways of being' (Tummons, 2021, p. 3). Those criticisms have been highlighted above including the inability of the approach to give an analysis that simply reinforces the traditional hegemonic processes. Therefore, Latour's approach now is interested in ontological pluralism in terms of further developing the understanding of the realities of the social world.

Rather than discuss ontological pluralism later, it is perhaps useful to elucidate it here. In general (and in Latour's interpretation) ontological pluralism is generally defined as a view of reality that holds that there are different ways of being (Cotnoir and Edwards, 2015). However, whilst an entity may have different ways of being, ontological pluralism (both generally and within Latour's interpretation) sits apart from relativism in the sense that it does not state that all ways of being are trustworthy or truthful. Therefore, it denies the relativist position, derived from a post-modernism, that all accounts of being equal (Tummons, 2021). If practices make reality, then different entities can have different *ways of being* in different *contexts*. It perhaps draws further on the work of John Law (2004) and Annmarie Mol (2002) in that reality becomes

fractured, rather than multiple. Perhaps, in line with the commitment to empiricism it may be termed that this approach to ontology is inherently realist and pluralist (Blake, 2014).

The *AIME* approach does not give any preference or privilege to different modes of existence within the project. However, each of the original 15 modes are categorised into different ontological conditions (with a view that there could/should be more). For ease, these 15 modes are then reduced to acronyms contained within square brackets. Within the following these are given below after the discussion of each mode. The first three conditions (network, prepositions, and double click) are seen as the infrastructure of the methodological approach (Conway, 2015) – that is, the conditions that need to be the starting point of the inquiry, whilst not having any privilege – they can be seen as finding the trajectories and associations within the inquiry. These can then be followed through what Latour describes as the first group, those modes of reproduction, metamorphosis and habit. These are seen as unique within the modes of existence as they completely ignore what Latour describes as the 'object/subject divide' (p. 378), and this will be discussed later. The next two groups seek to exemplify the object/subject divide that it is assumed resides within the researched (whilst not necessarily forming a part of the approach). These are therefore classified as quasi-objects (consisting of technology, fiction, and reference) and quasi-subjects (consisting of politic, law and religion). Latour notes that the qualification of quasi- is drawn from the work of Serres (see discussion of quasi-objects previously) and is meant to sensitise the researcher as to the hesitation that needs to be employed when discussing these terms (p. 288). The final grouping of the modes is under the umbrella of the economy. Namely, these three modes are attachment, organisation, and morality. These are said to mingle within the quasi-objects and quasi-subjects (almost in opposition to the first group). Whilst some of the modes are self-evident further explanation is required as to the nature of these and their use, to ensure that they are utilised fully within the work (Latour, 2013).

To avoid repetition there are a number of fundamental questions that can be asked of each mode of existence. These relate specifically to identify the trajectory[21] that is obtained through a discontinuity, the felicity conditions for the mode (notions of truth and falsity), the specifications for the type of being that is left by the trajectory, and the mode of alteration of the being-as-other. These questions are asked, in terms of the individual modes. However, when moving to

[21] A trajectory within *AIME* is a connection or network that leave entities within a specific mode. These can be caused by hiatus or discontinuity leading to different modes of existence.

the crossings (where different modes intersect) the questions asked form the basis of the analysis and these will be explicated in the methodology chapter and findings. However, for the sake of completeness, they relate to the trials within each mode of existence (e.g., where are category mistakes made and what are the various contrasts within the modes), what is the influence of institutional history, what is being learned about the modes, and the aims to emphasise the crossing (see 3.4.5).

3.5.1 The Infrastructure for AIME

In a traditional Latourian manner (e.g., Latour, 1999) there was not attempt to completely dispense with the previous approach. Again, as discussed earlier, Actor-Network Theory as an approach, whilst having criticisms associated with it, allows the tracing of the associations between entities. However, where perhaps the *AIME* project differs is that this is primarily seen as the starting point of the enquiry (Latour, 2013). Within *AIME* 'traditional' Actor-Network Theory has been reclassified as [NET][22], just one of the possible modes of existence (Latour, 2013). However, as this is the starting point, there is another mode that is required to enable the researcher (variously discussed within *AIME* as 'ethnographer', 'ethnologist', 'anthropologist') to effectively contextualise the associations within the network, through the use of a prepositional (or [PRE]) mode. Latour appears here to be addressing some of the criticisms of 'traditional' Actor-Network Theory. An example of this is the identification of boundaries within the 'flat ontology' discussed above. Through the [PRE] mode the intention is to sensitise the researcher to the 'type' of connection (p. 62). Here the [PRE] mode appears to allow the researcher to be immersed within a particular network and to be aware of the 'various values to which her informants seem to cling so strongly' (Latour, 2013, p. 64).

Latour also recognises that there is a modification here to the traditional view of Actor-Network Theory as an approach, which was, as Latour himself noted, to follow the associations where they go (Latour, 2005, p. 5). A reaction perhaps to certain criticisms of Actor-Network Theory, exemplified here by Harman (2018) through the accusation that Actor-Network Theory is an '…overmining method, the exact inverse of materialist theories that reduce downward of what a thing is and what a thing is made of.' (p. 109). Therefore, the [PRE] grouping appears to allow a modification of the 'overmining' allowing the researcher to identify the limits of the [NET] but also

[22] The square brackets are used within Latour's (2013) original work and are derived from the French terms in the original.

to recognise where there may be crossings into/out of the [NET]. A ‘crossing’ (p. 63) is a point at which the researcher can begin to observe ontological pluralism (i.e., the different modes of existence) through identification of the *contrasts* between the two modes. Latour identifies *crossings* as being the point at which contrast between the modes is recorded. These could be classified as a *category mistake* (i.e., confusion of the knowledge of the thing with the thing itself, similar to Bhaskar’s epistemic fallacy); as an *amalgam* (i.e., when modes cannot be distinguished); an *interpolation* (i.e., when one mode is examined with another); the crossing could be *harmonic* (i.e., when the mode are similar) or *composite* (i.e., modes that are not similar/identical but converge together). These crossings can be interrogated through a pivot table, allowing the research to identify the different elements that make up each of crossing points mentioned above.

The double click mode is an antithesis mode, something that is not necessarily part of the inquiry but that can be seen as a short-cut. This is the assumption that information can be transmitted ‘untransformed’ (Latour, 2013, p. 93). This is a mode that should be resisted by the researcher – it is essentially the assumption that information can be accessed easily, without effort. The apparent assumption then, is that heterogeneity of networks must be embraced, for if it is not, then this is untruthful (Latour, 2013, p. 93-94). Therefore, to operationalise this, it makes sense that the researcher must be alive to the proposition of a [DC] condition and allow further exploration. This may be a further illustration (and indeed extrapolation) of the ‘black box’.

3.5.2 The First Group: Reproduction, Metamorphosis and Habit

The first mode to be discussed here is habit [HAB] which is characterised by the movement towards a particular course of action. Whilst a course of action can mobilise all of the modes, it becomes apparent that certain modes will be more obvious and prominent than others. Therefore, [HAB] may be seen as a kind of default mode in certain trajectories. Reproduction [REP] relates specifically to a mode that does not overlap with the physical but allows reproduction and reprise to allow the mode to continue; in contrast metamorphosis [MET] which is linked in a manner to [REP] as this is where entities may be transformed in order to continue.

Latour is clear that there is difficultly within the identification of the three modes here. However, he is clear that these three modes completely ignore the quasi-objects and quasi-subjects

identified within the next two groups. Latour is also clear that the crossings within the other groups are suitable places for contextualisation. For example, within the current work, what happens when technology [TEC] or information [REF] are combined with the reproduction [REP] or metamorphosis [MET] within the network.

3.5.3 The Second and Third Groups: Quasi-Objects and Quasi-Subjects

Within his review of the *AIME* approach, Conway describes the quasi-objects as those which allow creative associations to develop and flourish. These quasi-objects are not unique to human beings. The example of the chimpanzee that turns a stick into a device that aids in the gathering of food, is an example of the impact of technology [TEC] as a quasi-object (along with fiction and reference ([FIC], [REF]). These quasi-objects are those things that are considered to be an object but are conceptualised not as these things. Serres (1982; 2007) uses the example of a ball, nominally an object, but when engaged within a game becomes the subject and the players of the game are *its* object (see previous discussion above Latour with Serres, 1995). This may be seen within the radiographic context as a pretext for discussions about the X-ray request.

However, rather than being seen as something which is relational it is possible to discern the X-ray request as something else? Latour (2013) discusses quasi-subjects as those things that may be layered with subjectivity but that are not subjects themselves, but rather that they allow quasi-objects to exist and add the subjective element to these. As Conway (2015) describes quasi-subjects give rise to ‘groups, responsibilities, rights, solidarities’ (p. 13). These are seen as law, politics and religion ([LAW], [POL], [REL]). In theoretically conceptualising the X-ray request, this can be interpreted as a quasi-object (making the radiographer, referrer, practitioner, etc. *act*). However, this quasi-object (i.e., the X-ray request) is inherently influenced by [LAW] and [POL] in that there are other actors which have influenced and put the X-ray request into action and given other actors within the network the ability and agency to act.

3.5.4 The Economy Group

Latour is clear within *AIME* that the economy cannot be removed from the inquiry. However, *gaps* must be identified in this group. These gaps are to be conceptualised as places where the economy and the experience of an individual are to be identified. Whilst initially, the discussion of the economy does not appear to be of use within the healthcare setting, the identification of

areas where there are potential economic impacts that may be useful from an analysis perspective. Latour's final three initial modes may be of utility when discussing healthcare work and radiography in particular. These are attachment [ATT], organisation [ORG] and morality [MOR].

3.6 Integrating Boundary Objects/Work into Actor-Network Theory

To further understand the interpretations of the different elements of the network, the X-ray request will be discussed as a boundary object. To explain what is meant specifically by this term the original work of Star and Griesemer (1989) and their original intentions for the application of this concept must be discussed. A boundary object is an entity with 'interpretive flexibility' (Star and Griesemer, 1989); which is to say that it there are different interpretations of the same object. Examples within the literature include how a campsite may be the object of one particular groups leisure activity and the site of special scientific interest to another group (e.g., North Yorks Moors National Park). The X-ray request is similar. For example, it is the result of a consultation between patient, their symptoms, the referrer and their experience/other entities; its action is to produce a radiological report which finds its way back to the referrer. It is produced by one group of professionals (normally non-radiologic) and then interpreted and used by another group (radiographers and radiologists), meaning that there is a shared meaning about their use, but perhaps not in the outcomes of using the X-ray request. The radiographer, however, uses the X-ray request to undertake a radiological examination of the patient. A different use of the X-ray request to the reporting radiographer, radiologist and referrer, but one which is essentially a conduit towards the production of a radiological report.

As Star (2010) highlights, there are a number of epistemological questions that arise from the concept of boundary objects, most frequently: can anything be a boundary object? The interpretation offered by Star as to what is (or can be) a boundary object as follows:

> "The object (remember, to read this as a set of work arrangements that are at once material and processual) resides between social worlds…where it is ill structured; [w]hen necessary, the object is worked on by local groups who maintain its vaguer identity as a common object, while making it more specific, more tailored to local use within a social world, and therefore useful for work that is NOT interdisciplinary; [g]roups that are cooperating without consensus tack back-and-forth between both forms of the object." (p. 604-605)

Therefore, the X-ray request can be conceptualised as a boundary object based on the interpretation above from Star. The interpretation of the X-ray request as being for work that is *not* [Star's (2010) emphasis] interdisciplinary. The work of the radiographer in the production of the radiograph is a predominantly singular disciplinary approach, especially in conventional radiography. However, the production of the radiograph is part of wider healthcare practices that are being performed to, and by, the patient to inform treatment and diagnosis. Therefore, the X-ray request is, ostensibly, something that is used by the radiographer for their work, but it originates across the interprofessional boundary and can therefore be deemed a boundary object.

The final point above requires the focus in terms of the current explanation offered by this research and requires further problematisation of the X-ray request. The description above from Star regarding the 'tacking back and forth' of the groups is perhaps the most useful way of seeing the actions that revolve around the X-ray request. It is important to remember that the X-ray request is assessed against the protocol guide (nominally iRefer (no date)). Therefore, an X-ray request may lead to the opposite of the outcome that the referrer wants (e.g., no X-ray examination takes place). This problematisation, in line with an Actor-Network Theory sensibility, indicates that the X-ray request needs to be unboxed. Therefore, the process of the theses is partly in identifying the various actors that are responsible for the action around the X-ray request.

As the X-ray request has been highlighted as a boundary object, the practices and activities that are ongoing around the boundary object can be conceptualised as boundary work. Boundary work requires some further discussion as to how it is being conceptualised here. Philips and Laurence (2012) highlight different conceptions that feed directly into the notion of boundary work such as identity, values, etc. and further conceptions have focused on the process of maintaining boundaries (for example, within a professional sphere) in terms of protectionism (Lamont and Molnár, 2001). Therefore, boundary work is seen as discursive practice that happens during the maintenance of a boundary, first conceptualised as the manner in which scientists kept the boundary between science and non-science (e.g., Gieryn, 1983). However, an alternate approach can be taken through the application of Actor-Network Theory and the concept of the boundary (Lindberg, Walter and Raviola, 2017) which can be seen more in terms of the practices that occur between different professionals who are working together. As

practices can be seen as a wide-ranging term, the interpretation of practices (and how it will be applied within this thesis, requires some further conceptualisation.

3.7 The Six Threads of Professional Practice

A key element of radiography and wider healthcare is the concept of professional practice. Often interpreted as something which is undertaken by professionals it is therefore useful to further unpick what is meant by professional practice. As a concept, Professional practice has been discussed as being under-theorized. This is important, given that the term practice is used without any thoughts to prior justification of what practice means (Reich and Hager, 2014). However, it is interesting to unpick the term under-theorized within the context of practice, as it may indeed be argued that the term under-theorized may itself be, *under-theorized*[23]. Within the current discussion this may be taken as being synonymous with under-researched, in the sense that practice (or practices), in and of themselves, is rarely an explicit focus for research. Schatzki (2022) gives perhaps the most succinct definition of practice, describing it as an 'open set of organised doings and sayings' (p. 27) further expanding to include bundles of practices that in turn can then be further arranged as 'constellations of practices' (p. 28). This is an interesting concept as it allows the researcher to focus on practices in different contexts making up different bundles and therefore the trajectories of 'a life' (Schatzki, 2022). However, using this concept of practice; therefore, further interrogations of the 'doings' of 'things' within the professional sphere is an appropriate element of analysis and further justifies the incorporation of the six threads from Reich and Hager (2014).

Reich and Hager are specific within the development of these threads of the influence of, and indeed that the framework is, in their terms 'broadly compatible' (p. 420) with Actor-Network Theory (as well as other approaches including Activity Theory). Whilst not it the strictest sense 'atheoretical', the threads appear to conceptualise practice in a similar manner to the Mol (2002) and Law (2004). The focus on practices and the material also aligns the framework appropriately with Latour's (2013) *AIME* approach. Therefore, these threads will be used to further expand the analysis, within the Actor-Network Theory frame. It is important to note, that Reich and Hagar do not view these threads as being mutually exclusive, they are in fact 'mutually entwined' (p. 421) and often very closely so. However, before this can be fully

[23] For a further and more thorough discussion of the issues that surround 'under-theorized' see Horwitz (2012).

discussed, an overview of the six threads is required. A brief reference overview of the threads is given in table 3 below. An expansion of this table, and the application to the current work is discussed below.

The first thread is that of *knowing-in-practice* which is built on the work of Gherardi (2008) and relates to an activity that forms the basis of the practice as a distributed and collective performance in a certain context (i.e., time and space). As this is a situated process it is not something that can be owned or passed on, in the same way as knowledge is often deemed to be. Reich and Hager (2014) draw on empirical studies that exemplify the approach. For example, Gherardi (2010) and Nicolini (2011) research embodies this approach to *knowing-in-practice* through discussion of the interplay between professionals, information technology infrastructure, and patient to constitute and create a new practice, that of telemedicine through collective and distributive practice. This can be seen in the sense of the radiographers' discussions around their collective practice, their interactions with, and references to, documents and their use of previous radiographs and reports. The distributive knowledge around X-ray request vetting is vast and involves many human and non-human agents. As previously discussed, professional knowledge cannot exist without the material world. There would be no knowledge of X-rays without Roentgen's experiments with 'cathode ray tubes' and electrons interaction with anodes to create them. This therefore leads towards another of the threads picked up by Reich and Hagar (2014) that of the sociomateriality of practice.

The sociomateriality of practices is defined by Reich and Hager (2014) as recognising that practice is sociomaterial as it will always involve both human and non-human actors in some way. This is analogous to Latour's discussion of the high technology (i.e., digital) and the low technology (lamps, tables). If these technologies are stripped away, then it will become very difficult to undertake professional practices in any form (Latour, 1994). The sociomaterial, and indeed the technical, aspects of practice are particularly important in the development of radiography which has, and continues to, undergo technological change [ref]. Schatzki's discussions that surround sociomaterial practice are clear, that there is a material *mediation* of practice. This means that the material mediates the practice that is undertaken. Again, this is clear within the radiographic context, as without the material (X-ray tubes, PACS, ICE, image receptors, etc.) practice simply would not happen and there would be no radiography to speak of (Schatzki, 2012). The nature of the mediation and the associations between human and non-human can be unpicked through the application of Actor-Network Theory to the approach. This

is seen in the mediation played out within the development of the noise within the system and the importance of material objects to radiographers work and knowledge exchange.

Table 3: Overview of Reich and Hagar's (2014) Six Threads of Professional Practice

Thread	Definition
Knowing-in-practice	Not knowledge as a concrete entity to passed on to other, but a 'collective and situated process' (p. xx). Therefore, something that is dynamic and linked to a particular context, particular people, and particular things.
Sociomateriality of practices	Recognition that practices require non-human things to work. In the X-ray department this includes documents, IT, etc. as well as the X-ray units, viewing screens, etc.
Practices as embodied	As practice requires the use of the body, therefore it is not useful to think of the body and mind being separate, but rather the outcomes expressed through bodily interaction (e.g., the radiographer moving the patient through touch).
Practice as relational	Expressed as the relationship between both people and things (i.e., material world). This includes non-human actors such as technologies and documents.
Practices exist and evolve in historical and social contexts	Practices change and evolve often because of complex social interactions, often involving power, which change how the work is 'governed'.
Practices are emergent	This thread highlights that practices that emerge are not predicable in an *a priori* sense but emerge from complex intersections of the practices outlined above.

Practices exist and evolve within *historical and social contexts*, which is an important thread in terms of understanding the work that is being performed by the radiographers. The importance of this thread cannot be overstated, as there are clear historical implications for all participants and through extension, radiographers - particularly those who had been qualified a considerable time. Some of the previously discussed criticisms of Actor-Network Theory was that it did not take account of the historical influences on practices which take place [ref]; therefore, incorporation of this thread would seem to be of importance, in a way that can help to make sense of the historical in particular, within the analysis frame. In Reich and Hager's (2014) conceptualisation of this thread there is an allusion to the law and governmentality, which, given the role of *IRMER 2017* and the reinterpretation required of the operationalisation of these statutory instruments as discussed previously, it would seem remiss in terms of analysis not to explicitly include these within the explanations of practices (present and past) within the analysis. The taking into account of history is also reflected in Latour's discussion of various

crossings within the *AIME* approach (Latour, 2013). This is a useful element to bring forth within this discussion which can allay some of the previous criticisms of Actor-Network Theory discussed in chapter 3. The empirical research that is given as the foundation of this thread relates to changes in governmental policy in child protection in Australia highlights the changing nature of practice and how these policies are enacted and situated within historical contexts (Reich and Girdwood, 2012) within which there are clear links with the aforementioned changes within the legislation that governs radiography.

Of note, also, within the framework is the notion of *practices as relational.* This of course, sits firmly within the Actor-Network Theory and therefore the operationalisation within this work. The associations between the human and non-human have been made to the be the focus of the previous chapter highlighting the approach of the non-human in introducing noise into the X-ray request and the decision made by the radiographer. Amongst sociomaterial approaches there is a variation between theorists and researchers as to the implication and power of the non-human. Those who approach sociomateriality from an Actor-Network Theory perspective judge the symmetry between the human and non-human, and therefore, prescribe agency to both regardless of their 'humanity' (e.g., Callon and Latour, 1992) whereas others subscribe to the position that there is a qualitative difference in potential agency between the human and non-human (e.g., Schatzki, 2002). However, even within the two approaches there is a focus upon the relations between entities that it is important to foreground within the analysis of the activities and practices that build the network.

This approach will also draw on the thread of *practices are emergent*. Reich and Hager (2014) indicate that it is possible to move past micro/macro and structure/agency through analysis of the practices that take place within a certain context. This essentially means that the activity and its connections are a mix of intended and unintended, predicable and unpredictable, consequences (MacLeod *et al.*, 2019). In this respect it is possible to explain the radiographers' decision making and the impact of those associations that produce noise and the resultant *emergent practices* that are created because of this. There are links also to be made here. For example, emergent practices can be postulated to have been happening since time immemorial, however, the echoes of the emergent practices are seen within the historical and social contexts. Therefore, there is a connection between what *emergent* and what is *emerging* from the practices. This can then be said to be mediated through the engaging of other material entities within the network (as an Actor-Network Theory approach is taken more broadly).

3.8 Application to the Research

These three theories have formed an important element of the research and therefore have been explored prior to the discussion of methods and methodology in particular. Primarily, Actor-Network Theory has informed the approach to data analysis within this research. When applicable, the modes of existence have also been used to provide the reader with some further enhanced description of the actions of the main actors within the radiography departments. The addition of the modes of existence was particularly useful in conceptualising the context within which the work was taking place. It allowed some further tracing of the actors and allowed the research, as Latour (2004) states, the opportunity to give as full a description of the network as is possible. This did not appear to be incongruous to undertake such an approach, as *AIME* is ultimately derived from Actor-Network Theory and is seen by Latour to be the starting point of *any* inquiry (Latour 2013). The modes of existence, their conceptualisation, and their implementation allowed for deeper, more nuanced discussions within the data, acknowledging actors that perhaps would have been missed if undertaking a different approach (or even an Actor-Network Theory alone informed analysis).

As such, and conceptually from the beginning, the X-ray request is not treated as a singular entity. It is not a calling card, device or tool that referrers simply use to ensure that a patient undergoes an X-ray examination. Through application of Actor-Network Theory on a theoretical level, prior to data collection, it becomes apparent that the X-ray request may indeed be a complex actor in its own right. It is something that affect the action of a radiographer, a group of radiographers, and a multi-disciplinary team. In line with the Actor-Network Theory and *AIME* approaches, the X-ray request is therefore something that needs to be further investigated and acknowledged as an entity with agency. This was the starting point for the research, and Actor-Network Theory informed the approach from an early stage. Within this discussion, is the conceptualisation of the X-ray request as a boundary object and the work which is put into practice by the X-ray request as boundary work. This is a useful way of conceptualising the X-ray request whilst maintaining Actor-Network Theory sensibilities.

Along with the X-ray request, and evident through the previous literature review and introduction there are other entities that Actor-Network Theory and *AIME* can raise the awareness of prior to engaging with the process of data collection. Whilst these elements were not the only sources

of data collection, they allowed the development of the ethics application to ensure that a clear indication of the data collection was given to the ethics committees to make an informed decision regarding the study. This took the form of a conceptual map based on the approach advocated by Law (2004), a figure of which is given below (fig. 2).

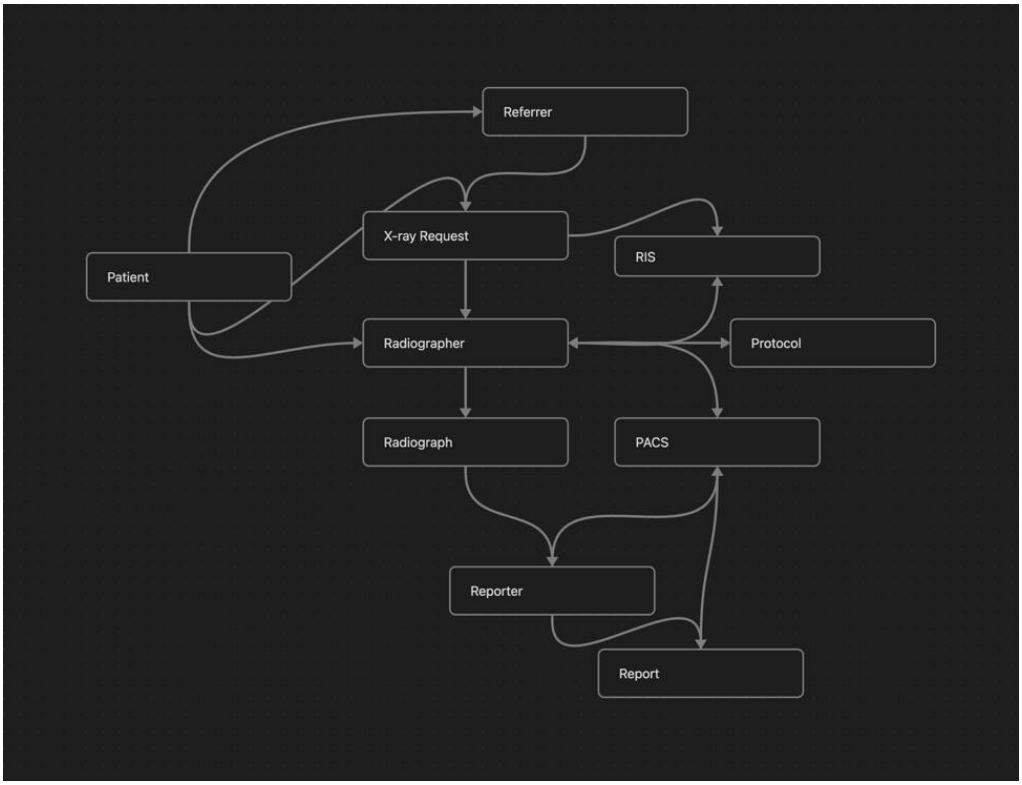

Figure 2: Initial mapping of X-ray request prior to data collection.

The application of the six practice threads is an important element to the discussions that surround the further analysis of the actions and practices that revolve around the X-ray request. The focus of Actor-Network Theory and *AIME* on the practices that take place and their importance, indicates that there is a space for the integration of a practice focused theory, which is drawn from Actor-Network Theory (Reich and Hager, 2014). Tied in with the idea of practices is that of boundary objects and boundary work, which have previously been integrated into Actor-Network Theory approaches, allowing some theoretical underpinning of what may be seen as more of a sensibility (Scholes, 2018).

3.9 Summary

This chapter has discussed the development of Actor-Network Theory through its inception within the discipline of sociology of scientific knowledge with Latour and Woolgar's *Laboratory*

Life (1986) through to *An Inquiry into Modes of Existence* (*AIME*) (2013). Actor-Network Theory, rather than being defined as a theory of something, is perhaps more adequately explained as a sensibility towards research rather than an explicit theoretical framework. The approach sensitises the research to the research area, the influence of the non-human, their agency, and their associates for example.

From these discussions the development of an alternate description of the (social) construction of scientific facts and, ultimately how the world can be understood as being a constructed assemblage can be traced. The various criticisms of actor-Network Theory from the predominate critiques such as Eldar-Vass (2012; 2015), Harman (2018), and Whittle and Spicer (2008) which appear to be around the assumptions of Actor-Network Theory and the operationalisation of it rather than as an approach *per se.* As Latour's development of Actor-Network Theory moves towards AIME, Latour has further engaged with these criticisms leading to further developments. As John Law stated "…Only dead theories and dead practices hang on to their names…" (1999, p. 10) therefore the evolving nature and refusal to commit to a *pure version* of Actor-Network Theory is to be expected.

The following methodology chapter will take Actor-Network Theory, and its assumptions around ontology and epistemology, to develop an approach to researching the X-ray request that is congruent with the preceding discussions here. The overarching approach of ethnography will be used, as this will allow for the rendering of associations between the human and non-human actors that will reside within radiology. There will also be a discussion of some of the intricacies of data analysis with Actor-Network Theory and the ethical issues of observing healthcare professions whilst they are caring for patients.

Chapter 4: Methodology and Method

"Reality is frequently inaccurate.…"

(Douglas Adams, *The Restaurant at the End of the Universe*, 1980)

This chapter gives an overview of the methodological considerations of the study, with a focus on the theoretical underpinnings of the research, the practical aspects of undertaking an ethnographic approach is discussed in detail and consideration is given to other ways of interrogating interprofessional working, drawing from the findings within the literature review. Consideration will be given to why a mix of 'classic' and 'post' Actor-Network Theory is the most appropriate lens through which to interrogate how the X-ray request can influence the practices of radiographers. However, as with any methodological decision, a thorough critical analysis of these underpinning methodologies is required. The integration of these paradigms will also be discussed, in terms of utilising an interpretative analysis and how this might be challenged. A discussion of reflexivity will be undertaken; consideration will be given to its importance and how it can be operationalised. This will lead the reader towards the production of aims and objectives, thus ensuring congruence between philosophical, ontological, epistemological, and methodological approaches and assumptions.

Following this, the methods of the research will be described and justified. The overarching methodological approach has been termed within this thesis is an ethnographic approach. Whilst the length of time that the researcher has spent within the environment is perhaps shorter than traditional ethnography (weeks rather than months) the positionality of the researcher as both emic and etic must also be taken into consideration. The researcher has over 10 years clinical experience within, and interacting with, radiography departments and the profession as whole, but may also be seen as a teacher and researcher by those who are participating in the research.

Following the discussion of data collection, the nature of the data analysis is discussed. The analysis employed here uses Braun and Clarke's (2022a) *Reflexive Thematic Analysis* as a guide through the data. Whilst Braun and Clarke are clear about the type of data analysis that thematic analysis can, and cannot be used for, they are clear that this approach can be adopted *in lieu* of other approaches such as constant comparative analysis (Braun and Clarke, 2019).

Ethnographic approaches are usefully employed within Actor-Network Theory as they embed the researcher within the network. Latour (2013) within the *An Inquiry into Modes of Existence* even discusses the researcher as being explicitly an ethnographer or an anthropologist of the moderns. This is perhaps unsurprising, given Latour's background as an anthropologist and the manner of his work in *Laboratory Life* (1986). The embedding of the researcher within the context allows them to trace the associations between the various actors within the network (Latour, 2005) and gives the researcher access to those non-human actors (such as documents).

A discussion of the practical aspects of ethics runs through this chapter, as this was a particularly drawn-out process prior to data collection. A particular issue was not necessarily around the data collected *per se* but of the nature of ethnographic data collection; essentially, that of exposure to others personal identifiable and personally sensitive data. This was navigated through discussions with the Confidentiality Advisory Group (CAG), the data controller within the trust, and through focus groups with service-users about how this particular sensitive topic could be navigated. The following chapter will explore the journey, the specifics of data collection, and the rationale for the approaches taken.

4.1 Ontological and Epistemological Perspectives

Whilst Actor-Network forms the primary theoretical framework, as the discussions in the previous chapter have shown, from an ontological and epistemological perspective there are many ways in which the approach can be interpreted. For example, there have been those who take a critical realist perspective on Actor-Network Theory's use, and those who sought to combine it with a phenomenological or hermeneutic approaches (e.g., Ezenwa, 2017). This section seeks to highlight the ontological and epistemological perspectives taken within this research and seeks to align them with the Actor-Network Theory and the concept of noise.

Ontology is generally regarded as the study of the nature of reality, of being, and of existence (Hammond with Wellington, 2021). This is usually depicted as a dichotomous perspective of ontology (much akin to the so-called 'paradigm wars' of the 1980s and 1990s (for further information see Galvez, Heiberger, and McFarland, (2020)). At one end of the continuum, is the realist, taking a view that the reality is real and knowable and the other end of the scale there are the relativists stating that reality is local, contextual, and interpreted by individuals (Coe,

2021). The discussion and nature of reality is often superficially discussed within social science research; however, in line with the theoretical framework, the intention here is to fully explicate the position taken within the Actor-Network Theory approach. Here ontology has been interpreted previously as being fractal (more than one, but less than many) and inherently intertwined with the notion of practices (e.g., Law, 2004). This can be interpreted as reality being created through the practices that take place within it. Therefore, different phenomena may be practices in different ways but still be a singular entity within reality. For example, Ann Marie Mol's work showcases this through atherosclerotic disease being singular but practiced in different ways in different contexts (Mol, 2001). Because of this, there is a commitment to empiricism within Actor-Network Theory and the subsequent *AIME* approaches developed by Latour (2005; 2013). This empiricism is perhaps where the ontological approach is best suited. The dichotomous relationship between realist and relativist is perhaps not best suited to a study of humans and how their internal processes (in this case decision making) and external elements (both human and non-human) can affect the internal. Therefore, within this study this dichotomous relationship is rejected in favour of a third approach to the nature of reality – that it is made up of practices, which researchers can observe. There are, however, alternate approaches to ontology that are similar to this approach, and which can draw upon them.

Critical realism is an approach to research that is concerned primarily with ontology. Built on the work of Roy Bhaskar (e.g., Bhaskar, 1975, 1997; Bhaskar and Hartwig, 2016) it posits the position that there is a singular, objective reality 'out there' regardless of the perception of it. Archer *et al.*, (2016) appears to offer a blueprint for critical realist research that is perhaps more accessible than the original writings of Bhaskar. Namely, that ontology is often neglected; that the post-modern approaches to historical and social contexts add value to social science research; despite flaws within all approaches some accounts of social phenomena can be judged as better by criteria; and that there is recognition that as much as facts are shaped by values, it is also useful to state that values are also shaped by facts.

There are also other elements to critical realism that influence the approach taken to analysis of this ontology. This leads to a discussion of the concept of abduction. Bhaskar postulated that there were three domains of reality – the real, the actual and empirical (Bhaskar, 1975; Sayer, 2000). The empirical consists of only experience and the real consisting of mechanisms, events, and experiences. Social scientific endeavour is therefore able to observe the empirical, but there are levels of abstraction (or indeed abduction) required to infer knowledge of the

mechanisms (which sit in the real domain) and events (which sit within the actual domain). There are criticisms of the approach taken by critical realists in terms of their influence on social science and whether there has been conflation of the philosophy with social theory. An example of this is found in the previously discussed notion of Bhaskar's 'epistemic fallacy' (2016) which identifies that positivist scientific approaches neglect otology and that this can confuse interpretations of reality as being the *same as* reality itself. However, whilst this may be an appropriate theoretical distinction to be made, there is still the issue how this plays out within the practical aspects of any methodology and its application. Whilst the assumption may be that ontology drives epistemology; it cannot be stated with any degree of certainty state that this is the case. Within this criticism Farasoo (2024) offers an interesting perspective in terms of overcoming this issue, which is that there requires a problematization of the epistemic departure of any research, in an effort to limit the degree to which there is a movement towards, and recognise the issues that surround, epistemic fallacy.

In an effort to do this, the nature of reality and the interplay with what can be known is part of the reason that Actor-Network Theory is chosen as the theoretical framework for the thesis. Rather than appealing to the continuum of ontology from realist through to relativist the position taken within this research can be seen more as relational or fractal ontology. Again, this is in an effort to move away from dichotomous nature of realist and relativist. This can be defined on a more foundational level as what differentiates an object from a subject is the relationship between them, rather than the substance of those entities (Schaab, 2013). This approach to ontology is perhaps the underpinning ontology of Actor-Network Theory, although Latour, as stated previously, has avoided such statements. Jóhannesson and Bærenholdt (2020) state explicitly that Actor-Network Theory appears to be informed by an ontology of relational practices. Again, this is congruent with the statements above that regard practice as making reality (e.g., Mol, 2002). In essence then, practices create reality, and the traceable relationships created within that reality are the evidence of existence. Therefore, to avoid the imposition of an epistemic fallacy the focus is upon the practices that are undertaken and how they create the reality that is seen.

Whilst ontology and epistemology are linked, epistemology (as intimated by the epistemic fallacy discussed above) relates to the interrogation of what ultimately constitutes 'knowledge' (Hammond with Wellington, 2021). As being closely related to ontology there is also the same apparent dichotomy observable within the various interpretations of knowledge within the

epistemological frame; namely interpretivism (human relationships, the nature of phenomena and experience) and positivism (cause and effect). Whilst interpretivism does not assume that *direct* knowledge can be known (Waring, 2021) there is, similar to the discussions above relating to ontology, a middle part of the continuum where claims regarding knowledge need to be made, and the nature of the claims need to be reported in a coherent manner that relates to the epistemological approach. Hammond with Wellington (2021) give a useful illustration of a student being overly critical with regards to their approach and began italicizing words within the dissertation to identify the contested definitions. However, before long, too many words were being italicized to make sense. Therefore, the sake of coherence, there needs to be an accepted (or explicitly defined) set of assumptions made on the nature of knowledge and reality that is already available, whilst being critical of the contested nature of that knowledge. From this, appropriate operationalisation of using Actor-Network Theory allows the research frame to follow a constructivist[24] path through epistemological thought. However, this is not the whole story, for within the social constructivist principles that are widely held through other theoretical positions, Actor-Network Theory (and therefore the position of the approach to this research) is conceived as being different. An example of this is the previous discussion in chapter three around Latour and Woolgar (1986) dropping the word 'social' from the second edition of *Laboratory Life.* Latour (2005) also alludes to some of the issues with various interpretations of a more radical approach to social constructivist and the negative connotations associated with this not being *real* (and therefore perhaps hinting at his own ontological position as being more along realist lines).

Drawing on the discussions above an outline of the alignment of ontology through to methods can be constructed. Following an Actor-Network Theory informed methodological framework, the approach here is that of ontological relationism (and pluralism) and epistemological empiricism and constructivism. These are inferred within the approaches of Latour (2005), Law (2012), Callon (1986); these literatures demonstrate Actor-Network Theory's commitment to empiricism and unpicking the construction of reality through the relationship of things. For this reason, an ethnographic approach is the most appropriate to unpick the practices of

[24] There are many differing interpretations of the difference between constructionist and constructivist. For sake of clarity, I have used the term constructivist within the work, as this is the term employed by Latour in *Reassembling the Social* (2005, p. 88-93). However, his interpretation within the book appears to be more in line with Berger and Luckman (1967) around the social construction of society. As these two terms are often used interchangeably, this footnote serves as a rationale for the use of the term within this work.

radiographers. To commit to empiricism from a social science perspective, then the collection of data using ethnographic methods should be at the forefront. This is also encapsulated in Latour's anthropological approaches to his writings. However, in a departure from the more critical realist approach, this approach also recognises that these realities are made up of the practices that happen within them, that these practices are contextual and contingent, and that the entities (objects and subjects within them) are connected to each other, the historical, and current environments and contexts in which they take place.

4.2 Methodological Approaches

The linking of methods and methodology is essential in any study to ensure that there is congruence between the methodological assumptions made, and the methods employed (Waring, 2021). This will ensure that aims, objectives, and research questions are answerable using the methods employed. This chapter shows how this has been achieved in the practical sense; it will include discussion around sampling, recruitment, data collection and data analysis. In accordance with previously discussed methodologies, the data analysis tools can also be seen in terms of what Law (2004) describes as 'method assemblage'. Just as the realities that are being attended to are in flux, so then, should the data analysis approach.

To aid in this endeavour, qualitative research is the chosen approach for the research. Quantitative research can obscure the intricacies of working practices, interactions, and decisions made at the 'coalface'. Reductionist principles may obscure the bigger picture and the contextual factors that affect the interactions that take place (Idema *et al.*, 2022). Therefore, the focus is on studying the interactions *in situ*. Perhaps it is better to let the actors, within any given situation, speak for themselves (Latour, 2005). One of the major issues with defining this paradigm is that it is often defined in contrast to quantitative approaches. This perhaps has a far-reaching effect on the self-perception of qualitative methodology within the literature, as it appears to form the basis of, a least in part, its critique.

There have been, and continue to be, criticisms of the qualitative methodologies on offer to researchers. It has been stated qualitative methodologies continue to be unable to answer three proposed central tenets of research. Namely, that research should be able to document observable differences; that research should 'rule-out' alternate explanations; and that its findings should be generalizable (Mills, 2014). Hammersley (2008) indicates that mixed

methods may be the way forward in terms of nullifying these criticisms, however, Hammersley's criticisms are open to alternate viewpoints also. For example, Hammersley's (2008) perspective that postmodernism undermines qualitative research as an activity is not to be taken lightly. Perhaps the intention is not to undermine qualitative research through the use of postmodern lens, but to imbibe it with a certain criticality that improves the researchers' knowingness of the research, themselves, and its implications. However, the major issue with Hammersley's critique is that it consistently refers to, what he regards, as the original purpose of qualitative research. There is no discussion or acknowledgment of the prevalent worldview of that time (i.e. the requirement to be scientific), which is particularly evident in the discussions of Winch (1958; 2007). This therefore renders this critique almost historical in its positionality; the previous interpretation of what qualitative research should be is contingent in that particular place. It also neglects to consider the development of the discipline and the evolution of qualitative methodology (e.g., Law, 2004). To be similarly critical of quantitative research would neglect the development of randomised controlled trials, systematic reviews and meta-analyses. There is also paradox hidden within this type of critique. For example, there is the notion that qualitative researchers do not generalise, but then they are admonished for theoretical generalisations (Hammersley, 2008). This viewpoint may be addressed through different interpretation of the meaning of such terms; for example, in case study research the difference between generalizable and universalizing are not the same (Byrne, 2013). Within the current study the focus is on contextual working practices and investigating them in depth, to elicit these working practices with the potential for them being applicable (i.e., transferable) to similar contextual areas. The aim is not to produce rules, or even guidance, to follow but to allow understanding across complex contextual practices.

Certain concepts will never be amenable to research that would adequately meet positivist criteria and to uncritically apply quantitative methodologies to these would result in distortion of the findings, either through the application of proxy measures or via the inaccurate extrapolation to other situations (Law, 2004). This is not to say that positivist, scientific methods are not appropriate for social science situations. Scholars such as St. Pierre (2021) and Koro-Ljungberg (2015) all intimate that this does not mean that there is not a place in the sociological canon for scientific methods; however, these should be applied to those situations where the approach is suitable (Kinchin and Gravett, 2022). As some social situations may be contextually independent from subsequent ones, with a number of potential variables that are either present (or intrinsic/extrinsic) or not within a given situation. For example, when studying behaviours of

teams or groups in healthcare, it may not be appropriate to use prescriptive *a priori* models of behaviour for categorisation. This may result in shoehorning of certain types of behaviours into *a priori* categories into which they do not fit (McCulloch, Rathbone and Catchpole, 2011). This does not mean that rigour and the development of theory should not be integral to qualitative research. Whilst a mix and match approach to methodologies is not necessarily a negative in qualitative research, researchers should be rigorous in terms of how they apply this to avoid a 'methodological stone soup' (Morse, 2011, p. 1019). The focus should be on *how* reflexivity is being operationalised in terms of its application to methods and *how* this reflexivity extends into the analysis of the data collected.

This study draws primarily on Actor-Network Theory (Latour, 2005; Law, and Hazzard, 1999; Latour, 2014) as its methodological framework using the previously discussed concepts of noise (Kahneman, Sibony and Sunstein, 2021) within the data analysis (as highlighted below). As both Actor-Network Theory and noise have already been discussed in depth in previous chapters, the overriding focus here is on the operationalisation of these concepts within the research, and the integration of the approaches taken and the different elements of data analysis that have been used.

4.2.1 Ethnography, Ethnomethodology, and the Influence on Actor-Network Theory

The approach taken below is primarily rooted in ethnography and can be described as a micro-ethnography (). Ethnography is traditionally seen as the immersion of a researcher into a particular culture, sub-culture or more recently, workplace (Silverman, 2024). The data collection methods are focused on observation (whether participant or non-participant observation) along with discussions with participants to understand the whys and wherefores of the actions and practices undertaken (Delamont, 2004). The rationale for taking this approach is two-fold. In essence this research seeks to understand the practices that are created by the X-ray request to undertake a particular task (Hammersley, 2017) and along with that the theoretical framework of Actor-Network Theory appears to be congruent with the approach, to a certain degree. However, within Actor-Network Theory the influence of ethnomethodology is seen, and this requires some further interrogation as to the approach and operationalisation of Actor-Network theory and the particulars of the ethnographic approach undertaken. To summarise, the data collection methods (which are fully explicated below) that are taken here

will include observations of participants in the practice setting, semi-structured participant interviews, and documentation collection from within the department.

The term ethnomethodology was coined by Harold Garfinkle as an approach to the study of people's methods of mattering (Ndame, 2023). The rendering of the name is important, as *ethnos* relates to people, *-ology* relating to study and method as an example of ways of doing things; there has been an intimation that Garfinkle was perhaps being deliberately provocative, thumbing his nose at prevailing sociological approaches in the 1960s (Blackwell, Blythe, and Kaye, 2017). The distinction between ethnomethodology and ethnography can appear blurred, but it is important to fully define them. The focus of ethnomethodology is *not* on what the members of the group *do* (as in ethnography), but rather the *methods* that they use to make sense of what they are doing (Barber, 2020), hence its influence on Actor-Network Theory and the focus on practices. As an example, this in essence means that the focus is not on aspects of family, but on how members make visible the family and how they account for themselves in matters relating to the family. However, this can mean that ethnographic methods can be used in ethnomethodological approaches, as well as within other qualitative paradigms (Barber, 2020).

Ethnomethodology's influence on Actor-Network Theory is apparent through the endless focus on detail and a refusal to be constrained by theory. A criticism therefore is that this renders it ineffective due to not knowing where to start the analysis of the large amount of data uncovered (Kapelinin and Nardi, 2006) and the production of endless detail and description (p.17), echoing the criticism of Harman of Actor-Network Theory in that it is an approach which may result in overmining of data (Harman, 2018). This argument can be countered by Garfinkle's initial indifference to theoretical underpinning, seeing Ethnomethodology as a method of placing the emphasis on the empirical and not letting external *a priori* theory get in the way. Ethnomethodology is therefore contingent – i.e. its analysis is applicable and is rooted within the situation that the data is taken from (Garfinkle, 1967). In this respect, it influenced Actor-Network Theory as it too is rooted in empirical analysis of the situation or context from whence the data is derived, with no *a priori* limit on the scope of the research (Latour, 2005). However, this research will take forward Latour's revised notion of the [PRE]. This addresses some limitations of the research in terms of its scope, from a pragmatic, practical, and temporal perspective (Latour, 2013).

The approach deemed most suited to study how radiographers interact with their environment, colleagues and other healthcare professions was an ethnographic approach (given the discussions outlined above). It is truer to state that this work is more of a focused ethnographic approach. This has been employed to allow observation of radiographers in the backstage[25] area of the radiography department, namely the viewing area (a space where radiographers congregate), the collection of documentary evidence either used within the department (e.g., protocols) or those alluded to within the discussions and the semi-structured interviews with participants (e.g., iRefer/HCPC Standards of Proficiency). Given this, it seemed most appropriate to employ ethnographic methods to data collection. The term 'focused' has been used to define the approach as it does not necessarily utilise ethnography in the traditional anthropological sense (Rashid, Hodgson, and Luig, 2019; Andreassen, Christensen, Møller, 2020). For example, Latour spent two years working within the Salk Institute during the data collection for *Laboratory Life* (1987). Hammersley (2006) discusses that this long-term approach has now fallen out of favour within the academy, due to time pressures, advances in recording equipment, etc. in favour of what can be described as 'micro-ethnography' (p. 6) or a focused ethnography (Knoblauch, 2005). That being said, the lines between focused ethnography and traditional ethnography are not clearly defined (Wall, 2015). For example, Trundle and Phillips (2023) question the perceived differences between the two approaches. The normally cited differences of a more limited timeframe, limited scope, insider researchers, and applied results of focused ethnography were not as obvious when compared to studies that were identified as taking a traditional approach. For example, some focused ethnographic approaches collected data for more than 5 years, whereas some traditional ethnographic approaches collected data for 2 months.

However, the approaches in this thesis do fall towards the focused end of the spectrum outlined within Trundle and Philips (2023). They also highlight that a primary difference within focused ethnography is that ethnography is seen as guidance for data collection, rather than an overarching approach that informs the entirety of the project (i.e., ethnography as method and ethnography as methodology). These critiques, along with researchers not being aware of the wider historical influences upon the institutions are of course fair. However, within the current work, the data was collected by a researcher embedded within the profession (a HCPC

[25] The term back-stage is not used in a Goffman (1956) sense but relates to the area of the radiography department that is not patient facing, rather than the examination room where the radiographer examines the patient.

registered radiographer and radiographic educator). Whilst this means that the researcher is acutely aware of the historical and potential professional implications of the work, there are other issues which need to be taken into consideration, particularly around the emic/etic issues inherent within this approach. In an attempt to address this, a reflexive diary was kept, and this was underpinned by a positionality statement.

4.2.2 Reflexive Positionality

As previously discussed, the position of the researcher within this type of research is important, and reflexivity forms an essential aspect of the methodological framework; not only from an Actor-Network Theory perspective, but also at the meta-level. The researcher in this instance is also a radiographer. Subsequently, the position of the researcher within the chosen situation must be made explicit within the analysis. Whilst it is generally acknowledged within qualitative research that the researcher can never be a fully isolated, impassionate, objective recorder of data (Creswell and Poth, 2025) the position of the researcher as a registered radiographer is important to acknowledge. To engage further with this, what it means to be not just reflective in the work undertaken but what it means to be a reflexive researcher must first be elucidated. This will then lead to a discussion of the importance of reflexivity in the research.

Reflexivity is often cited as being a key component of rigour within qualitative research. Whilst this may be the case, the practicality of undertaking reflexivity is often missing from the research (Darawsheh, 2014). Reflexivity undertaken by researchers can be defined as a process of constant reflection (Finlay, 1998) or the ability to ‘turn back on oneself’ (Atul Davies, 2008, p. 4). This can be seen as the process of making explicit the realization that the effect of undertaking of the research has on the products (i.e. data, analysis, and conclusions) of the research. This interpretation of reflexivity in research is, however, a utilitarian view of reflexivity. It is therefore not enough to view the influence of a ‘researcher’ but, in this case, to view the researcher as a ‘radiographer and researcher’.

An alternate interpretation of reflexivity is that of the researcher ‘problematizing’ where they sit within the research process. Whilst biography is undoubtedly important in terms of the researcher, it may be prudent to think much broader about what reflexivity means to the researcher (Cousin, 2010). This can be seen as the process of problematizing where the researcher is in the research, both in terms of their action and their interpretations. The

‘radiographer and researcher’ identity is an example of this, however, there are more identities that the researcher may inhabit. Some may be stationary, such as race and gender; others, such as class, may be seen as more fluid and possibly require further elucidation in terms of the effect they may have on the research. The importance here is not only on how the socialization processes of becoming a radiographer and the socio-cultural experiences of being a radiographer, may influence the questions asked and the interactions with other healthcare professionals. This also includes the other experiences of the researcher (as a man or women; working or middle-class; etc.) and how these may also influence the research. This does not mean that an attempt has been made to move the researcher away from the data or to bring about an objective interpretation, far from it. The process is part of the research not something that is going on in the background that requires bracketing or purging from the analytical process (Clarke, Friese and Washburn, 2017; Cousin, 2010).

Reflexivity has been made explicit within the project and formed part of the data collection process as a reflexive diary. The importance of this process has been outlined above. It should, however, be reiterated that the removal of bias is not the *raison d’être* for the inclusion of this process. It is included to increase the rigour of the research and to make explicit some of the assumptions of the researcher. It also means that acknowledgement of private and personal positions should be paramount (Olmos-Vega, Stalmeijer, Varpio, and Kahlke, 2022) For example, a male researcher from a white, currently middle class, originally from a white working-class area, must allow their assumptions and lived experience to be acknowledged, as well as the previous experiences of being both a radiographer and a researcher. The objective must surely be to allow the reader to see why the analysis has been conducted in the manner it has and why the questions have been asked in a certain way. By making these experiences explicit the research is more rigorous because of this. This has been problematised further, with a particular emphasis upon coloniality, through Gani and Khan (2024). Gani and Khan (2024) question the reasons and rationales for the use of positionality statements. Their premise is that the positionality statement itself is a colonial activity, attempting to (re)affirm the unequal power dynamics that already exist. Through acknowledging the possibility of this, this was further added to the reflexive approach that took place as part of this work.

The following section will be written in the first person to enhance the credibility and depth of the reflexive process, particularly from the perspective of encouraging critical thinking within the reflexive process. This helps in avoiding producing something inauthentic and superficial, which

is a particular issue within reflection and reflective practice (e.g., Davies, 2012; de la Croix and Veen, 2018).

4.2.3 Positionality Statement[26]

My position in terms of the research is very close to and heavily influenced by the reading that I have performed over the last 5 years that relate to Actor-Network Theory. The philosophical underpinning of the approach as a potential 'rethinking' of social science research sparked an interest in myself around this particular area. Further reading around critical realism also influences my approach, however, I feel that there is a requirement to commit to empiricism and, as Latour intimated let the actors speak for themselves (Latour, 2005). I think that this commitment to empiricism stems from my background in the natural sciences (I have a first degree in Pharmacology).

My own background may further influence the research, and it is important to make this explicit. I am from a traditional working-class background. My father was a security guard prior to becoming disabled because of a car accident in the 1980s. My mother left her job as a shop worker to look after him, my brother, and me. However, I would describe myself currently as white middle-class but from a working-class background. I am male and identify as a cis-gender man. I am a diagnostic radiographer and therefore, as discussed below in terms of ethics, need to make my position as both insider/outsider (emic/etic) clear. I recognise that as a white, male, radiographer and an academic, these things afford me certain privileges that need to be addressed within the approach to the research not just in data collection, but also in data analysis and write up. The use of a reflexive diary was implemented, the musings within the diary formed part of the data collection process and reflected on wider elements of society, such as Black Lives Matter, a reflection on seeing David Olusoga and Dan Jackson and literary festivals, and my own upbringing. These gave, I believe a certain interpretative lens, one which focused on intersectionality, both with myself as a researcher, and those of the participants.

4.2.4 Research Questions

- What are the associations within the X-ray request network that make it durable?

[26] Through the positionality statement the first person will be used.

- What happens when disturbances occur and how does this affect the work of the X-ray request?
- Can the radiographers' work be more effectively conceptualised in terms of the non-human entities around them?
- Does the physical environment, technology, patient, and departmental protocols play a role in the development of noise and the practices of radiographers?

4.3 Focused Ethnographic Method

The choice of a focused ethnographic method can be traced back to the underpinning ontology of the approach; that of a focus on practices and that practices make reality. Therefore, to fully explore the practices, the ability to observe these in practice was required. In line with constructivist epistemology stemming from Actor-Network Theory as the approach to the data, it was felt that there was a requirement for interviews with the participants to be undertaken. A focused ethnographic approach the methods employed to collect the data were varied and involved both searching publicly available archives (such as the HCPC Standards that were current at the time the research was taking place (i.e., HCPC, 2012)), interviews, non-participant observations, and collection of documentary evidence from within the radiographic department where the research was taking place. This also aligns with the empirical nature of data collection within the Actor-Network Theory informed approach being undertaken (Tummons *et al.*, 2018); the hope at the start of the data collection was that the researcher would be able to 'follow the actors themselves' (Latour, 2005, p. 12). However, from a practical perspective this was challenging, and this is often cited as a shortcoming within the Actor-Network Theory approach from other scholars (Scoles, 2018). The limited access, limited timeframe for data collected, and focused research questions identified here all align with the use of a focused ethnographic approach along with identification of hours of observation, (Trundle and Phillips, 2023). The practical implementation of the data collection is outlined in detail below, but consists of observations of practice, semi-structures interviews with participants, and tracing of non-human actors including documents alluded to in the interviews to be treated as data.

4.3.1 Study Setting

The study took place within a district general hospital in the Northeast of England. The data collection period was for 3 months from March through to May in 2019. Whilst maintaining the confidentiality of the site, the hospital, at the time of data collection had yearly inpatient

admissions of approximately 30,000, over 50,000 A&E attendances, and over 150,000 outpatient attendances.

The X-ray department has 3 X-ray rooms that are used for A&E, outpatient attendances, and general practitioner (GP) referrals. There is also a fourth separate room that this used primarily for inpatients. The three main X-ray rooms are shaped in a U with the X-ray rooms spread evenly within the arc of the U. Each radiographer is assigned a room and will work that room throughout a morning or afternoon session. There are other rooms and areas, including a fluoroscopy room and cardiac catheter lab that are outside of the scope of the study. Portable requests (including those for A&E) will also come through the main X-ray area. The sites for the observations were the main X-ray area and the in-patient room.

4.3.2 Recruitment of Participants

Radiographer participants were forwarded an email by the Gatekeeper from the researcher with the participant information sheet attached (appendix A). Participants were asked to contact the researcher directly, indicating times when they would be available to be observed by the researcher, and following this, they would also be invited for a semi-structured interview, a common approach to participant recruitment (Kristensen and Ravn, 2015). A convenient time was selected in tandem by the researcher and participant to enable observation of the participants within the 'viewing area'. Participants were consented prior to the observation period and the interview period separately (see appendices A, B1 and B2). This was performed to enhance the autonomy of the participants, allowing them the time and space to think about their inclusion within research; consent for involvement in both the observation and interviews was obtained face-to-face (Davies, Kolstoe and Lockett, 2024).

Ethical principles (Beauchamp and Childress, 2019), in particular participant autonomy and informed consent, impacted the approaches taken. Participants were given the time and space to consider their participation. Consent during the observation period (once obtained) was then verbally reaffirmed by the participant at the end of each observation session across the two-week period. Within clinical trials it is not unusual to gain verbal consent followed by written, but this does have ethical implications (Lawton *et al.*, 2017). Having performed the process of written and verbal the opposite way round (explicit verbal followed by verbal reaffirmation for observations) appears to be in line with appropriate practice (Denscombe, 2009).

Some staff indicated that they would be amenable to take part in one aspect of the study (the observations), but they would rather not be interviewed. As the approach to consent of the participants operated on a two-way process, it was deemed suitable to include the participants who were happy to be only observed in the study. Participants were also happy to discuss aspects of their work during the observation period. One participant was unable to be observed due to their shift pattern during the observation period. Consent was dealt with separately for the interview, again, with the researcher reaffirming the right to withdraw at any point, without giving a reason and without penalty. Participants were also reminded that they did not have to share any story that they felt uncomfortable sharing with the researcher (see appendix B).

4.3.3 Observational Period and Field Note Collection

The observational period for the participants took place over a two-week period. The researcher's main area of data collection was the practices that revolved around the X-ray referral. Field notes were collected by the researcher throughout the time in the clinical area and were integrated into the data analysis. Notes were made by hand and collected within a notebook which was used exclusively for the purpose of collection (Hammersley and Atkinson, 2019). These notes were then transcribed *verbatim* into a word document following each of the individual sessions. The written-up notes were organised on a day-by-day basis. The notes were organised into general observations (particularly relevant given the acclimatisation required to the department) and observations that related specifically to the observed practices of the radiographers and their discussions, both with each other and the researcher (Emerson, Fretz and Shaw, 2011).

Time was taken on the first day to acclimatize the researcher to the research environment. A schematic diagram of the viewing area was produced along with a thorough description of the work area by the researcher during the first day of observation. This was seen as essential as the researcher had previously been a clinical radiographer; however, they had not practiced clinically for some time. There had been some technological advances made to the equipment which changed the process of the work undertaken (namely the move from computerised radiography to direct digital outlined within the introduction (Strudwick, 2024). Following this the field notes became more focused on the practices of individual participants that were influenced by the X-ray request. However, even though there was a disciplined approach to the

capture of field notes, it must be recognised that these notes are fragmentary at best (Flora and Andersen, 2018).

A conscious decision was made, based on a reflexive diary analysed prior to beginning data collections and the engagement with a thought experiment from Law (2004), that the following overarching structure would be employed to ensure that the data collected was relevant and able to be interpreted in line with Actor-Network Theory (see figure 2). Thus, the data collected focused on the practices around each referral process, and the identification of those entities that have agency. Particular attention was paid to instances of disruption or challenges around the X-ray request (Geessink, 2022). Notes were made by the researcher following discussions and interpretations of the radiographer participants and their handling of the referral: notes were taken outlining the technology used (including telephone, bleep system, computer systems, etc.); communication with colleagues; communication with patients (although this was not observed by the researcher but followed up using *ad hoc* discussions); interaction with protocols/written schemes of work; previous images (patient images not seen by researcher); previous radiological reports (also not seen by the researcher); referral to technique guides; referral to external guidance; etc. These data points were added to through discussions with the individual participants regarding their work, and the interactions that they had with other staff members (who were also participants). To adhere with Actor-Network Theory, this list was not considered exhaustive, but a starting point for sensitisation to the processes of collecting data (Desai *et al.*, 2017).

The aim of collecting this data was to produce a thorough mapping of this particular place. The production of these maps draws on the work of Payne (2017), which was used to produce a full and thorough outline of the work that is undertaken by the radiographer during the justification/authorisation processes. These maps were then integrated into the interpretation of data, forming a point of triangulation between the codes and thematic analysis undertaken and the influence of the documentary data and field notes within this.

4.3.4 Interviews

Interviews were undertaken with the participants within a designated room within the hospital grounds. All the interviews were audio recorded and followed a semi-structured pattern (see appendix C). The interviews were then transcribed *verbatim* (Braun and Clarke, 2012). The

development of the interview schedule was informed by the reflexive account of the researcher's own clinical experiences, and this was seen as dynamic as it was further influenced following the observations and subsequent interviews with the participants own individual experiences. This led to the development of an interview schedule that is fit for purpose in terms of providing a loose structure for semi-structured interviews (Bathran and Samuel 2024). Prompts were used and these were often derived from observational data taken prior to the interviews beginning (Bearman, 2019).

Rapport building with participants is seen as being a skill and this was used to break down barriers between the 'foreign' researcher and the 'native' participants. This was done partially through disclosure of being a radiographer and drawing on previous experience to ensure that no artificial barriers were present; this allowed a rapport to build with the participants through the shared experience whilst maintaining the position of the researcher in a certain time and space (Lareau, 2021). The interviews with the participants lasted between 35 min (shortest) to 75 mins (longest) with the interviews taking a mean average of 58 mins to complete. No interviews were terminated or stopped, and the interview schedules were completed.

4.3.5 Documentary Data Collection

The local rules and technique guides are required under UK law (namely the Ionising Radiation (Medical Exposure) regulations, 2017; Ionising Radiation Regulations, 2017). The local rules are required under IRR (2017) and the protocol guide for justification/authorisation of requests is required under IR(ME)R (2017) to aid in the risk benefit analysis process that must be taken by practitioners and operators under the regulations. There is no set manner in how these are written, nor in how they are interpreted by the clinical staff who use them. The technique guide was obtained via the Gatekeeper and included for content analysis, along with the posters that were within the department. There were also a number of documents that were recorded by the researcher that were present within the viewing area. These documents were predominately from the Society and College of Radiographers and provided guidance around various aspects of the radiographers' work (CoR, 2022). As these are available publicly these were also collected and added to the documentary data collection. During the interviews, participants also mentioned other documents, such as the HCPC Standards of Proficiency. These were also collected, as publicly available documents, and added to the documents for data analysis.

4.4 Data Analysis

Initial data analysis was three-fold; analysis of the observational data, using an X-ray referral as a unit of data; analysis of interview data using reflexive thematic analysis; and a reflexive thematic analysis of the written documentation. Prior to the discussion of data analysis, it is prudent to discuss the intersection of the theoretical underpinnings on the approach.

4.4.1 Actor-Network Theory and Noise: Informing the Analysis

As previously discussed, Actor-Network Theory is best described as an overall approach to research that incorporates the associations between entities and describes the nature of those associations. Therefore, the approach is able to be combined with the concept of noise during decision making. The aim here being not to focus on the complex cognitive nature of the decisions being made but identify entities that introduce noise into the decision-making process. Whether this is from a presence *within* the network or via enrolment *into* the network.

Weaved into the data analysis is the concept of noise (Kahneman, Sibony, and Sunstein, 2021). Whilst Braun and Clarke (2021a) state that *a priori* categories should not be used within thematic analysis, the concept of noise was drawn upon from an analysis perspective, but not at the coding stage, rather at the thematic development stage. This was to allow the elements of noise to develop in an *a priori* manner, from the development of the associations within the network. This means that the participants discussion of the processes and the field notes collected could intimate the noise inherent within the network. Following from this, the notion of crossings and the interrogative questions from the pivot table was also used to contextualise the thematic development.

4.4.2 Integrated Data Analysis

Data analysis was undertaken using Braun and Clarke's (2022a) reflective thematic analysis approach in the initial stages. Reflexive thematic analysis was used as a way of interrogating the interview data. There are issues with the use of this approach, and Braun and Clarke themselves have highlighted that there are questions that need to be addressed when using their approach in circumstances where there may be ontological and epistemological incongruencies within the approach (2021a; 2022c). However, given the epistemological (relativist) and ontological (critical realist) approaches given, Braun and Clarke (2022b; 2021b)

give a rationale that within this methodological position there is a place for reflexive thematic analysis within an Actor-Network Theory approach.

A previous discussion regarding the difficulties of defining Actor-Network Theory in terms of methodological positionality has already been given, but overarching, standardised guidance to its application is not available, and again, given the discussions above, nor should there be. This draws on points made by Latour (2013) and Law (2004) that this is perhaps a strength of Actor-Network Theory. However, as Actor-Network Theory lies (very) broadly within this position, then this appears to be an appropriate approach to take. It is important to acknowledge that Actor-Network Theory does not provide a rigid theoretical framework within which to work, but an approach and sensibility towards the research as whole (and therefore the analysis). The codes and themes were developed from the data, in line with inductive approaches (Bignetti, de Souza and Petrini, 2023).

MacLeod *et al*. (2017) have perhaps written the fullest account of Actor-Network Theory application within a methods perspective. They themselves are clear that their account is not definitive and should not be seen as recipe of 'how to do' Actor-Network Theory but perhaps an example of its application. The approach advocates the application of constant comparative analysis through using Grounded Theory as a potential way of applying Actor-Network Theory. At first view this appears to be an appropriate group of methods to apply. Braun and Clarke (2021b) are however, more sanguine regarding the notion of constant comparative analysis describing is as a concept that is applicable to all qualitative data approaches that seek to analyse within a relativist lens. Therefore, within the approach taken here, it may be argued that constant comparative analysis does not offer any more in terms of analysis of data than reflexive Thematic Analysis. Whilst MacLeod et al (2017) advocate a grounded theory approach, Braun and Clarke (2021b) also note that there may be times when the research could benefit from reflexive thematic analysis. These include when the sample is small and homogenous, and the researcher may be considered a novice (both of which are indicative of this particular thesis).

The approach taken within the interview, fieldwork and textual documents was that of a reflexive thematic analysis approach, utilising the six phases of thematic analysis outlined by Braun and Clarke (2022a). This incorporated the six phases of the approach, beginning with data familiarisation (Braun and Clarke, 2022a). This was in part achieved through the native

verbatim, orthographic data transcription performed following the interviews to allow familiarisation with the datasets and through engagement with reflexive note making during the transcription period along with concomitant notes made during the interviews themselves (Couceiro, 2024). The coding phase and the familiarisation phase, perhaps happened in tandem as further coding of data that related to the research question allowed for the further familiarisation with the dataset (Terry and Hayfield, 2022). The development of the codes into themes for further analysis was a complex, non-linear process which is highlighted by Braun and Clarke themselves. There was also the interplay of Actor-Network Theory, *AIME,* and noise at this point, whereby these theoretical sensibilities were interlaced over the initial codes and also used to further interrogate the themes within the analysis. It is this process that allowed deeper analysis of the data, which aligns with the application advocated through Braun and Clarke (2022a) and utilised in other research (e.g., White *et al.,* 2015).

The initial coding was revisited and further refined on four separate occasions. Initial codes were produced keeping in mind the research questions, along with the sensibilities derived from Actor-Network Theory and noise, as outlined above. This means that coding at this point also took into account a focus on the non-human elements (within the interview data in particular) and that when thematic development took place, there was also a particular focus of association between the entities that had been coded (Latour, 2005; Braun and Clarke, 2022a). Following the development of initial themes, these were further revisited and refined, along with the processes for the documentary analysis highlighted below by MacLeod *et al.,* (2017). The reporting of the findings has been produced in an integrated manner, to allow the results to be further contextualised through theory and previous research (Byrne, 2022).

Whilst reflexive thematic analysis was utilised within the interview data, fieldwork data, and textual documents. There was another layer to the analysis taken particularly regarding the textual documents. The analysis of this data was undertaken through an approach outlined by MacLeod *et al.* (2017). This involves asking five sample questions of the data namely:

1. “Why is this document enduring/durable?
2. What work does the document do?
3. How are humans in the document positioned in relation to the materials?
4. Which objects/humans/actions is this document connected to?
5. What effects emerge through this particular assemblage?” (p. 182)

The integration here of reflexive thematic analysis and the five questions outlined is best outlined by the following process. During the development-review-refining of themes (rather than coding) these questions formed an overarching approach to thinking about the development of the themes within the data as well as the rationale for the collection of the data in the first place (e.g., question 1 guided the collection of the protocol as participants talked about this within the observation period). These are very much questions that derive from the Actor-Network Theory approach. The questions being posed here of the textual documents form a wider perspective, which fits with the interpretive approach outlined by Braun and Clarke (2022a), where they outline of the importance of the analysis being defensible and ensuring that findings are arrived at *through the data* rather than being pre-formed. This is akin to Latour's (2005) remarks around the focus on the empirical. This ensures that when building the description of the assemblage, or network, within which the X-ray request resides, it is not just the work of the request itself, but also the work that the other textual documents are doing, the actions that they influence, and the influence across the network (MacLeod *et al.*, 2017). Therefore, at this particular point, the questions outlined above from MacLeod *et al.* (2017) also informed the development of themes and their conceptualisation.

Data was analysed initially using *AtlasTi 24* (ATLAS.ti Scientific Software Development GmbH, 2024) for coding, refining and thematic development. Following the coding, the final codes were then transferred to *Obsidian 7.4.1* (Obsidian, 2024) where the codes were organised into themes and the connections between the codes were developed, using the functionality within the software. *Obsidian 7.4.1* allows the connection between files (or in this case, each file was a code). This was useful as it allowed a fuller picture of the association between the codes as well as where they fitted within the wider picture.

The themes were developed through engagement with the stages of Braun and Clarke (2022a) and MacLeod *et al.,* (2017). Through this, significance within the thematic analysis was elicited through engagement with reflexivity and, crucially, with the research questions (Braun and Clarke, 2022a). Therefore, coding frequency was not an analytical tool that led to the development of the themes, but rather the codes that clearly influenced the participants themselves and were evident across the data. This was garnered through their intonations, body language, and how they discussed the elements of the questions. Where possible these have been kept within the extracts from the data collected and are within square brackets in the excerpts. Therefore, utilizing reflexivity (Bukamal, 2022) and recognising that some themes

have inherent dichotomies within then (Braun and Clarke, 2022a) the significance of the themes were deemed to be important, rather than coding frequency across the data corpus.

4.4.3 Production of the Actor-Network Theory Diagrams

Following this primary analysis, this data was then collated into a situational map, providing an overview of the work that is undertaken during the patient's referral for an X-ray examination. The open codes, category data, along with the situational map. The production of the Actor-Network Theory diagrams draws on the work of Payne (2017), with adaptations. These adaptations were required as the application and theoretical approach taken by Payne were slightly different in terms of the interpretation of Actor-Network Theory applied. To develop the diagrams *Obsidian 7.1.4* (Obsidian, 2024) was utilised. The canvas function within the software was used to develop the diagrams which form a useful adjunct to the data analysis, allowing the reader to see the complexity within the network, as well as allowing the wider network elements to be broken down, especially the X-ray request. These were the developed to show the potential agency of the non-human actors within the networks discussed.

4.5 Ethical Considerations, Research Governance and Approval

As the study included access to participants who were members of staff at an NHS Trust, access to the site was required from the Research and Development (R&D) department of the hospital trust (appendices D1 & D2). Prior to this, Health Research Authority (HRA) proportionate review took place via an application though the Integrated Research Application System (IRAS) (approval seen in appendix D3). The Teesside University Research Ethics and Governance Committee (REC) of the School of Humanities, Social Sciences and Law (SHSSL) where the research project and PhD student were attached to, was applied to first. This was approved following the granting of the letter of access as a condition of the Teesside University SHSSL REC (appendix D4).

The research methods employed allow for the critical interrogation of the approach from an ethical perspective. As the approach has been conceptualised as a focused ethnography, ethnographic ethical issues applied to the operationalisation of this research, such as the tension between those who have consented to be in the study and those who are in the 'area' but are not necessarily the focus of the researcher (Hammersley and Atkinson, 2019). Another primary ethical consideration was a concern regarding the researcher being exposed to person

identifiable information and personal medical information. This stemmed from the researcher being within the space of the X-ray viewing area and potentially having access to personal identifiable information regarding patients attending for X-ray examinations (including their health records as well as their subsequent radiographs) as this could be seen as breaching patient confidentiality, though the patients themselves were not the focus of the researcher. There were also concerns from the perspective of the other people who were in the X-ray department who were not the focus of the research (i.e., those who have not consented to being explicitly involved in the research) and their interactions with the participants of the research.

To address these issues, adherence to the four principles of public involvement outlined by the Health Research Authority (HRA) was integral to the operationalisation of this research. These include involving the right people; involve enough people; involve those people enough; and describe how it helps (HRA, 2019). An initial focus group took place within the university setting with a number of members of the school's patient, carer, and public involvement (PCPI) team. This is a group of patients and carers who contribute to university activities (such as programme development, learning activities, and crucially, research). The group was made up of individual patients who have experience of radiology departments and the care that they would normally receive within them. Their involvement in research development from the inception stage and is often described as beneficial and being good practice (Price *et al.*, 2018). To prevent the engagement becoming tokenistic the focus of the discussions with these individuals was what would their concerns be around the conduct of the research within these surroundings, with aim of ensuring that, whilst the patient was not the primary focus of the researcher, there was an opportunity for them to contribute to the design of the research (Domecq *et al.*, 2014). The following recommendations were implemented on the recommendations of the PCPI group.

Signage was placed at the front desk of the radiology department alerting both staff and patients that a researcher was within the radiology department (appendix E). In line with the recommendations of the PCPI group, the patient poster assured patients that no data was being collected about them and that if they would like to speak to the researcher then they were able to do this. No data was collected regarding individual patients and no information regarding the individual diseases/conditions that the patients were suffering from were collected.

Discussions also took place within the PCPI focus group regarding patients in the X-ray room with staff and how the researcher would approach this situation. It was considered that a similar

approach be taken as that currently happens with the students. The researcher would introduce themselves to the patient, explain the nature of their work within the X-ray department and ask if they could sit in on the examination and make some notes about what the participant was doing. It was felt that, as the risk to the patient was very low in terms of identification there was no requirement to gain explicit written consent, but to use the same process as would be required if a student was in the room observing the examination. Whilst the researcher thought that they would not need to access the X-ray room, this suggestion was also reaffirmed through the guidance given by the Health Research Authority in their proportionate review feedback, following their assessment of the research. However, during the data collection period the X-ray examination room was never entered by the researcher.

Gaining access to any area can be a difficult within any organisation, along with other added difficulties within healthcare settings (e.g., Rashid, Caine, and Goez, 2015). These include difficulties in accessing hospital areas, given the sensitivities of being able to access (whether or not this happens inadvertently) people's demographic and personal information, and the complexities of the processes which are in place to protect the public and staff (Kowalchuk, 2019). Informal discussions with the Chair of the Ethics committee revealed the potential for potential breaches of confidentiality. Following this correspondence was initiated with the Confidentiality Advice Group (CAG) and the data controller within the local trust. The advice from CAG was to discuss the matter further with the data controller of the trust to ensure that their governance procedures were followed, as they [the data controller] were responsible for any breach of confidentiality with regards to patients. The data controller advised that an honorary contract or similar would be sufficient with regards to mitigating the possibility of a breach of confidentiality. This was obtained (appendix D1 and D2) and was also a condition placed upon the research by the Teesside University ethics committee. The research governance assessment deemed that a letter of access was sufficient.

Accessing participants for semi-structured interviews and observations, the processes employed must address the potential for abuse of power and coercion. The observational and ethnographic nature of the research means that access to the environment, for a prolonged period, can be difficult. Ethnographic research requires some further attention to those who have not consented to be observed, but are within the observation space, as it is often impractical to consent those whose presence within the natural environment may be seen as fleeting (Strudwick, 2020). However, all staff must consent to the presence of the researcher,

regardless of whether they were actively involved in the data collection. To address this, a discussion with all the staff took place prior to the data collection period beginning. The study was outlined to all the staff, and an opportunity was given for questions. Through the interrogation of the reflexive diary, the emic/etic status of the researcher helped with putting the staff at ease. It was apparent that the staff recognised that the role of the research was exploratory in nature and that, as a radiographer first, certain standards of conduct and ethics are assumed within that role, as well as a researcher. To gain the trust of the staff, especially in discussions with them, the radiographic identity was made more apparent than that of the researcher (Purdy and Jones, 2013), even though the researcher identity was also very clear. To emphasise that the researcher was not a member of the radiography team *per se* a decision was made that a radiography uniform was not worn, and a notebook was carried at all times during the observation period, which clearly marked the researcher out as an outsider (Surfin, 2015). The emic/etic debate within ethnographic approaches has been widely debated throughout the literature (e.g., Harris, 1976; Markee, 2013; Naaeke *et al.*, 2012) and notions of bias, half-truths, exclusion, points of reference, etc. are widely contested within each approach. However, as seen above, using the insider status can build trust and a rapport with potential participants and those indirectly affected through the research process. This familiarisation and distance can be difficult and the need for positionality and reflexivity is apparent when engaging in this type of research (Gelir, 2021) however, the reflexive diary and previous clinical experience helped with the observational processes (Lambert, 2019).

Regarding the taking of field notes the researcher carried with them a notebook within which they made the notes regarding the participants when they were in the X-ray viewing area. The notes within the notebook were made available to all participants (whilst maintaining the confidentiality of the other participants), should they want to look through the notes that related to them and see what was being written about them. The notebook was split into section with my general observations regarding the day, which were not related to any individual person (that were open to all) and notes regarding each individual participant within the study, which were open to that individual participant, so that they could see what was being written about them. None of the observed participants, nor the other radiographers or assistant practitioners wanted to read what had been written about them within the notebook.

4.6 Summary

This chapter has outlined the processes that have been undertaken to develop a coherent methodological strategy that aids in the development of the aims and outcomes of the research. The overarching theoretical framework of Actor-Network Theory has informed the approaches taken, and this chapter has also explored how this theoretical framework fits into the different ontological and epistemological assumptions that underpin the research. From this, there is an outline of the adapted ethnographic approach to data collection that was employed within the data collection.

An adapted ethnographic approach was employed to collect data and ensure adherence to the sensibilities of Actor-Network Theory. The approach allowed (within reason) the researcher to follow the actors and their associations within the radiographic network, allowing the researcher to focus upon the X-ray request and the agency that it has within the radiography department. The data collected included documentary evidence from the department along with the further associated documents (such as legislation), interviews with participants, and non-participant, overt observations from within the radiography departments.

The ethnographic approach employed does not come without associated risks, especially where other professionals, personnel and patients are potentially part of the data collection process. The current research has been developed to mitigate these risks, whilst maintaining the integrity of the research itself.

The analysis of the data and the findings of the work are discussed across the next three chapter of the work. They highlight the nature of the practices undertaken by the radiographer. However, the following chapters also allow a further exploration of the X-ray request, and the various actors that reside within this potential black box. The approaches discussed and justified above allow the unpicking of the various non-human actors, with the help of the concept of noise (Kahneman, Sunstein and Sibony, 2021), to highlight the key practices that ensure that the network is held together, and ultimately, the patients' symptoms, the patients themselves, and the radiograph make their way through their different diagnostic journeys.

Chapter 5: Noise and the X-ray Request

> "The answer to the great question...of Life, the Universe and Everything...is...forty-two."
>
> (Douglas Adams, *The Hitchhikers Guide to the Galaxy*, 1979)

This chapter will explore the work of the X-ray request, radiographer and other actors during the process of authorisation/justification. This allows the exploration of the roles of both the human and non-human in determining the trajectory of the patient and the X-ray request. The relationship between the entities within the network will be explored as will the process of ordering and re-ordering. The durability of the network (why the network, as it currently stands, works), the potential for disruptions within the network, what happens within these disruptions, and what objects (actors, intermediaries, mediators) are enrolled into the network to ensure stability. Various entities will be discussed in terms of how they influence the network, with a particular focus on the potential noise that they may bring to the assemblage. Before these are attended to, an example of an Actor-Network Theory 'black boxed' object will be discussed, the process of authorisation/justification will be conceptualised from the data, the X-ray request will be highlighted as a boundary object that resists being black boxed, before the objects that influence the action can be discussed.

The categories above (intermediaries, mediators, etc.) can be seen in the analysis of the process outlined below. Here challenges can be observed within the interpretation of clinical data, use of the protocol guide (a mainstay of the radiography department), noisy objects within the radiography department, and the moving of objects (in particular the X-ray request) across boundaries. The radiographers who participated in the study ranged across the Agenda for Change bandings from band 5 to band 7, including reporting radiographers. The sex of the participants was 6 female participants and two male participants. The number of years qualified was also across a wide range from newly qualified (within the last 6 months) to radiographers who had been qualified more than 20 years. The participants within the research have all been given a pseudonym. This was randomly generated via Excel (Microsoft, 2023) from a list of names which were not related to the participants, other than by sex. Due to the field work period (two weeks within the department) there were some challenges in terms of involving participants across both parts of the data collection (observation and semi-structured interviews). One radiographer (Doria) chose to be observed during their day-to-day work but was not able to be interviewed. Another radiographer (Coleen) was only able to be interviewed

due to their shift patterns across the data collection period. All other radiographers agreed to be both observed and interviewed (see table 4).

Table 4: Participant Experience and Pseudonyms

Pseudonym	Years of experience range	Participation
Vanessa	10 >	Observation and Interview
Gabrielle	10 >	Observation and Interview
Gill	10 >	Observation and Interview
Alonzo	10 >	Observation and Interview
Stephani	5 > 10	Observation and Interview
Doria	10 >	Observation only
Elliott	< 5	Observation and Interview
Coleen	< 5	Interview only

Whilst the range of experience is highlighted here, the qualifications of staff have not been disclosed for confidentiality reasons. Where a reporting radiographer has mentioned something within the discussion that pertain exactly to this, this is reported as [Reporting Radiographer] rather than attributed to a pseudonym. This is to ensure the anonymity of the participants; the department where the data was collected was relatively small and giving further information could mean that these participants may be identified with this information (Bos, 2020). The document collection was guided through the interview and observation. Table 5 gives the source (often multiple) of the document collection.

There are various trajectories for various objects within any actor-network or assemblage (Scoles, 2018). The focus is on the X-ray request and its journey into the radiography department from the clinic[27] and how this then creates a radiograph (or not) of the patient. The X-ray request is originally generated as the patient engages with the (potential) referrer (see figure 3). There are many referrers that refer patients to the radiology department, and they are situated in many places. The participants identified a number of different referrers from within the hospital (junior doctors, registrars, consultants, nurse practitioners) and those outside of the

[27] Here the clinic is conceptualised as the place where a patient and referrer (whether this is a medical professional, physiotherapist, etc. is immaterial at this point) meet, and a decision is made for them to have a radiological examination (or X-ray examination).

hospital (mainly General Practitioners but also other health care professionals). The obligatory passage point (Latour, 1993) into the radiology network is via the X-ray request, which is conceptualised here as a boundary object. This is information that is used in different ways by different professionals. The X-ray request is used by the referrer to obtain a diagnosis whereas the radiographer uses it to ensure that an examination can take place (Star, 2010). Therefore, the object itself will be created differently at different times and different actors will have a different effect on the X-ray request (e.g., patient symptoms, referrer, electronic referral system, consulting room, etc.).

Table 5: List of documents and source

Document	**Identified through Interview, Field Notes, or other documents**
IRMER 2017	Interview
CoR IRMER Practitioner Guidance	Field notes, Other Docs
Department of Health IRMER guidance	Interview, Other Docs
CoR Radiographer as Practitioner	Interview, Other Docs
Joint IRMER Guidance (CoR/RCR/IPEM)	Interview, Other Docs
Students and Trainees as operators (CoR)	Interview, Other Docs
HCPC Standards of Proficiency (SOP)	Interview
HCPC Standards for Conduct Performance and Ethics (SCPE)	Interview
SCoR Standards of Ethics	Interview
SCoR Paused and Check	Field Notes, Interview
Protocol Guide	Field Notes, Interview

The X-ray request arrives within the X-ray department from the referrer and is (depending on the referral source) vetted by a radiographer. This process is seen as being aligned with two roles described within *IRMER 2017* as authorisation or justification. A decision is made at this point whether the patient is to receive an X-ray examination or not. If the examination goes ahead the radiographer will engage with the X-ray unit and produce a radiograph. If the examination is deemed not be justified, it will be rejected and not go ahead. As with all things there is a story behind these decisions, and this will be the focus of the findings chapter.

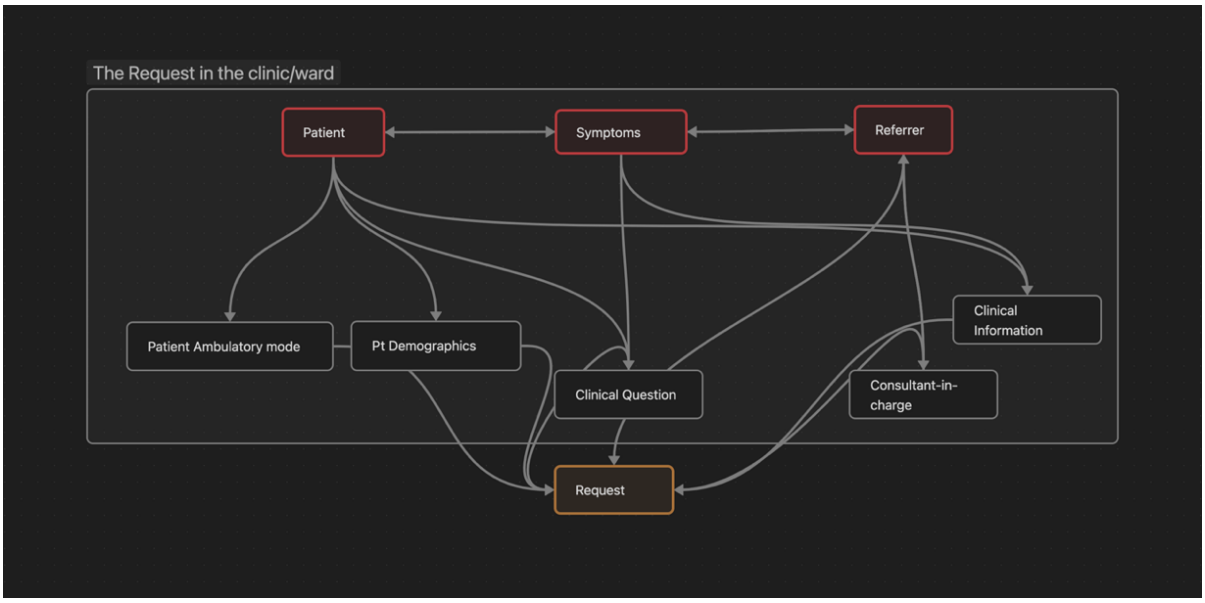

Figure 3: Unboxing the X-ray request into constituent parts.

5.1 The X-ray Machine – An Example of a Black Box

The findings from both the empirical and latent themes suggest that certain entities within the radiology department can be said to have been 'black-boxed'. This description can be used for those items which transmit meaning faithfully between other actors within the network (Stalph, 2019). The findings here show that the X-ray machine and image receptor are indicative of such an entity. The process of identifying, clarifying, and peering into/prising open black boxes can allow the parsing of the network and trace the actions of elements which may be termed mediators and help in the identification of discontinuities within the network. A black box may not always be working as assumed.

The X-ray machine is an example of something that may, in terms of the wider radiographic network, be black boxed. For example, the X-ray tube works through a stream of electrons flow from the cathode to the anode, hitting the relevant target and emitting X-ray photons (Holmes, Elkington and Harris, 2021). The input (from the radiographer, patient, etc.) and then the output (the resultant radiograph) gives an example where part of this network is filled with intermediaries that can be black boxed (Dennis, 2020).

Radiographers did not discuss the X-ray machine as being a source of discontinuity within the process of authorising/justifying the X-ray request, despite being an essential component of their work.

"…in the rooms the X-ray equipment moves into position automatically depending on the examination requested or to be undertaken. This brings a small pause in the process of X-ray examinations as the radiographer prepares for the current patient…" [Field Notes]

There may be an occasion where the radiographer may input the incorrect X-ray parameters[28], this is where the radiographers talk about what exposure factors to set, but normally within a wider context:

"…checking it's justified writing the exposure all this…" [Stephani]

and some complained about the current knowledge of students on the matter:

"…exposure factors they [students] did not know anything about it…" [Elliott]

The mention of the pause and check in terms of setting of exposure factors is useful, as these were found throughout every X-ray room:

"…each room has a PAUSE[D] AND CHECK poster from the SoR within it as well…" [Field Notes]

The Pause and Check (CoR, 2016) is a useful document and can also be drawn attention to here as this does indeed explicitly note the checking of the exposure factors set:

"…Set optimal exposure factors (ALARP) [as low as reasonably practicable]…" [Pause and Check Poster]

The setting of the exposure factors does not however disrupt the black boxing of the X-ray machine and image receptor, as it is considered that the X-ray machine will faithfully interpret the input (the kilovoltage (kV) and milliamperage second (mAs)) and produce an X-ray beam

[28] These are kilovoltage and milliamperes second. This controls both the amount of X-ray photons released by the tube and their energy.

which has energy characteristics that link to the kV and mAs set. This X-ray beam interacts with the patient and the signal on the receptor is analysed by the digital image receptor, thus producing a radiograph (Yucel-Finn *et al.*, 2023). When a radiographer incorrectly sets exposure factors, the X-ray machine will faithfully interpret these and produce X-radiation that is characteristic of the factors set[29]. The incorrect setting of the exposure factors leads to a resultant radiograph that will have the characteristics of *that* X-ray beam interaction (i.e., there will be certain factors in an under/over exposed radiograph that can be seen). Therefore, having pried inside of the process, this black box process appears suitable as the input and output are inexorably linked and faithfully transmitted. The modern X-ray unit can be seen to be very robust, most viewing units have elements within them (altering the widow width and level for example) that can mitigate the variances of the inputs from the radiographer (Murphy, 2019). This means that this process can be black boxed even further, particularly from the viewpoint of the justification and authorisation of the X-ray request. It is the outcome of this process that has an effect within the network, rather than the X-ray photons themselves directly influencing the process.

The process of black boxing by the researcher appears to be a useful tool in this instance. Within the field notes and interviews there appeared little variation in the practices performed. Within the data, this is apparent as the participants themselves indicated that this process is black boxed. During discussions around ionising radiation dose with the participants the following excerpts give an indication of the black boxing by participants of this part of the radiograph generation process, the discussions intimated towards variance at the input point rather than variances within the process, as the discussions of when things go wrong the participants used personal language for the error, never the equipment:

"…my centring is good and my positioning is good so my doses are quite low and like generally I don't repeat anything…" [Gill]

[29] If the exposure factors are insufficient, as an example, if the kilovoltage (kV) is set too low for a particular patient this would therefore result in the X-rays leaving the tube not having enough energy to adequately interact with the patient to produce a diagnostic radiograph. The radiograph would not have enough penetration (darkness) or contrast (difference between light and dark) to make an adequate diagnosis, and this would require further X-ray examination.

5.2 Authorisation/Justification in the X-ray Department

There are roles that are highlighted within *IRMER 2017* regulations and certain aspects of those roles, that are assigned certain monikers. For example, the role of the referrer is fairly straightforward[30], however, the roles of the operator and practitioner under *IRMER 2017* (and subsequent amendments) are distinct from the normal healthcare-wide understanding of these terms. For the purposes of this analysis, practitioner, as defined under *IRMER* are those individuals who are designated by the employer to justify:

….an exposure and such other aspects of an exposure as is provided for in these Regulations..." [*IMRER 2017*, p. 3]

This essentially is the person who is taking responsibility for the risk assessment of the examination within this context. Authorisation is slightly different, and it defined within the regulations as being when it is:

"…not practicable for the practitioner to authorise an exposure as required by paragraph (1)(c), the operator must do so in accordance with guidelines issued by the practitioner…" [*IRMER 2017,* p. 7]

This is the protocol[31] or technique guide highlighted by the participants within the interviews and was collected and analysed during the research period. The protocol within the context of this radiography department highlights who is allowed to operate as a practitioner, and a very clear definition is given within this documentation:

"…Overall Practitioner Responsibility is the Clinical Lead for Radiology. Consultant radiologists and reporting radiographers will also act as practitioners…" [Radiographic Justification Guidelines]

The initial analysis for the conduct of X-ray examinations is given in figure 4. This shows the process of the request being raised from within a ward/clinic and the different elements that make up the X-ray request. The request (containing the information highlighted above) is then

[30] The person who is allowed by the employer to refer patients for X-ray examination.
[31] Protocol here is used to define what may commonly be described as 'Referral Guidelines', 'Technique Manual' or 'Technique Guide' within many departments.

interacted with by the radiographer within the X-ray department who will then check that the X-ray request is justified (through the process of authorisation/justification). The radiographer (if the patient is already in the department) will then undertake the X-ray examination and produce a radiograph. This radiograph, in most (but not all) circumstances, will then require a radiology report. This is produced either by a reporting radiographer or radiologist, using the request to provide contextual information. This report (and in some circumstances the radiograph as well) will then be actioned by the referrer.

Individual radiographers themselves also identified a process that they undertook during the vetting of individual requests. Whilst all the radiographers did these activities, they described them often in different order. The diagram below is an amalgamation of the different approaches. Whilst there is an apparent order to the process identified below, given the discussions of the process, this is not an algorithm where if one point is missed then the request is rejected. It is a network of interactions, and each request is considered by all the participants as being a whole.

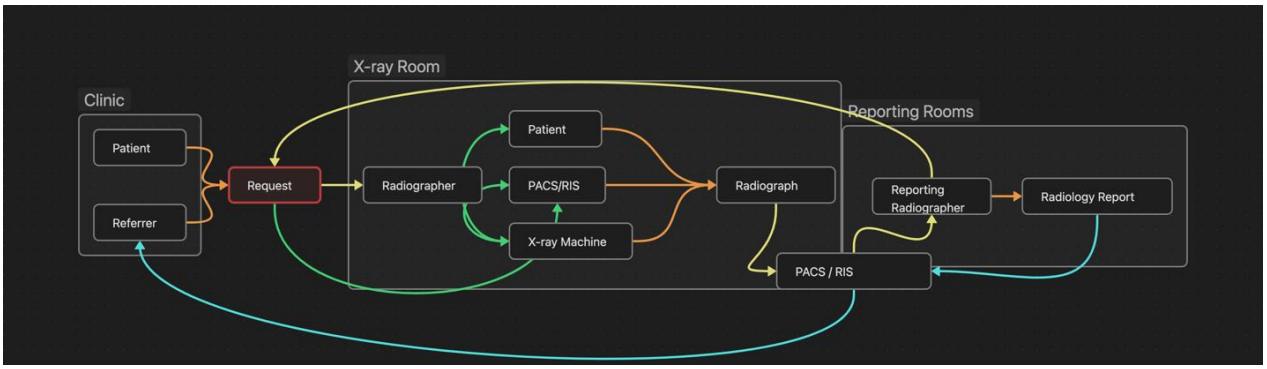

Figure 4: Simplified process of patient undergoing an X-ray examination.

5.3 Durability of the Network

Radiography as a profession, within this research, has been conceptualised as a sub-contractor, within the wider healthcare system. This means that, essentially, radiography sits outside of the wider disease-related specialisms. This can be seen when the patient attends a clinic for a chronic condition or attends the GP for an acute pathology, following this, the referrer will move the patient from the ward or clinic towards the radiography department. There the patient will receive a radiographic examination the results of which will then be passed back to the referring

clinician. The subcontracting of the radiographic activity to the radiography department is apparent from this. This is in line with what Tannenbaum *et al.* (2012) describe as being a transient part of the wider team, almost akin to a sub-contractor. Powell and Davies (2012) have conceptualised healthcare work as being stratified within specialist parameters. This means that healthcare work is increasingly performed along disease/specialist roles, rather than professional subgroups. Within radiography the organisation of work, as previously discussed, is primarily aligned to the different imaging modalities rather than the disease to which the patient suffers (Knipe, 2024). Therefore, the radiographic work can be conceptualised as residing outside of the wider healthcare assemblage. Because of this, there are certain entry points into the network. The X-ray request can be seen as the object that is used to gain entry into the radiography network.

This work focuses in on the X-ray request as the principal actor that gains access into the network and can therefore be conceptualised as a boundary object (that which allows associations to be developed across networks) and that this object requires some boundary work to ensure that it crosses the boundary, and it then initiates action. It is therefore important understand that as the X-ray request is made up of different elements and therefore, it is not a single entity (i.e., it cannot be black boxed effectively, in the same manner as the X-ray unit). It is a complex document that is the result of the bringing together of the patient (and their symptoms, history, and place) with the referrer (and their knowledge of the symptoms, process, history, and experience) to produce a document that outlines the required clinical information that an operator and practitioner will require for that patient to be exposed to ionising radiation, and allow interpretation of the results for the patients clinical benefit. It is also important to note that whilst other actors (whether human or non-human) associate with the X-ray request, the other objects in the network can be seen as intermediaries (essentially those that transmit meaning faithfully) and mediators (those that alter meaning or that cause disruptions within the network).

The request usually contains patient demographic information, clinical history, referral source, and referrer name. These elements (and others) each play a role in the process of authorisation/justification. Under what may be termed ‘normal circumstances’ the X-ray request may be black boxed. This term denotes a number of different actors that are placed together within a process that are faithfully translated and all that matters is the input and output (Heeks and Stanforth, 2014). With an X-ray request the means of input are decided by the referrer-

patient interaction (as highlighted above) and the output of the process is the undertaking of the X-ray examination by the radiographer. This obligatory passage point enrols the radiographer and patient together to complete the undertaking of a radiographic examination (Latour, 1996). The complexity of the network is outlined in the figure 5 below. Whilst not all elements of the network have been outlined, the figure demonstrates the complexity within it. The major entities that introduce noise into the network have been outlined, and their influence traced through the application of an Actor-Network Theory sensibility. Those entities that introduce noise have also been identified, and the direction of that influence has been indicated. The discussion that follows will also allow the identification of the differing type of influence that noise has on the X-ray request and radiographers.

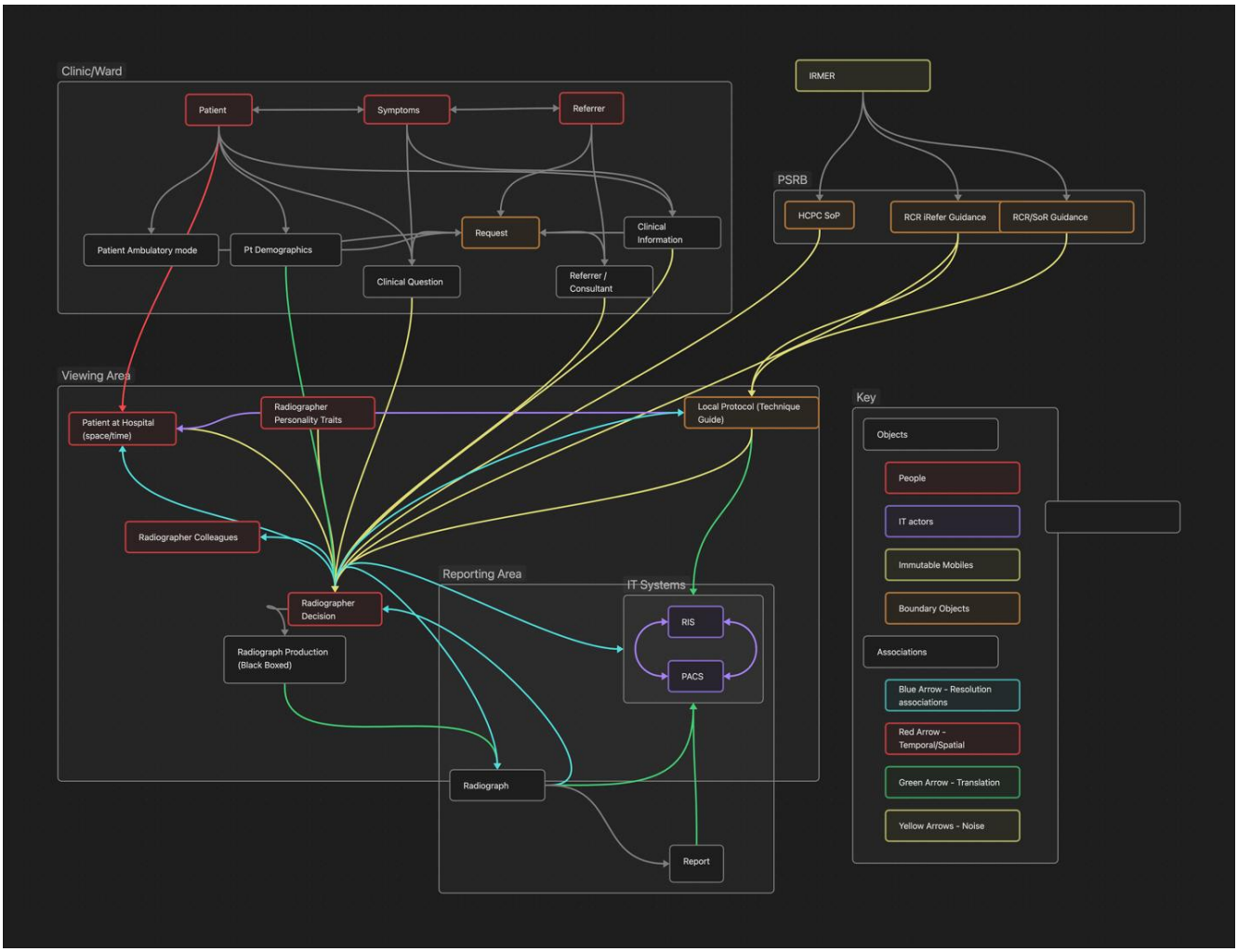

Figure 5: Actor-Network Theory diagram showing the complexity of the network.

5.4 Noisy Objects in the Network

Noise can be identified as arising from different objects in the network (see yellow arrows in figure 5). As described previously, Kahneman, Sibony, and Sunstein (2021) categorised noise into three main and interrelated types which are level, stable pattern, and occasion. Level noise is perhaps best described within this particular scenario as the predisposition of the radiographers to make particular decisions. Stable pattern noise can be seen as when radiographers fall into a complex pattern of decision making in which they deviate from their level noise, but not in a random manner, rather in a complex pattern. Finally, there is also occasion noise within the system. This can be further described as when extraneous factors such as mood or fatigue influence the decisions that are made and are random, to a certain extent. Examples of all three of these are given below.

Within this process there are a number of points which associations within the network may turn objects from being intermediaries (faithfully transferring meaning from one point to another) into mediators (unfaithfully translation of meaning). Mediators are those elements within the network that can cause proliferation of associations as well as complicate them. Therefore, noise can be seen as an association which, caused by mediators within the network, can have an impact on the way in which the network holds together, proliferating the actors within it in the process. This chapter seeks to unpick those objects which are mediators and describe the effects that they have within the network.

To understand the disruptions within the process, the individual elements that can play a role in the undertaking of X-ray examinations need to be explained first. Effectively, from an Actor-Network Theory perspective the ‘black box’ of the X-ray request needs to be opened, to further understand why the information is not being transferred faithfully from one place (clinic/ward) to the other (radiology department). However, before approaching the X-ray request itself, it may be useful to consider the impact of level noise within the decision-making process, and to do this consideration needs to be given to any predisposing factors within the radiographers themselves. Therefore, level noise within the network will be attended to first.

5.4.1. Level Noise Objects in the Network

Participants in the research not only discussed their preferences for how to perform authorisation/justification but they recognised that there are inherent differences between the

predispositions of radiographer to this activity. There was a recognition in most circumstances of their own approach and recognition that other radiographers also have different predispositions. To be clear this is not a critique of each individual's process for authorisation/justification being provided by the participants. The majority of radiographers described a very similar process of checking X-ray requests for suitability (which is highlighted above) however, they all appeared to recognise that there is a split in general disposition between some radiographers.

To begin, the majority of radiographers interviewed within the work identified that they would normally work with referrers to ensure that the patient received the X-ray. These may be said to be 'examine-focused' radiographers. They appear to be predisposed to undertaking the examination, for the perceived benefit of the patients. The term 'patient-focused' did not appear to be correct for these participants, as all of the participants wanted what was best for their patients, it is a matter of interpretation as to what 'best' would be in the circumstances.

"…erm I think that I probably sit somewhere in the middle erm…so that I think that there is just differences in what should be done and I think that a lot of it with the radiographers is lot of confidence…then you'll have other members of the team who think that they know exactly what they're doing and are probably slightly over confident…" [Gill]

"…I think that there's a confidence thing there so sometimes I'd be thinking well its not quite by the book but OK on balance…" [Gabielle]

"…I don't want to turn people away…" [Coleen]

"…there is a fine line and I know some radiographers who will actually spend more time not X-raying the patient than it would have taken just to do it…" [Alonso]

The majority of radiographers who decided to take part in the study could be analysed as having an 'examine-focused' predisposition but acknowledged that others may be more 'protocol-focused'. The argument below is that both of these are in fact patient focussed, but perhaps protecting their patients in different ways. All of the participants identified above appeared to be predisposed to performing the X-ray examination. Many participants also alluded to examples where they had influenced (particularly novice) referrers to alter the request or to give them

further information so that the examination could go ahead. There was also a recognition of the difficulties that some of the referrers had in terms of ensuring that the patients that they were responsible for got their X-ray examination.

"…if I thought that the request was absolute rubbish I would generally just speak to the referrer and be like…what are you looking for…please tell me [laughs]…" [Gill]

"…when I first qualified I was…I think a little bit more…bolshie…you know it was more of a…I couldn't believe that this house officer could would request such a silly thing…I realised that these poor doctors had not received an awful lot of training and I would then kind of coerce them and say you know…try to drag information out of them that was required so that I could justify the request…" [Vanessa]

There were also those participants who felt that the guidance provided was paramount and needed to be adhered to (i.e., rule-focused). The primary rationale for this put forward by those radiographers who were more protocol driven was that it was a matter of patient protection. These radiographers may perhaps be termed 'rule-focused' in terms of their interpretation of their own patient care priorities; their focus is ensuring that they do not needlessly expose patients to ionising radiation if it is not in their best interests.

"…I think that it can be depending on someone's personality some people like the one-upmanship to say that's a gateway and I'm the gatekeeper and that's not in the rule…" [Vanessa]

"…yeah we've got probably some members of the team who are…sticklers…for it has to say what iRefer says and nothing else…" [Gill]

The participants here highlighted that they felt there was a difference between the way in which they worked and the way that some of the other radiographers worked too. Some actively highlighted these differences in approach:

"…like it's my patient I'm going to do it I'll face the consequences if it comes back to me…" [Stephani]

However, level noise describes what is happening 'on average'. There may still be variation and noise introduced to the system on a decision-by-decision basis. There are extraneous objects that may influence the decisions being made. There may be variations within the decisions made that follow a stable pattern. These may be objects that enter the network that mean that the radiographer will deviate from the predisposition (i.e., the level noise) but not necessarily in a random way, but in a patterned manner.

5.4.2. Stable Pattern Noise Objects – Clinical Information

Prior to discussing stable pattern noise, it is useful to revisit the approach of the radiographers to authorisation/justification. Here the participants focus upon the clinical information that is supplied by the referrer and the clinical question to which they (the referrer) would like an answer. During the discussions both in the field notes and the interviews it was highlighted that this information is normally present on every request. However, the amount, type, and specificity were reported as not being consistent, for example:

""…as long as it [the request for radiographic examination] vaguely talks about that body region…" [Gill]

"…we do get like sometimes erm…clinic patients for example er with very insufficient history…" [Elliott]

This is perhaps the first introduction of a non-human mediator into the system. The participants also discussed that it is not just the amount of clinical information that is an issue they also highlighted problems with the specificity of the information provided. This was particularly evident amongst those participants who were also reporting radiographers who use this information to inform their interpretation of the resultant radiograph:

"…that the other thing from my point of view as a reporter as well and as a radiographer is…I…clinical history that is like…an essay…like…where it's like [changes tone] patient was born in 1968 and they once fell over a dog [laughter] and then they…[normal tone] and it's like…what's the point…" [Gill]

"…some referrers'll put loads of information on and some will put hardly anything…" [Stephani]

The mediator-action of the clinical information will normally result in further enrolment of other objects into the network, to allow the network to be maintained and durable. However, this would normally only happen if the clinical question to be answered was missing or incomplete. It is not uncommon for the clinical question to be missing, and a number of participants alluded to this during the interviews:

"…I was reading through the requests I was like are they going to ask a clinical question I can't justify any of these…" [Elliott]

"…we've had a few audits in the past through like A&E and stuff like that and they've all come back terrible because they don't ask a clinical question usually…" [Alonzo]

The lack of the clinical question and the perceived poor clinical information provided to the participants leads to the enrolment of new objects into the network, that would not normally have had the opportunity to develop an association within the network, for the purposes of authorisation/justification. These included elements: previous experience, the internet, the patient, radiologists, other colleagues, time/space, patient ambulatory status, the referrer, protocols, and radiographs.

"…I think a little bit of it is and we probably shouldn't do it and it does happen is reading in-between the lines…so like between what the clinical history is and then there is no clinical question but actually you can probably guess what the clinical question is…or deduce is probably a better thing than guess…" [Gill]

"…is there something out of this that I can like…justify it or use or read between the lines or not…" [Coleen]

"…they haven't used the word obstruction but they've written a paragraph alluding to it but because they haven't used that word…you know what they are looking for…" [Alonzo]

But there is also an element of wanting to undertake the radiograph as a matter of course to aid in the patient's diagnosis, which links with the level noise introduced by the radiographers themselves:

"…just give me a little more history…" [Coleen]

The participants in the study also alluded to using the patient as a proxy for the information that is provided on the request card. There were numerous incidences throughout the data collection period within the field notes and the interviews (highlighted below) where radiographers consulted with the patients as a way of gleaning further information when the clinical information provided and/or clinical question was insufficient and there was a distinct lack of trust between the radiographer and what was included on the request:

"…take some of what the patient says and balance it off against what's actually on the request…because quite often the histories are quite appalling actually…" [Gabielle]

"…that's probably not the most PC thing to say but the patients probably aren't going to lie to you as much as clinicians are…actually telling you when the fall was rather than knowing that they've got to say this to get that…" [Gill]

Some of the participants also alluded to the histories that patient give also not being truthful:

"…patients lie and the clinicians lie so what…the clinical history says could be absolute nonsense like people who fall on the 5th [metacarpal] [smirks] you didn't did you you didn't fall…" [Gill]

The option to consult with the patient was not available to those patients who were being referred in from outside sources (normally the GP). There was also an interesting element of stability provided within the network, time and space.

5.4.3 Enrolment into the Network: Space and Time

Traditionally space and time have been seen as the arenas where interactions, disputes, and organisations are made. However, Actor-Network Theory can bring a different interpretation –

that of space being an open and dynamic arena that is constituted through the interactions that take place within it, and they are the elements that create the space (Vásquez, 2013). This approach allows a reinterpretation of objects. Essentially, space and time can be conceptualised as being interdependent on one another and this is discoverable through the practises that take place within it (Clegg and Kornberger, 2006). This therefore gives rise to the notion that space-time is performative, not in the Goffman (1959; 1990) sense but in that practise takes place within it (Mol, 2002). Therefore time-space is:

"...the sphere in which distinct stories coexist, meet up, affect each other, come into conflict or cooperate" (Massey, 1999, p. 274).

The data demonstrates that the participants, patients, their X-ray requests, and radiographs can affect changes through 'tele-action'; i.e., that these entities have an influence beyond their physical presence. The effect of the patient being in the room with the radiographer is demonstrated above, along with the process of information gathering that is often undertaken by the radiographer when they have not been sufficiently able to 'read between the lines' of the information provided on the request. An example here provided by Stephani exemplifies this:

"…Stephani decided to go ahead with the request as the discussion with the patient had appeared to persuade them that this was now justified. This appeared to be based on the clinical symptoms that the patient had given the Stephani…" [Field Notes]

This was then taken up in the interview with Stephani:

"…the conversation that the patients had with the GP will be very extensive and then…and they said like oh well my GP thinks it's this I'm going to go for an ECG I'm going go for an echo and I need to have this done…so I thought well he's getting this like full cardiac work up…we know we have to X-ray for heart failure to see like enlargement of the heart and to see if there's any consolidation if they're like leg cramps or they might have like oedema or anything starting…" [Stephani]

This is an interesting piece of decision-making being undertaken by the radiographer. The patient has influenced the decision making through space (being available) and their historical conversation with their GP previously. This information did not make it onto the clinical

information or clinical question clearly enough for the radiographer to make an informed decision of authorisation using the request alone. Interestingly, here the radiographer is possibly acting as a practitioner – interpreting the clinical information and making a decision based on alternate information from the patient without the explicit use of the protocol guide. This is an example that highlights the fluid nature between the process of authorisation of the request and justification of the request under *IRMER 2017*.

There appears to be a wider spatial effect of the patient on the way in which the radiographers engage with the request. For example, Gill stated that:

'…with our radiologists is the first question they'll ask is is the patient here and that shouldn't make a difference whether you X-ray them or not but that is the first question they'll ask' [Gill].

This indicates that presence – the act of being within the hospital grounds in this case, clearly affects how the radiological request is being interpreted by the parties that require it. The important point here (over and above the unsurprising act of communicating with the patient) is that the mere presence of the patient, predisposes the participants to undertake the request. As Gill intimates in the discussion above, '…it shouldn't make a difference, but it does…'. The implication being that what is being used to provide durability and stability within the network is the presence of the patient within the space of the hospital, not wholly whether the request for radiological examination is justified. Within the interviews there was no obvious rationale given other than time becoming an influence on the way in which the some of the participants interpreted the urgency of the request:

"…I suppose this is where it comes down to is the patient here or not…if the patient is here you think is it reasonable…then ok do it…" [Alonzo]

This was echoed by participants who highlighted the various issues regarding the presence of the patient from the General Practitioner who were not as accessible than the other referrers who were perhaps seen within the network. This led to participants highlighting that there is perhaps more time to scrutinize the request or to seek further clarification from other staff:

"…if they're not [here] then you've got the time to put it on hold…" [Alonzo]

This approach does not seem to work for everyone. For example, some radiographers were very wary to vet the requests, particularly from GPs as they thought that they did not have the experience to understand or follow-up on the requests:

"…I don't vet because I don't feel like I am experienced enough to put my name to every request…yeah…mmm…some of the requests from the GPs are pretty rubbish…" [Coleen]

This indicates a degree of confidence in the application of the protocol to the clinical information that is given. The discussion from Coleen was also reflected in some of those participants who were more experienced that this participant. Vanessa, for example, when discussing the potential implications of incorrectly authorising/justifying an examination expressed a fear as well as a lack of confidence in the process:

"…I'm frightened to put a step out of line…" [Vanessa]

"…I think it's quite a difficult place that IRMER has put us in with that erm…because we're not trained to assess the patient…" [Gabrielle]

Gabrielle's point also emphasises the radiographer's interpretation of the work that they are undertaking and the nature of the request, in relation to *IRMER 2017*.

The impact of space within the context cannot be underestimated. The physical space can be seen to be the overarching element of noise introduction. Without it, there would be no opportunity for the interactions with other colleagues during the workday. There would be no patient presence within which noise is introduced. This is exemplified here through figure 6. A number of different noisy entities gain their access to the physical space and can therefore introduce these elements of stable pattern noise within the system.

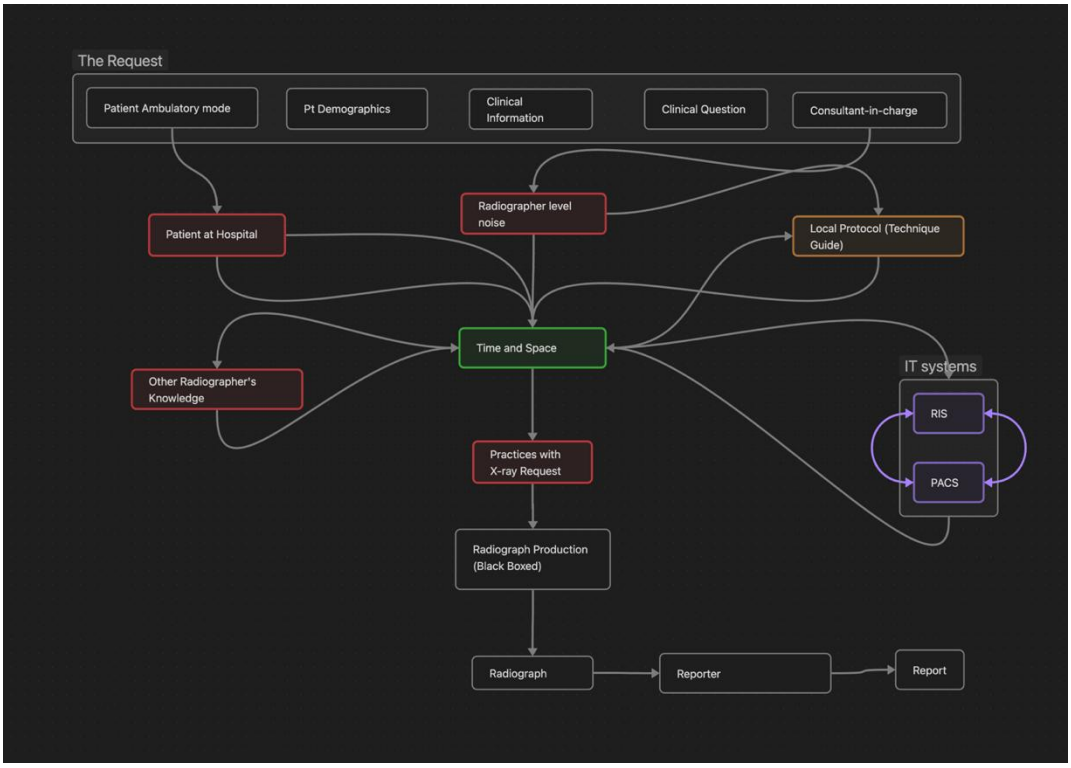

Figure 6: Figure showing the influence of time and space on the practices of radiographers.

5.4.4. Enrolment into the Network – Protocol and Other Documents as Actor

Data collected during the research included the departmental 'protocol' which acts as a guideline for the radiographers to use as part of the day-to-day running of the X-ray department. It has two main foci; the first is to provide the radiographers with guidance on what diseases and conditions are appropriate for X-ray examinations and the second is to provide the radiographer with guidance on the specific X-ray examinations that are required to demonstrate presence/absence of disease and to answer the clinical question posed by the referrer:

"This manual is intended as a guideline with recommended, evidence-based clinical practice for the most commonly requested examinations. It does not replace professional judgement, nor exclude views not described within it." [Radiographic Justification Guidelines and Technique Manual; p.1]

The protocol here is highlighting that there may be times when projections may indeed be undertaken if they fall outside of the protocol, and that there is a requirement for the use of professional judgment. However, as seen above, there are very different approaches taken to

the operationalisation of this protocol within the clinical practice environment. It was also noted by a number of staff that whilst there may be challenges with the referrers in terms of discussions and poor clinical information the protocol was not referenced as often as perhaps it should, in the perception of some staff:

"…so but I would say that most people if they look at it once a year…[smiles] I would be surprised…" [Gill]

"…I should look at it [protocol] more than I do…" [Alonzo]

"…you kind of learn by rote you have a medical understanding of why they want the X-ray…" [Vanessa]

The participants here felt that the protocol was there more as a back-up than as something to visited on a regular basis, relying on their previous experience and what was seen as an inherent knowledge of a piece of guidance from the Royal College of Radiologists (RCR) the iRefer guidance.

"…our referral guidelines are very much geared towards iRefer [RCR guidelines]…" [Alonzo]

"…we've got the iRefer manuals so if it is not in there then I'm like well obviously I'm learning more…" [Coleen]

When interrogating the use of the protocol within the network, the protocol should provide the network with stability, and this in essence does happen. The guidance document within this network is drawn primarily from professional guidance:

"…[t]he purpose of this manual is to improve the quality of radiographic imaging and to reduce radiation doses by standardising techniques and procedures in accordance with the Royal College of Radiologists' Guidelines. iRefer — Making the best use of clinical radiology…" [Trust Technique Guide]

A clear line is drawn between these documents (the iRefer and the technique guide). Within the technique guide the content is very similar to the iRefer document from the Royal College of Radiologists (RCR). The main differences relate to the type of projections undertaken for certain conditions from certain referral areas. Within the documentary data collection, it is apparent that the protocol that is used in the department is very much based upon the iRefer guidance published by RCR. The influence of the document can be seen diagrammatically in fig.2 showing the association of the iRefer document, not only to the departmental protocol but also to IRMER 2017 as well. Remember that this document (and the departments own protocol) has a performance aim. These two documents (iRefer and departmental protocol) are very much actors within this network, moving the responsibility for justification from the practitioner to the protocol guide.

In the majority of circumstances, the participants highlighted that the protocol and iRefer guidance added stability to the network, allowing them and their colleagues to influence the referrers. This allowed change to some of the referrals so that the radiographers were able to perform their duties of authorisation/justification:

"…I'll ring them [the referrer] and be like and I'll quote a protocol and be like can I have this like in these words just so I can add it onto here…because you don't want to not do it…because…because it's a patient at the end of the day…" [Coleen]

"…not enough information on the form I'll bleep the doctor and ask for a bit more information erm…[shrugs] [laughter] yeah…we've also got an erm…a file a technique file which has got clinical indications what's erm…what's justified…" [Vanessa]

The participants indicated that, particularly when the referrals were generated inside the hospital then the referring clinician would be contacted and asked for more information so that the request was brought into line with the guidance contained within the protocol. This decision appears to conform to stable pattern noise within the network.

One participant took a different approach to the protocol and iRefer often discussing these documents and where to find them with the referrers themselves. However, they appeared to be exasperated within the approaches taken by the referrers when they suggested these documents as a reference for them:

"…they have access to the iRefer website as well…but do they actually follow it…no…" [Elliott]

The protocol is, of course, not the only document that has the potential for agency within the network. Whilst not mentioned by all staff the CoR 'Paused and Check' document (2019) was prevalent within the department as a poster within the viewing area and within the X-ray examination rooms (usually within the controlled area). This document serves the purpose of reminding all the radiographers working (and assistant practitioners) of the process of undertaking any examination within the radiography department. The document contains a nominal 26 checks that are required to be undertaken during the process of examining a patient and then discharging them from the radiographer's care. Whilst this may give an indication of the process, it does not however cover all of the actions or decisions that are required to be made by the radiographer. For example, in the context of this work the first statement of the poster is 'Check the exam is justified'. This is a task that is complex and can involve making a decision that is influenced by the radiographer themselves as well as other actors in the network. The complexity of this process is then outlined implicitly within the CoR poster, as the next point ('check examination history for recent studies and duplication') is a part of the justification process.

"…if you actually read that pause and check document…it's quite long… but you don't realise how many things that you do in your head for just one patient…even like checking your images afterwards and everything…" [Stephani]

There is an implication here from Stephani that some of those activities has become automatic for her at least. However, whilst a large portion of the CoR document was seen by the participants as being automatic, the decisions around justification were not seen as always being so. A lot of the radiographers described the justification process as anxiety inducing or problematic. And this is just the first question on the checklist.

5.4.2.2. Enrolment into the Network – Radiograph as Actor

Whilst objects that create noise (or act as mediators) within the network can be identified, other objects can act to provide durability to the network (i.e., the associations of these objects in the

network allow it to hold together) even when they may at first site appear to be mediators. For example, the protocol guide purpose is to provide stability within the network, however, there are times where it cannot do this. For example, it has no association between the patient-referrer interaction (despite the attempts outlined by Elliott above). Therefore, other objects become enrolled within the network, allowing the identification of another passage point. One of those other objects is the previous examination, either as a historical entity or as a newly formed entity.

An example of this enrolment can be seen in the following excerpt:

"…you get more experience of like what's justified and what isn't…if I was like to teach a student how to do it…I would like definitely check the previous because if they haven't had a chest X-ray for like two or three years and they're like say over 70 and they're complaining of shortness of breath or a cough or…they've got like previous cancer or like they're suspecting cancer then like it's definitely justified…so there's like things that are like barn door like definitely do it…" [Stephani]

"…Elliott then vetted a number of requests whilst explaining what they were doing so that I did not have to see the request card. For example, they would state 'I'm now checking the previous' which was something that happened every time (or if there was no previous, they would state, checking for previous, which they have none) and 'poor clinical history'. They would state 'looking for their last X-ray' or 'looking for the last report'…Elliott talked through a request which required further imaging based on the last report. The last report was looked through and a note placed on the attendance as to when they should be appointed for…" [Field Notes]

The checking of previous imaging and reports prior to the exposure of the patient is widely advocated by the professional bodies and taught within pre-registration programmes (SoR, 2017). So, whilst the clinical information for the patient may be poor, through interrogating the previous X-ray history of the patient the examination may be able to be undertaken.

Whilst the radiograph can influence the course of action prior to the patient being examined, the radiograph may become enrolled within the network after the point of X-ray examination:

"…they [referrers] tend to…over order on kids…they say can't examine patient is distressed so they order like shoulder to finger…and then I had one of them the other day and because you know what where the common fractures are on kids I started on…the elbow…here was a massive fracture so I was like I'm not doing the shoulder and the humerus…" [Stephani]

In this example the participant is highlighting the impact of a radiograph to stop undertaking further examinations. The presence of the fracture within the radiograph is answering the clinical question in this instance (i.e., query fracture). The radiograph is enrolled into the network to stop further examinations from taking place. If a literal approach is taken towards X-ray request interpretation, then the radiographer may, in such instances, be able to continue with the examination until all of the areas of the body have been examined. However, a decision by the radiographer taken here is that the clinical question has been answered in this instance and this process can now stop, rather than exposing the patient to further radiation.

5.4.2.4. Enrolment into the Network – Perceptions of the Referrer as Actor

Where the patient is unable to be re-enrolled into the network through time/space there is an apparent heuristic being employed by the participants within the research. During the process outlined in fig. 1 the radiographer looks to check the referral source of the request. This includes viewing the ward/clinic from which the request is generated and also the person who is identified as the referrer on the request. This information was discussed by the participants as being a useful proxy and/or supplement to the lack of clinical information and question. However, the circumstances of its use, vary depending on the context in which the work is taking place.

"…I think like it depends who requests it because obviously when you work somewhere you get to know who…are the ones that are like who would only refer if it was really needed…" [Stephani]

"…if you're a specialist doctor…whether it be orthopaedics or erm…chest clinic or anything like that…and to be fair you do tend to get a fairly decent history because they are specialists but we would probably do things for them that we wouldn't do for other people for the same clinical history…yeah they get an upgrade…so I think that's probably how it works…" [Gill]

"…yeah they are someone who is a chest physician and think…yeah they probably know what they are talking [about]…" [Coleen]

"…the previous medical history appeared not to conform with current guidance as Gill remarked that '…essentially no, I don't think its justified…'. There appeared to be some deference to this particular referrer as Gill then remarked that '…although…given where it's [the request] come from…'" [Field notes]

Here the perception of the referrer is influencing the decision to go ahead or to challenge the referrer for more information. Where a referrer is seen as a clinical specialist, who may in certain circumstances be interpreting the resultant radiograph, there is a certain amount of leeway given to those referrers. They are perceived as having more knowledge by the participants. However, the specialist knowledge does not appear to extend to beyond the hospital. In one discussion with a participant, they gave an interesting conversation regarding external trusts requesting certain projections prior to being able to have the patient transferred over. Whilst this example only comes from one participant, they cited a number of different specialities (orthopaedic, urology, neurology, vascular) across different working environments, an example of which is given below:

"…they're not going to accept them unless they've got standing spines and that's what it would come down to…so they won't be accepted to be transferred so then their boss would tell my boss that I'm not X-raying them and we're now delaying their treatment because they won't take them until they've had seven spines and then I'll get a kicking for not doing it…so…yeah…" [Gill]

In the above example, there is a different rationale given for the acceptance. That of not delaying the patient's treatment or diagnosis. These example circumstances are different in terms of context – in one, the participant has made an active decision, a sort of heuristic, to enable them to make a decision based on the referrers standing (or reputation) and the other where the decision is being based upon the requirement to ensure that the patients treatment and transfer to another hospital/trust is not delayed unnecessarily, although in this instance the participant clearly does not think that the request should be actioned.

The perception of the referrer for the request can also work in the opposite direction when insufficient clinical data is given from the referrer. Many participants highlighted that often junior doctors did not provide sufficient information. For example, noise is being added to the network through the perception of the radiographer with junior doctors (specifically the FY1 and FY2) not providing the participants with enough information to be to authorise/justify the request:

"…[junior doctors] they're more concerned just with getting the X-ray because the consultant wants it and not necessarily with giving you a history that's justifying it…" [Gabrielle]

"…some of them haven't quite learnt to put pneumothorax on the end so you end of having to ring them and be like [emphasis] what are you looking for…" [Coleen]

"…realized that these poor doctors had not received an awful lot of training and I would then kind of coerce them and say you know…try to drag information out of them…" [Vanessa]

The radiographer may also be seen here as assessing the credibility of the referrer:

"…you have to assess the person who's trained to assess the patient…" [Gabrielle]

This may be seen as an example of a noisy object within the network, that may occasionally introduce stability into it in the cases of referrers having a favourable perception from the radiographer. The use of the referrer within the justification process appears to be acting as a heuristic in the first instance, interfering with the application of the protocols (which might normally be described as an immutable mobile) and therefore introducing noise into the network. However, where the referrer is seen as not being an expert in their field the majority of participants highlighted a coercive strategy to ensure that the request was justified, and the correct course of action was followed. These processes highlight the fluid nature of the authorisation/justification process.

5.4.3. Occasion Noise

The objects that cause occasion noise, as demonstrated in the literature review, are difficult to identify particularly in the natural setting (and can be difficult to replicate within the experimental setting). In the data collected there are some signposts within the field notes and interviews that

indicated that occasion noise may play a part in the authorisation/justification processes. For example, the source of the referral is important, not from a human perspective but from a department:

"…think about it very few people from A&E actually have pathologies and I think that we know that from research don't we but I don't want to be the one who turns the patient away after it was requested...you know and to have missed something…" [Alonzo]

Here the radiographer is considering the referral area of the patient, not the individual patient nor the individual referrer. This is a different perspective to the point raised above regarding the referring clinician. The occasion noise here is the occasion of the referral generation. The discussion above is predicated on the probability of the *patient* having a visible pathology whereas the previous discussions regarding individual referrers was based on the participants perception that the referring clinician had their own reasons for referral and that these reasons may not be visible to the radiographer via the request.

The heuristic being used here, when occasion noise is apparent and brought into the network, is one that focuses on a non-human entity (the department where the referral is being raised). The decision being made here may also align with the space/time elements discussed earlier. The patients who are referred from A&E are available to the radiographer and are in the radiography department, making them available for further information and to undertake the examination there and then. However, in terms of this influencing the authorisation/justification process as occasion noise more interpretation is required of this statement in conjunction with the following:

"…I remember a reporter as being well just do it just in case there's something on it and you'd be like are you joking me this does not need doing they had it X-rayed last week and it will be absolutely fine and you'd have a proper like [blows raspberry] fine and then huffty off sort of thing and then as a reporter I'm now the one saying just do it just in case because you have seen stuff where we've missed stuff and somethings not been on it and actually they've got a broken ankle and it's a week later and we've not seen it…so I think that I probably now…with the ones that are a bit merh I'm a bit more like oh actually it is worth just doing it…" [Gill]

The fear of missing a potential disease or condition was highlighted by the participants, particularly those who perhaps identified with the examine-focus participants. In the example above Gill here recalled the feeling of being told to 'just do it' and contrasted this with their current perception as a reporting radiographer. Both above examples may be seen as shedding light on the potential for occasion noise. For example, two patients presenting with the same clinical information and disease at different times may be influenced by the previously missed fracture or the fact that a patient did or did not have a condition previously.

Occasion noise may also be seen at different times of the shift; the following excerpt from the interview with Vanessa demonstrates:

"…doctor said that I will do the X-ray as even though the bone doesn't show up he would be looking for soft tissue signs like swelling or air in the soft tissue to indicate a bone perforating or stuck…this made plausible sense at 2am and was a low dose procedure, so I said fair enough and did the X-ray…" [Vanessa]

In the same manner as the judge who makes different decisions at different times of the day, so the participant here is alluding to the time of day having an influence on their perception of the request. The manner of the discussion here also appears to intimate that they perhaps knew that there may be an issue with the rationale that the referrer was giving for the request to be undertaken. The findings within this chapter relating to occasion noise also fit conceptually with Kahneman, Sibony and Sunstein's (2021) conception of how stable pattern noise and occasion noise may be seen as related categories of noise in decision making.

5.5 Summary

Through viewing the work of the radiographer via Actor-Network Theory and using noise as a potential type of association in the network it brings unique insights into the radiographers' role in operationalising *IRMER 2017* (as it was at the time of data collection). There are a number of different objects apparent that both hold the network together and also to introduce elements of disruption within it.

The clinical information within the X-ray request appears to be the main entity that introduces noise into the network, and this countered by the participants here using a variety of objects to

ensure stability. The creation of new associations also ensure that the network remains durable during periods of instability. These practices that the participants and radiographers engage with will be further characterised through the discussion of practices in the following chapter, as this is an appropriate way of furthering the analysis within the actor-network theory framework chosen.

These findings show that there are elements of the work undertaken within the radiography department that may be considered black boxed by the participants, this is primarily the X-ray machine and its role in the patient examination. The X-ray request could be considered black boxed however, it is the discrete parts of the X-ray request that introduce disruptions to the network. The X-ray request is the obligatory passage point of the patient moving from the referrers network and into the radiographers' network; therefore, the X-ray request is also the boundary object, between these two networks (Allen, 2015). There is also an important conceptualisation of the work that is undertaken within the department. This has been termed authorisation/justification to acknowledge the fluid line that can be seen between these two different roles within the radiographer's work. The participants also recognised that there are differences in the approach that they and other radiographers take to the authorisation/justification processes. This can be seen as being the first type of noise that is introduced into the system, that of level noise. The level noise within the system can be seen as being the result of two main approaches to the process of authorisation/justification. Participants can be seen as either being rule-focused or examine-focused on their approach. However, the other noise elements of the network, in particular stable pattern noise and occasion noise mean that the practices of the radiographer change and adapt to these. The radiographers are, in essence, acting to keep the network stable, through enrolment of other actors into the network. This has important implications for the practices of radiographers, which are further developed within the next chapter.

The concept of noise and the influence of this on practice is discussed and developed further in the next chapter. There are a number of practices which may be already evident in the discussion above, that are put into action by the proponents of noise, that hold the network together as an association of actors. These result in *emergent practices,* and these are influenced by the radiographers tinkering at the edges of the protocols, the material nature of the practices and the historical and social contexts at play, in particular the physical environment.

Chapter 6: Practice and Practices with the X-ray Request

"'Forty-Two!', yelled Loowquawl. 'That's all you've got to show for seven and a half million years' work?'"

(Douglas Adams, *The Hitchhikers Guide to the Galaxy*, 1979)

The previous chapter has outlined the causes, as identified in the data, of the noise that is apparent within the undertaking of authorisation/justification of X-ray requests. These elements include the primarily the clinical information on the request and the lack of a clinical question identified within it. These can lead to the enrolment of entities into the network that have the potential to create stability (Scoles, 2018). These entities allow the creation of stability through the creation of practices. The non-human and the human come together within the network to produce new practices, and from a post-Actor-Network Theory sensibility, they can create fractal ontologies within this.

The findings, thus expanded below, provide a further insight into the work of the radiographer when undertaking the authorisation/justification of X-ray requests through further expanding on the previous chapters findings that focused on the noise created by non-human actors within the network. Prior to this explanation a further interrogation of Reich and Hager's (2014) threads of professional practice is required, as these are used to further explore and aid in the interpretation of the practices of radiographers within this particular setting. These threads of professional practice (informed by Actor-Network Theory) allow further interrogation of the noise discussed in the previous chapter. From this position, new insights into the process of keeping the network stable, though it is inherently dynamic, has implications for how practices are enacted and organised within the radiography department.

Prior to the discussion of these newly conceptualised practices, a brief reacquaintance with Reich and Hagar's (2014) six threads of professional practice is required. The discussion will then turn to focus on the three major findings that developed through the integration of the threads, namely *historical echoes through time, operationalisation of documents,* and *creating and refining practices.* These findings will also be linked to Latour's (2013) *AIME* with a focus on the crossings of each of the modes of existence (as outlined in 3.5). The findings demonstrate that within the radiology network that surrounds the X-ray request, the three

practices coalesce into a series of emerging practices that keep the network in a state of dynamic stability.

6.1 Six Threads for Theorising Professional Practice and AIME

The six threads of professional practice and Latour's (2013) Inquiry into Modes of Existence (AIME) have already been discussed within chapter 3 (see 3.5, 3.7 and Table 3). A brief overview of these threads has been provided here to provide context prior to furthering the discussion within this chapter.

The six threads for theorising practice allow observation of the different practices which are used to engage in the tasks of the work environment. They allow conceptualisation of the way in which reality is created. This, when overlayed with the *AIME* approach allows insight into the overarching practices that take place and the influences that allow the practices to develop. The use of noisy actors from the previous chapter, allows the identification of the key actors within the processes and when combined six practice threads and *AIME* gives further theoretical conceptualisation which highlights the dynamic nature of the work being undertaken.

It is also worth reiterating that the six threads are not mutually exclusive within the framework. They are rather a loosely connected and intertwined set of categories. Reich and Hager describe these as 'mutually entwined' (2014, p. 421). Within this chapter the focus will be primarily on these threads in particular; *knowing-in-practice, sociomateriality of practices,* and *practices that evolve within historical and social contexts.* This does not mean that the other threads are not seen, but that through focusing on these the other threads will also become apparent through the discussions. This is exemplified as a final focus on *emergent practices* is a key element to this chapter as this thread does, in effect, bring together the other three dominant threads. This helps in the conceptualisation of the work of the radiographer and highlights an important finding – that the radiographers work in this area can be classified, in part, as not only justifying the X-ray request, but also as preforming elements of the referrer role as well.

6.2 Historical Echoes through Time

Participants intimated in both the field notes and the interview data that the X-ray request had changed over time, whilst the information that is required of a request has not been altered,

there is a technological change in the practice of the request being handwritten through to the request becoming subsumed into an electronic system originally designed for pathology requests (ICE or Integrated Clinical Environment). The technological change (marked as [TEC] within *AIME*) has brought benefits for the radiology department which is exemplified here:

"…discussion with Doria regarding the implementation of the paperless system, whether they thought that it was an improvement or not. Again, the general consensus from them was that it is a much better system. Echoing perhaps the number of years qualified she alluded to many a difficulty that a radiographer of a certain vintage can empathise with, the, often poor, quality of doctors handwriting: '…I think that we've had it 18 months now…much better sometimes you were [squints with hand in the air as if holding an imaginary piece of paper]…it makes it so much easier now'…" [Field Notes]

The paper-based nature of the request appeared to have been held onto by the department for some time through printing the requests off as they arrived in the department. There appeared to be some further advantages to having a paper copy to hand. This included that they were visible in some way, normally through being in a docket. This made it not only visible but removable from the system if required.

"…it was all paper based before so if we weren't sure we would write on the request…and go and physically hand it to the appointments clerks…I think that in a way when it was paper based there was much less room for error because if that request form wasn't there nobody else can vet it and nobody else can just arrive it…" [Alonzo]

There was a sense of ownership with the paper, perhaps even standing as a proxy for the patient. The participants often appear to describe the request as being their patient, rather than an X-ray request. This is something that is common throughout the X-ray literature in terms of shortening the discussion of the process. Patients may often be talked about in terms of their body part to be radiologically examined (the Pelvis), rather than being described as a patient who requires an X-ray examination (the patient needs a pelvis X-ray examination):

"…so you ring them while you do the pelvis…" [Elliott]

This talk is not meant to be derogatory towards the patient, but like the term X-ray or X-rayed, appears as a shorthand for professionals to discuss with each other in a timely and meaningful manner. This has been postulated that this can lead to a negative effect on the manner in which the radiographer *perceives the patient*. The radiographer's focus on the image rather than the patient can lead some to develop a lack of empathy with patients that lowers the quality of their work (e.g., Aweidah *et al.*, 2016). A lack of empathy from the participants was not observed within the data collection, the observation period, nor is it apparent within the data analysis. The data showed that the focus of the participants appeared to change when there was a problem with the information that is explained within the request. Here the participant's focus was solely on the quality of the X-ray request, and a disconnection is made in terms of patient association. The participants who had been qualified the longest appeared to relate more to this, but other participants also recognised elements of these practices still being enacted.

"…a junior radiographer I've gone and done X-rays where the consultant has said oh it's rubbish [the request] but just do it…" [Alonzo]

"…fairly newly qualified and working in A&E and we had…a box that said JFDI [just fucking do it] on it...and it just got put in there because you know that it wasn't justified but you'd just have to do it…" [Gill]

The word 'it' has been underscored within the quotations above to highlight the dissociation that occurs here between the patient and the request. Drawing upon the *practices as embodied* thread here, then it is apparent that there is a break in the *practices as relational* thread between the patient, the X-ray request, and the radiographer.

Whilst the move to paper-based systems brought with it some further improvements in terms of legibility, the changes have not always been seen as so easily reconciled. One radiographer found that the movement of paper was easier to manage. In essence, they felt that it was more portable. This made the X-ray request something that aided discussion with other colleagues in the care of the patient. The current situation appears to be a barrier to this, in terms of getting a second opinion upon a request for examination, regardless of the profession and location of the colleague:

"…literally show them the request but now you've got to be like come to *my* [emphasis] room and look at this on *my* [emphasis] screen…" [Stephani]

This isolation of the radiographer within the X-ray room appears to be reinforced by the field notes:

"…there is no toing and froing from the radiographers into the viewing area in-between patients. Everything is streamlined into the room with the patient. The worklist from the RIS is there and the patients are picked up off the list, and this list is in the room with the radiographers and students as they work. The only time they come out of the room is to look at the main computer – this is used to view wider worklists, confirm mobile and theatre examinations, and to vet incoming requests from all out-patient and GP Sources…." [Field Notes]

This change in working practices appears to have been driven by a combination of the change in technology and the increasing number of patients to be examined. Previously, radiographers used daylight processors or computed tomography processors to produce the radiographic image, and this meant that the radiographers had to leave the X-ray examination room to process, and then view, the image (Tesche *et al.*, 2002; Platt and Strudwick, 2009). The images were then either displayed on light boxes (daylight processing) or on computer terminals within the viewing area (hence the name). With the advent of direct digital radiography, this means that the image is instantaneously displayed on a monitor within the X-ray examination room (Jessome, 2020). This can relate to the concept of *practices as relational* (Reich and Hager, 2014). There is a change of time of the way in which the radiographers have engaged with each other and with the X-ray request.

For example, the legibility of the X-ray request has improved, but this has come at the cost of the X-ray request not being as mobile within the X-ray space as it once was. This means that, as Stephanie has outlined above, more movement is required from the radiographers rather than the X-ray request. Therefore, the change within the environment also means that there is less mobility of people as well as things. It may be concluded that the radiographer is tethered to the X-ray room in a way which in the past they were not. This tethering is caused by the decrease in the mobility of the non-human entities within the division of labour. There is, theoretically a paradox at play in terms of the non-human entities and their ability to be mobile. The digitisation of the X-ray request has made it more mobile in the sense of it making its way to

the radiography department. This, through the ICE system happens almost instantaneously. However, the practices from a radiographic perspective appear to have changed and altered. The change from paper to digital has decreased the mobility **within** the X-ray department, exemplified by Stephanie's comment above.

The instantaneous nature of the radiographic image, the electronic nature of the X-ray request means that everything is to hand in the X-ray room, but it is also restricted in its ease of movement, leading to the X-ray request affecting practices that take place around it.

6.3 Legislation, Operationalisation and Variation

All of the participants described the process of undertaking either authorisation or justification as justification and believed themselves to be performing the role of the practitioner under *IRMER 2017* in most circumstances. None of the participants mentioned authorisation as a term, nor recognised that through using the departmental guidance that they were in fact performing authorisation in the majority of circumstances. However, there were elements when the radiographers were working as a practitioner, especially when requests were described as having incomplete clinical information and the majority of the times a limited (often missing) clinical information. In these circumstances radiographers making decisions carry out certain examinations based on *their* assessment of the patient. Depending on the interpretation of 'guidelines issued by the practitioner' (*IRMER 2017*, p. 7) these examples can be interpreted as working outside of the guidance:

"…Stephani vetted a request which had not been previously vetted by any other radiographer. They appeared to be slightly confused and could not decide whether the request was going to be justified. They then decided to ask a colleague what they thought. Stephani intimidated that this was because there was an initialism/acronym on the request that was not a common one that is used…searching for the initialism did not appear to help the radiographer in this instance. Stephani then, after trying the internet search, said 'I'm going to ask the patient'. Following their discussion with the patient, Stephani decided to go ahead with the request as the discussion with the patient had appeared to persuade them that this was now acceptable..." [Field Notes]

The condition that the participant has identified via the initialism was not within the protocol guide, but following the discussion it appeared that the patient was under investigation for a variety of cardio-thoracic conditions. Therefore, the participant decided that the examination could go ahead.

"…but actually the conversation that the patients had with the GP will be very extensive and then and they said like oh well my GP thinks it's this I'm going to go for an ECG I'm going go for an echo and I need to have this done so I thought well he's getting this like full cardiac work up…we know we have to X-ray for heart failure to see like enlargement of the heart and to see if there's any consolidation…" [Stephani]

Here the participant is using their previous knowledge, interpretation of the iRefer guidance and departmental guide and applying this in a strategic way. This fits with the notion of *knowing-in-practice* (Reich and Hagar, 2014). In this example, practice is modified through the relationship between knowledge, things in practice (such as the protocol), and the relation between these and, of course, the patient and their symptoms (*practices as embodied)*. They have drawn on these materialities as there is a disconnect to the protocol relating to the initialism that was communicated via the clinical information. This therefore breaks the chain of action within the network. The enrolment of, and actions within, the network of the materialities leads the participant to undertake an X-ray examination. This is due to Stephani understanding the cardiac nature of the condition and that the patient is possibly heading towards a 'full cardiac workup' [Department Technique Guide, p. 13-14]. Whilst the disease is not explicit within the departmental protocol nor the RCR iRefer document (no date) there is an assessment made by the radiographer in order to maintain the stability of the network. This ensures no discontinuity with the patient and their passing through the radiology department on their way to a diagnosis.

The issue from the data above relates to incomplete clinical information – information that does not match with the protocol guide. As previously discussed, the enrolment into the network of space (e.g., patient presence) leads to durability within the network. It can also lead to emergent practices, as the participants 'read between the lines' [Alonzo] or tinkers at the edge of the protocols (Reich and Hager, 2014; Fenwick, 2012). The nature of a protocol is of course, that they are unable to fully define the processes that are required for a particular action and there will be circumstances that cannot be covered. It is also interesting to consider how the participants interpret *IRMER 2017* as a regulation, iRefer, and departmental protocols as a set

of guidance and how these link together, as the focus for the participants is often on the protocol from an operational perspective and legislative from regulation perspective.

"…if it's written there in black and white and that is the protocol that everybody has to abide by and they've all signed it then nobody can say no […] so as long as you've got concrete evidence like [goes quiet] you're right […] well yeah you are [laughs] you are black and white…[laughter]…yeah well they are guidelines but yeah…but it is sort of like if it's written there and it says you shouldn't do this for this like unless there's a really good reason or a patients got multiple things going on I would just say always make sure that you have got evidence…" [Stephani]

The above discussion appears to have very litigious overtones, with a discussion focusing on the law and evidence. This was further highlighted in discussions with the other participants who gave a similar interpretation of the legal issues that may surround the X-ray examinations of patients.

"…the history says dot ok and the clinical question to be answered says dot as well…I was like well what's going on there I can't do it personally because this is a legal document at the end of the day…" [Elliott]

"…I think that it does yeah I mean I think if you take IRMER to the letter…maybe they should use the magic word and maybe they should use obstruction but if that's all you X-ray for…[laughs]…I mean in a court how would you defend it I suppose…you know if it got to that stage how do you defend it…" [Alonzo]

"…think that medico-legally and the fact that we've got two organisations that sort of provide guidance…but people are frightened…well I certainly am…" [Vanessa]

The legal ramifications of this part of the work appear to be on the minds of the participant quotations. Within *AIME*, Latour's further development of Actor-Network Theory (2013), this can be interpreted as a [LAW x REF] crossing point within the network. Here the influence of the legal is apparent, though not fully direct. There is an allusion to the spirit of the *IRMER 2017* within the discussions, rather than an objective adherence to a certain part of *IRMER 2017*. The legality of the documentation, the legality of action and the potential for losing professional

registration are all intimated as potential outcomes for non-adherence. There is, however, a break in the chain of reference [REF] as there is a break in the chain of law [LAW]. The instrument of law, which in this case is the protocol, poses a potential issue. This is overcome by the radiographer by finding more information that relates to the patient [REF] regardless of the material nature of that information (e.g., previous images, reports, symptoms, discussions, etc.). However, this does not stop the participants from using their professional judgment, either to help the referring clinician to ensure that the appropriate examination is undertaken or to protect the patient from unnecessary exposure to ionising radiation. Examples of this from the perspective of the participants include:

"…I said for example it was discussed with the patient and the patient said blah blah blah blah blah and therefore decided to go ahead…" [Elliott]

"…I mean I've noticed it in myself and even this morning actually the patient said you know…and I was just like…well it's alright…" [Alonso]

"…you know what is justified so you would ask questions to find out if they have any of the conditions that are justified and you can dig for information that the GPs looking for…" [Vanessa]

Whilst the participants here are not circumventing the 'law' in any sense, they are acting within the scope of practice in terms of being able to assess a patient's suitability for the radiographic examination (HCPC, 2023). An example of this suitability assessment is given in the example taken from the field notes given below:

"…Doria was working in the main X-ray rooms and had a paediatric patient that was proving to be non-compliant. The more the examination went on the more difficult it appeared to be getting as Doria was away for some time. They came in and out of the room several times and asked another member of staff to assist. In the end a different position was chosen for the patient that made the examination easier to undertake. Doria stated '…I don't like it when they assume that they won't be able to get an X-ray'…" [Field Notes]

Within the justification process there is also an assessment of whether the patient would be able to comply and therefore undertake the examination. In the example given above, the

radiographer is using all means necessary to enable them to obtain a diagnostic image from the combination of the patient and X-ray beam. However, the patient's non-compliance with the radiographic examination can be a reason not to undertake the examination in terms of risk benefit. A further example of this can be seen below:

"…query NOF [neck of femur fracture] and the patient moved and it was an elderly patient and literally if I describe it she was like that [crunches up into a ball in their seat] so literally I did as good as I could I mean I said right I'm going for my break we can't do the HBL [horizontal beam lateral] on this patient…" [Elliott]

In this example the participant undertook the X-ray examination partially. They have managed to give the referring clinician a radiographic image but not the complete examination (which would include the horizontal beam lateral (HBL) to indicate anterior-posterior displacement of the fracture). They have made an assessment that, in this circumstance, it was better to not to attempt the HBL as this would not yield any further diagnostic information for the referring clinical staff. Here is the influence again with regards to *knowing-in-practice* and *practice as relational*. The relationship between the patient, radiographer, X-ray tube, resultant radiograph, and X-ray request means that there is an issue within the network. To allow this assemblage to remain stable and the patient to pass through the network towards treatment, a decision needs to be made. If, however, an X-ray examination cannot be completed the participant in this instance did not attempt the examination. According to the participant, the patient was then sent for a computed tomography[32] examination. This alternate examination was also discussed by Gill, who talked about the appropriateness of an abdomen examination and consequent computed tomography:

"…if there's nothing on it they get a CT [computed tomography] and if there is something on it they get a CT scan…[laughs] so just given them the CT scan…or ultrasound them or clinically assess them or just do whatever you need to do but don't X-ray them it shows you nothing or it shows you something that you need to investigate further…absolute nonsense…" [Gill]

[32] A CT scan uses X-ray to produce an axial 'slice' of the body. Generally regarded as increasing the amount of diagnostic information, this comes at the risk of greater ionising radiation exposure (Seeram, 2019).

This practice of negotiating and enrolling different materials to adjust working practices appears to be normalised within the department, but it is not an official approach, nor has it been codified within departmental protocols. In a similar vein with Fenwick's (2012) work surrounding police and their adherence to protocols, there are specific examples of how things and materials are integrated or discarded from the practice of authorisation/justification. How these newer practices are shared is therefore dynamic and varied.

"…Stephani then wrote a note onto the RIS system some further information that they had gleaned from the patient. Stephani then told other staff what they thought the initialism meant, following their discussions with the patient. This created some further discussion amongst the staff…" [Field Notes]

"…Elliott picked up a request that had an unknown initialism within it and tried to google it but they could not access the internet. Alfonzo then got his phone out as he felt that it would be quicker but this did not appear to help. A discussion then took place between Elliott, Alfonzo, and Gabrielle as to the nature of an abbreviation on the request. When Elliott asked Gabrielle, she stated that this abbreviation was unknown to them and mentioned that 'they [referrers] should not use abbreviations…it's an official document and they [abbreviations] should always be spelt out first'… A foundation years Dr was on rotation in the department observing and explained what it was used for. It was acknowledged that the term was archaic and wasn't normally used in contemporary medicine…" [Field Notes]

In tandem with this sharing of knowledge between radiographers, the participants raise some issues with regards to the changing nature of radiography. These quotes allow exploration of two different elements within the analysis – that of a metamorphosis within the practice of radiography [MET] and that of historical and cultural practices within the system (Latour, 2013). It becomes apparent within both the field notes and discussions that radiographic practice has become more individualised, and the human interactions of radiographers have changed over time:

"…the radiographer spends less time in the 'viewing area' than in my previous clinical experience. Each radiographer (sometimes with a student) will work directly out of the individual X-ray rooms. The patient list is brought up within the room. The ease of

communication between radiographers is perhaps restricted given that they are now siloed in the sense of the intra-professional interactions on a daily basis…" [Field notes]

'…you are just in the room on your own and you could just literally not leave the room the whole time…before you could easily have just like bumped into somebody and being oh just look at this like…" [Stephani]

Metamorphosis within the *AIME* is seen as one of change within the conditions. The change here is primarily driven by technology; a move from daylight processors and/or computed radiography to direct digital radiography. Previously, radiographers would have to wait in the 'viewing area' for their image to be processed, either by the daylight processor or the computed radiography reader. However, with direct digital, the image is instantaneously available for the radiographer seconds after the patient has been examined (Whitley, 2018). Therefore, this can be conceptualised as being a crossing of [MET x TEC] notation. A change in the reality that has an effect on the way in which radiographers share knowledge between *each other*. Therefore, the agency of the non-human (in this case the X-ray request) has increased. The equipment that is being used has influenced the nature of the work and now extra effort is required to enable the radiographer to *share* knowledge with other radiographers. However, within this vein, the new process has become habit as, as Stephani intimates:

"…it's much more streamlined now…everything else is better…" [Stephani]

The question remains as to the impact of this particular technological advancement. Has *knowledge-in-practice* and sharing of knowledge been sacrificed at the altar of a streamlined service that allows the *individual* radiographer to increase *their* production? What effect may this have on elements that are wider than the X-ray request, such as training, support, etc. of colleagues and students? Has this barrier been thought about from a wider practice-based position? These questions are beyond the realm of this particular study, but it would appear that the change from film-based and computed radiography to direct digital has introduced a barrier to knowledge sharing within the workplace and produced a radiographer that appears to be more individual in their approach to the radiographic workday, in particular respect to authorisation/justification.

The key elements of skill that are being displayed by the participants are those of, primarily, patient history taking and occasionally elements of rudimentary clinical examination. Regardless of the training that has taken place within the radiographic curriculum or via formalised education (or apparent lack thereof) there is an element of *emergent practice* that is being used by the radiographers. An example of this can be seen in the explicit examples given above or in the other approaches taken by radiographers when there is insufficient clinical information, and the patient is within the department:

"…I'm pretty good at chatting to the patient anyway…so usually if I can…I usually just say that the doctors been a little bit vague…can you just tell me what your symptoms are or whatever…" [Colleen]

"…to be honest even the referrers tend to request it you won't get a better history than from the patient themselves…" [Elliott]

Here participants are using the discussion with the patient, their (the patient's) discussions with the GP, and any further information that may enable them to go ahead with the examination. The toing and froing of the information, the pseudo-history taking and pseudo-clinical assessment[33] employed by the participants highlight the relational element between them, the patient and their (the patients) symptoms and other tests. It also brings to the fore the discussion of the potentially embodied practices that may occur within the practice setting that allow the radiographer, not only to justify the request but also to make sure that the correct examinations have taken place, and even, in certain circumstances to predict the outcomes of the patients X-ray examination.

"…yeah and I think especially with A&E like whenever I sit in on any sort of reporting sessions with anyone I'm always like…patients lie and the clinicians lie so what well what the clinical history says could be absolute nonsense like people who fall on their hand [smiles] you didn't did you…you didn't fall…" [Gill]

[33] I have used 'pseudo' here to indicate that, until the recent update of the Standard of Proficiency (effective from 2023) formalised clinical history taking was not part of the pre-registration undergraduate radiography curriculum. Therefore, no formal training was undertaken by any of the participants in terms of this particular skill.

Power and agency appear to reside with a number of different actors within the network, and these appear to change with the nature of the missing clinical information. The work being undertaken on a day-to-day basis by the protocol guide cannot be understated, however its impact can be difficult to trace within the network. For example, the protocol can be said to be an agent of power within the network [POL] as well as an agent of [LAW] and cannot therefore be dismissed as an agent of purely legal endeavour. What the protocol does provide is perhaps a crossing between [POL x HAB]. As the protocol has normalised particular approaches it is of use as an immutable mobile within the system. Therefore, the protocol is used to maintain stability within the network. Its particular use, apparent in the data, was to authorise X-ray request and to reject them *when the patient was not present.* This is to say that the protocol became a reference point for the rejection of X-ray requests from a distance. Within the field notes this became apparent in the vetting of the X-ray requests being the primary marker of rejection only for General Practitioner patient or where patients had come from a non-referral source (e.g., non-medical referrer).

"…Stephani said to the surgery '…this is outside of our normal guidelines [……] there doesn't appear to be any clinical indication given on the request…no clinical indication'. Stephani then intimated that if '…you can give us some further clinical information we can have another look at it once it [the request] is resubmitted'..." [Field Notes]

There is, in most circumstances an interplay between power and agency and [LAW] that can be further elucidated within the realm of the *AIME* project. However, the field notes only identified two instances of a contestable request being referred onto the radiologist or reporting radiographer. In the instance highlighted below the reporting radiographer does not give the 'answer' of justified or not but instead indicates that Doria themselves should make the decision, and that this decision should be based on the outcome of a discussion with the patient as to the area of their pain.

"…Doria asked Gill what she thought about a particular request and the clinical information that is within it…Gill suggested that Doria '…ask the patient where their pain is…' as a way of eliciting a little more information to justify which projections to undertake…" [Field Notes]

Doria here accepts that the clinical information on the request is justified, however, there is an issue with the examinations requested. Therefore, there is a second element to the justification/operator process, which is ensuring that the principles of ALARP[34] are adhered to. Again, this appears to relate to not delaying the patient in their time towards their diagnosis or treatment. The example from the field notes above also highlights the importance of the *practice as embodied* thread. In this example, both radiographers are discussing ways of using these types of practices to not slow the progression of the patient towards their diagnosis. In this circumstance it is to ensure that the correct radiographs are produced for the interpretation of the images.

There is also a separate element to this. Radiographs under *IRMER 2017* require a clinical evaluation. This is normally performed through the radiological report (normally produced by a reporting radiographer or radiologist) (e.g., Department of Health and Social Care, 2024). Therefore, the radiograph that is produced is normally for the person reporting or interpreting the radiograph rather than the patient. However, it is the radiology report (whether this is provided by the radiology team or occasionally, the referring clinician) is the entity that will have the impact directly upon the patient. It has been postulated that patients occupy a 'liminal space' which is seen on the healthy-ill continuum. At the time the patient presents within the radiology department they may be neither healthy or unwell (Holm and Olesen, 2024) and are therefore occupying a space that lies between these two points. Until the radiology report is produced and actioned, the patient still occupies that liminal space with the radiographer. Therefore, without the request, the X-ray machines, and the resultant image the patient is unable to start to move along the continuum. This is perhaps a simplistic viewpoint, as it does not take into account the complexity of the diagnosis (which may require the addition of blood work, etc.). However, the approach appears to have merit and there may be a knowledge divide between patient and radiographer in such instances.

6.4 Creating and Refining Practices

The analysis thus far has shown how a task can be influenced through a wide variety of actors; whether these are the elements of noise that have been previously discussed or the nature of historical and embodied practices that have developed. To cope with this, there is an argument

[34] As low as is reasonably practicable. This relates to the process of optimisation for the radiographer, which is the process of gaining a diagnostic image at the lowest practicable ionising radiation exposure for the patient.

to be made which relates to the emergence of practices within the radiography space that allow the network of entities to 'hold together'. These practices include intended and unintended consequences, or predicable and possibly unpredictable elements of an activity (Reich and Hager, 2014). This is important from an empirical perspective as the activities, relations, and networks that are created are what can be observed. The approach taken within the research attempts to build on this empiricism within interviews as an explanatory method for the actions and connections that are undertaken. This again, builds on Latour's *AIME* approach, with through the different modes of existence and the consequences of the crossings that become apparent (Latour, 2014). There was also the approach undertaken by Fenwick (2012) in which interviews were deemed a suitable data collection for certain individuals where it may be seen as being difficult to certain areas of practice due to geographical, governance, or ethical challenges.

Emergent practices is a useful tool to summarise these discussions above, as they highlight the unstable nature of the X-ray department and the ways in which the radiographer can subvert the normalised approaches within the department to ensure that work is performed, that work is appropriate, and that patients do not receive unnecessary doses of ionising radiation and that information is shared in a timely fashion. The most commonly occurring emergent practice is perhaps the adding of information to the initial X-ray request by the radiographer. Within the departmental protocol and within the RCR iRefer guidance the amendment of the X-ray request by the operator is not mentioned. Within the ethnographic field notes the amendment of the request (or addition to the request) is seen on a number of occasions.

"…Stephani took some details to identify the patient on the RIS. The radiographer who had originally vetted the request had made notes which Stephani referred to during the conversation. Stephani said to the surgery '…this is outside of our normal guidelines […] there doesn't appear to be any clinical indication given on the request…no clinical indication'. Stephani then intimated that if '…you can give us some further clinical information we can have another look at it'. The request was looked at and re-vetted and justified by Stephani …" [Field Notes]

"…there was a request related to a thumb and wrist, from the A&E department. Gill suggested that Doria '…ask the patient where their pain is…' as a way of eliciting a little more

information to justify the request and focus on which projections to undertake Doria then recoded the extra information in the RIS…" [Field Notes]

"…today's huddle [discussion] included the vetting of requests and the addition of the relevant notes to the RIS system. It was requested that any information that the radiographer felt was relevant in terms of the patient's condition, extra clinical information, etc. should also be recorded on the system…" [Field Notes]

In the three examples highlighted above, the participants here add to the information given by the referrer, to ensure that the requests are justified. Pervious research on protocol operationalisation and workarounds has identified that there is a fear that the quality of a particular service decreases if the protocols are not adhered to (e.g., Fraczkowski, Matson and Lopez, 2020). However, this research appears to counter this argument. As noted previously regarding protocols, it is simply not possible for them to cover every eventuality (Berg, 1997; Horck *et al.*, 2024). In essence, the participants actions of getting more pertinent information from the patient or elsewhere could be seen as the radiographers, not necessarily acting within the realms of the practitioner or even the protocol, but almost as a 'proxy-referrer'. This crossing of the interprofessional boundary is one which is collaborative in nature (Meier, 2015). The approach to gaining extra information helped to adapt and change the X-ray request into something which can be utilised by both the radiographer undertaking the clinical examination, and the reporting radiographer/radiologist seeking to interpret the radiograph and issue a clinical report. This is important, as previously stated, the patients time within a liminal disease space (i.e., not knowing whether have a diagnosis or not) is reduced through the activities of the participants.

This *emergent practice* appears to be in line with the temporal influence on these practices. The presence of the patient and their symptoms (*embodied practices*) influence the manner of the participant's approach to keeping the patient moving towards their diagnosis and treatment. There is perhaps also something else at play. The guidance from the Society and College of Radiographers and discussions from the Royal College of Radiologists (RCR, 2022) make no mention of these types of approaches towards the authorisation/justification of the X-ray request. Recent work from Torenholt and Langstrup (2023) describes the use of protocols as having a potential influence around disruption. The idea is that those within the political environment seek to disrupt the practices of those working within a patient facing setting –

whereas what is happening is that the protocol/guidance merely continues the practices that take place. Therefore, in this context the protocol is in place but there is an emergent practice workaround that is driven by the radiographers and appears to be accepted by the reporting radiographers and radiologists:

"…they'll [radiographers] come in and be like I've got this what do you think I should do and my first answer is well what do you think that you should do because they know the answer…" [Reporting Radiographer]

Here the reporting radiographer is encouraging the ownership of the decision making by the radiographers. It is worth noting that the protocol guide within the department states that:

"…Any referral not meeting the criteria should be referred to an entitled practitioner who will make a decision on the justification of the exposure […] Consultant radiologists and reporting radiographers will also act as practitioners…" [Department Protocol Guide]

Given the apparent approaches taken by the reporting radiographers and the protocol guide there is perhaps an element of pragmatism within the approach. There is a wealth of evidence around decision making and interruptions that are perhaps at play when reporting radiographers are interrupted from their operational role of interpreting imaging studies. Interruptions and task overload are implicated in a decrease in accuracy within the reporting setting (Wyn *et al.*, 2018; Westbrook *et al.* 2010).

Time and space provide an arena where the emergent practices of the radiographer can be viewed. The following example from the field notes highlights the manner of emergent practices focused on the X-ray request and its justification.

"…Gill was called over to look at a request for a patient. The patient was being referred from outside the trust. The previous medical history appeared not to conform with current guidance as Gill remarked that '…essentially no, I don't think its justified…'. There appeared to be some deference to this particular trust as Gill remarked that '…although…given where it's come from'…" [Field Notes]

The referral source has already been discussed in terms of the noise that this can create within the network. Gill also acknowledged the difficulties in terms of different practices within the different hospitals, which also adds an element of emergence with the processes.

"…it's just the pinnacle of it is just standing spines for orthopods just nonsense…absolute nonsense and if a GP asked for it…you'd be like behave…you would never do it but they're going to [another hospital] and they want standing spines and it's coming from a spinal referral and we're going to do them…it's because of where it's come from not necessarily…like if it had come from the GP or from the ward you'd just be like…[exasperation]…no…like never and then…you say look they need a CT or MRI you don't need a standing spine and it'll look exactly the same…like when I report them I'm just like well it looks like the other one…it looks exactly the same as the other one…" [Gill]

The occasions where materials, information etc. do not fit into the wider protocol can be theorised as introducing emergent practices. This is closely linked to *knowledge in practice* where tinkering at the edges of protocols/procedures leads potentially to emergent practices that then become embedded within a particular context, through mediation. However, perhaps something else happens in these circumstances, which again, may be the influence of time upon how the radiographers' practices at the boundary. In the example above, Gill recognises that whilst the referral centre is asking for something that, in their eyes, is currently not justified, the justification switches to one of expediting patient care. They recognise that the patient needs to be referred to the specialist centre so that appropriate care can be delivered to them. Therefore, the risk assessment moves towards ensuring that the patient is treated.

"…you won't accept our patients until they've been scanned but then the scans probably not what you want and then you're going to rescan them anyway [arms upturned and shrug]…" [Gill]

Gill, in the example above, clearly is not happy about this, and is frustrated at the extra work and in particular, the extra ionising radiation that the patients may be exposed to. There is also a clear power dynamic being enacted here by the larger referral hospitals, perhaps at the detriment to their own working practices. Gill also commented that, as she had previously worked in larger referral centres, she remembered instances where there was an impasse between two referral centres:

"…they wouldn't accept our patients and we wouldn't accept their [patients] until theirs if they hadn't had like say [examination] of this and that…" [Gill]

This appears to indicate a 'tit-for-tat' circumstance being enacted as a way of ensuring the patient being referred was appropriate and that appropriate care could be administered. There are also elements of a particular crossing point within the *AIME* approach which would be where morality [MOR] impacts with knowledge [REF]. The morality here is perhaps the driver of trying to ensure that the patient receives the most appropriate treatment. Equally, this may be also enacted by the receiving hospital (i.e., not causing the patient to be transferred unnecessarily).

Whilst the three sections of this chapter have discussed various elements, they in fact are not mutually exclusive elements, as discussed previously, but practices that interweave together. That being stated, it is perhaps *emergent practices* that are the practices that tie together the noisy actors from the previous chapter into the discussion here. These *emergent practices* are also linked with the boundaries within the system and the X-ray request as that boundary object. This has been schematically demonstrated below (figure 7), but as with all schemas, this is perhaps an over-simplification of the complex interrelation of actors within this system.

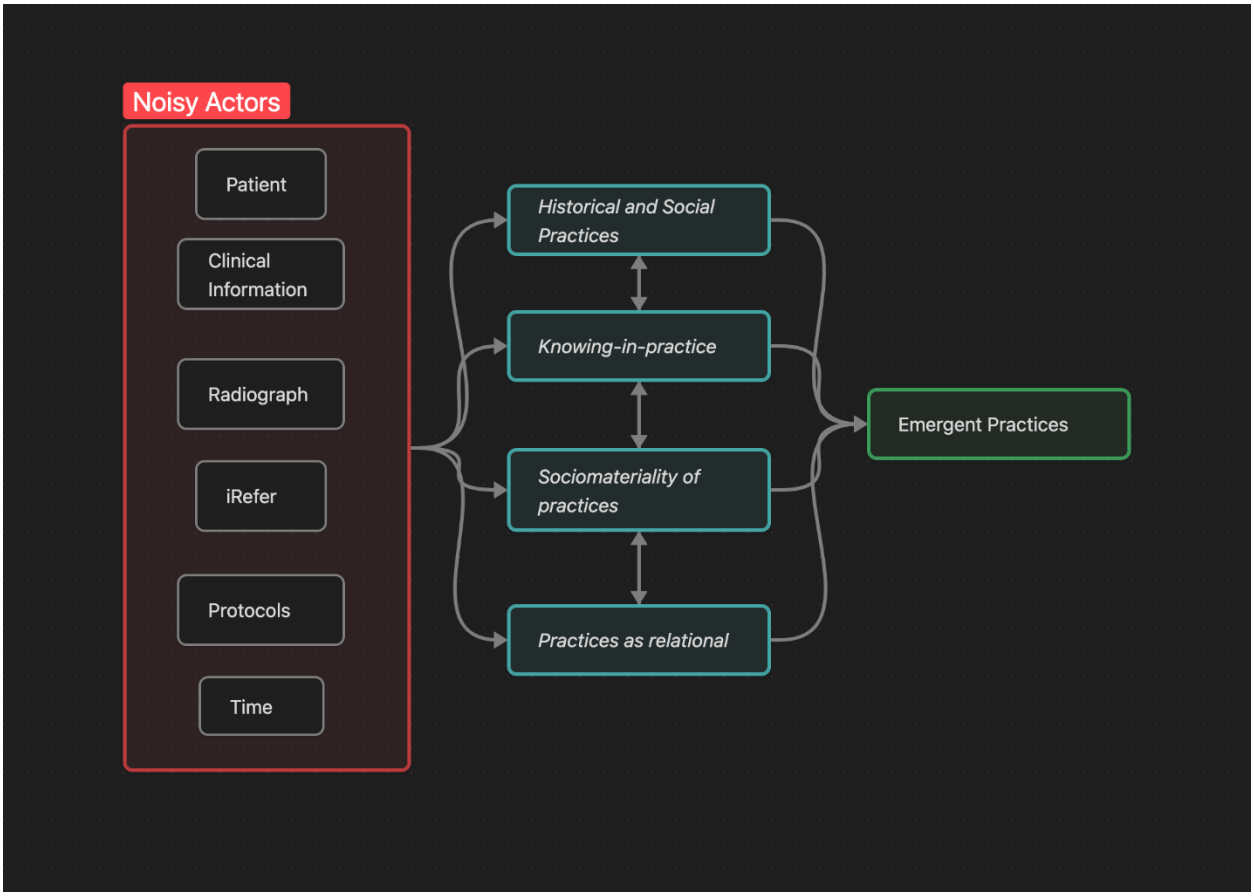

Figure 7: Inter-relation of noisy actors and practices.

6.5 Summary

The whole radiographic project, when interrogated through an Actor-Network Theory lens is operationalised through the use of technology. Its influence is seen through the application of the X-ray examination, the requesting process and the interactions that happen with both staff and patients. The patient's symptoms, when combined with the referral data can give the radiographer new information within which to make decisions based on. The discussion highlighted, both in this and the previous chapter, indicate that the resultant practices emerge to maintain the flow of patients both through the department and on their wider diagnostic journey. The previous chapter demonstrated the noise that is inherent within the network and how the radiographer's practices are affected by this noise.

Noise also has other effects within the wider system and within the wider work of the radiographers. However, this does not necessarily diminish the work undertaken by radiographers. The noise introduced may lead to emergent practices, which can be shared

amongst the staff within the department. This can be further conceptualised as the staff engaging with emergent practices. However, there is an element of isolation within current radiographic practice, which indicates the interplay between *emergent practices, practices as relational,* and the *historical and social context* within which practices emerge. Technological innovation and widespread use of direct digital imaging appears to be hindering the sharing of knowledge and practices, with a further impact on the abilities of those who are new to a department or recently qualified not being able to fully engage with wider, experienced radiographic workforce.

The following chapter will further discuss and build on these concepts and the emergence of these practices. This will help to contextualise the practices within the realm of the radiographer, their place within the radiology department, and the X-ray request. The notion of the boundary object and the emergent practices that arise are further developed around the notion of 'boundary work' and the role of the radiographer as 'proxy-referrer' will be further explored. There are also wider implications for the discussions here in terms of what it means for the future of the radiography profession and their relationships with the organisation of the work being undertaken and the technology with which they have a mutual relationship.

Chapter 7: Discussing Professional Implications

"…Exactly!" said Deep Thought. "So once you do know what the question actually is, you'll know what the answer means…"

(Douglas Adams, *The Hitchhikers Guide to the Galaxy*, 1979)

The argument that has been developing throughout this thesis is that radiographers, the X-ray request, and the work of authorisation/justification that has been described is more complex than simply following a protocol and operationalising it. This complexity is due to the noise which these actors introduce into the networked processes that radiographers are part of. The analysis that has been drawn from the data has shown that radiographers' work is more nuanced and can be associated with a number of different actors, over and above the protocol, the regulations and guidance that inform it. In Chapter 5 this complexity is visualised through the concept of noise and the identification of the actors that can both introduce noise and moderate it within the system. An Actor-Network Theory approach has been taken in an effort to identify sources of noise that may include both human and non-human actors in the system and how they may be enrolled into it. From this analysis, visualisation of the potential impact of level noise and how this may occur through the Actor-Network Theory concept of hybrids was undertaken.

In chapter six, a sociomaterial, and further Latourian analysis was undertaken to identify the nature of the resultant practices that were employed. The nature of these practices and the application of An Inquiry into Modes of Existence (*AIME*) (Latour, 2013) approach was taken to identify crossing points where different entities within the assemblage may intersect and create new practices. From this analysis there is an interplay between noise and emergent practices that appears congruent with the effects of both human and non-human entities. Some of the emergent practices can be seen as those which seek to moderate the introduction of the noise within the system.

Within the following chapter the aim is to further illuminate the activities of the radiographers within the authorisation/justification to explore, make explicit, and relate the major findings of this thesis to the wider literature. These major findings are the description of the implicit and explicit work are the radiographers really doing, in comparison to that work which is codified under the legislation and the protocols within the trust, and potentially what is able to done with

regards to the noise within the network, and the potential interventions that may need to be implemented to ensure that the noise can be further reduced. There are also some wider issues around the work being undertaken and whether an alternate way of conceptualising what is happening to the boundary object, through the interrogation of the boundary work being performed. This work is then outlined and categorised as being pragmatic in nature, due to the context and nature of the work (i.e., usually undertaken at a distance). These boundaries and the work that is required for radiographers to negotiate them leads to questions about the way in which this boundary work is managed and maintained. Within this chapter, the argument will be made that the practices being enacted by radiographers is primarily emergent Finally, there will be a further discussion that surrounds the working practices for radiographers and how the socio-historical shift from daylight processors to direct digital radiography may be having an effect on the manner in which the radiographers interact with each other, and further to that the development and management of emergent practices within this space, both in regard to the process of authorising/justifying requests and the potential for wider impact on the other practices that radiographers undertake. The notion of time and space/place will also be explored within this context of socio-historical and emergent practice. From these discussions the implications for the delivery of radiographic services and the pedagogic implications for radiographic profession will be discussed, with recommendations for a rethinking of the spaces in which radiographers undertake their work and targeted educational interventions to lessen the impact of noise within the work of justifying and authorising X-ray requests.

7.1 Noisy Actors and the X-ray Request

Prior to discussing those noisy actors that are apparent in the network, there is a requirement to be specific about where these noisy actors are found. The X-ray request, as the focus of the thesis has been conceptualised previously as a boundary object. This is an object that is created within a particular way, at a particular time, by particular actors. The actors here are viewed as being the patient, their symptoms, the referring physician (or non-medical referrer) and the electronic referral system (found within the confines of the consulting room, either in the hospital space or in the community). The data analysis has shown that, when problematised, the X-ray request it is made up of a number of different elements. Therefore, some that are black boxed (i.e., move from one place to another and faithful convey that information) do not accomplish this (Latour, 1999). It introduces noisy actors into the network, and these then enrol other noisy entities as well. The noisiness of the different components of the X-ray request and

using Kahneman, Sibony and Sunstein (2021) means that categorisation and conceptualisation of noise is able to be undertaken and identification of the actors within the system is able to take place.

In the case of radiographers and the X-ray request, the limits of the system are not set in a finite manner. Stability is only set for a finite time, with some elements of the network changing and the researcher's conceptions of the objects under discussion influencing how these objects are perceived and discussed (Law and Singleton, 2005). The actions that actors initiate is what keeps the network within a dynamic yet stable position, despite its ever-changing nature (Joks, Østmo, and Law, 2020). This means that when a radiographer and X-ray request come together the different actors that are enrolled mean that the system is not set, but it is constantly shifting and moving through further enrolments. It is thus the *emergent practices* discussed previously are made explicit and these play a part in maintaining the overall stability within a dynamic environment.

The data within the current study shows that the radiographer and the other actors work for the most appropriate action for the patient, so as not to impede or delay their diagnostic journey. However, from the data there are two predominant approaches to when the X-ray request does not fall neatly inside the protocol's boundaries; that of 'examine-focused' and 'rule-focused'. From an Actor-Network Theory perspective it is perhaps not useful to think of the radiographer being the actor in these situations, but like Latour's 'Citizen-Gun' (Latour, 1994) the patients symptoms and the radiographer come together to form a hybrid entity that undertakes a particular action ('examine-focused') or that the protocol and radiographer come together to take a particular action ('rule-focused'). This is the first element of noise within the system, that dictates the *level* noise within the given system (Kahneman, Sibony and Sunstein, 2021).

Whilst hybrid entities can be a useful analytical tool, there are issues around where to stop in terms of their, that is, the hybrids, composition. For example, Nimmo (2011) discusses the innate hybrid nature of milk, taking into the account the sociological and natural; Stalph (2019) focusses on integration of the technological and the human to produce the 'digital journalist'. Within this research, hybrid nature has been conceptualised as human and non-human entities coming together, regardless of the technological intervention. However, these hybrid entities identified are only the beginning part of the noise analysis and represent an entity that *wants to do a certain thing* (i.e., apply a rule or ensure a suitable examination). These hybrids are as

manipulable as other elements of the network to the actors that can be enrolled within it. Therefore, the noise (and the entities that introduce it) within a specific network can be seen as acting upon the hybrid, rather than joining with it; the hybrid can be seen as the point zero for their action.

Therefore, to implement a noise reduction strategy within the radiography department, a pragmatic approach would be ascertaining the current level of noise within the decision-making processes. This may be achieved through identifying the preference of the radiographers within the system. However, there are some limitations to what can be done with the data from noise audits in terms of meaningful changes to the decision-making processes. Srinivasan (2022) identified the noise levels in those making decisions about the possibility of people reoffending in the criminal justice system and found that even making participants aware of level noise did not change the level noise (i.e., people did not make less noisy decisions just because they were aware of noise in the system). This has interesting implications and can, perhaps, be summed up in terms of the Actor-Network Theory approach taken within this particular study. This current work shows that noise is multi-faceted and in systems where it is not possible to moderate for the input of extraneous actors into the system, noise will be introduced through by a myriad of different actors which are not related to the clinical information or the clinical question (as seen in the data there are decisions made around the type of referrer, the referral source, etc.). However, further studies have shown that targeted educational interventions rather than 'awareness raising' have had greater success (Mohan *et al.*, 2017).

If the goal is to ensure that the patient receives a timely diagnosis, then certain heuristics employed within the system may facilitate this; this would then mean that it would be implausible to remove all noise from the system. An individual who consistently employs critical thinking within a particular space may feel cognitively overloaded and become fatigued – this itself may introduce further noise into the system (Crosskerry, 2020). For example, within the data collection and analysis participants were seen, and discussed, using the referrer as a decision point when the clinical information was uncertain or did not adequately match the protocol (to ensure that that the network and the patient's journey through it are unimpeded). Once again, the impact of time as an actor is apparent here – the time that would be taken to contact the referrer, glean new information, and then to further X-ray the patient may be a driver for using a simplistic heuristic such as this. Previous studies on time within Actor-Network Theory have focused on a significant period of time, around 10-20 years, as opposed to the immediate

impact of time (or perhaps timeliness) within a network (Sarif, 2021), whereas in the data, time was perhaps related to minutes.

Relevant to the discussion of time is the number of tasks being undertaken within a given period. Whilst the decision-making that is the focus of this study is around the X-ray request; it is useful to think of the wider role of the radiographer within the radiography department. Participants within the study also alluded to the number of other decisions that are made within the working day on a per patient basis. These are highlighted within the Society and College of Radiographers (SCoR) 'Paused and Check' document which contains, nominally, 26 separate tasks that are involved within the imaging process (SCoR, 2019). However, as seen within the data analysis, this depends upon the nature of the examination being undertaken. These tasks may expand or decrease, depending on the context, the patient, their symptoms and the X-ray request. Of the 26 nominally separate tasks, six relate explicitly to the X-ray request whilst others may be related to it, depending upon the answer from the patient, radiographer, or referrer.

Whilst heuristics may be useful, their implementation relies upon the availability of a reliable input to the system, which can be seen as a source of noise (Kahneman, Sibony and Sunstein, 2021). From an Actor-Network Theory perspective, the input is best described as an actor, albeit a reliable one, if the heuristic is to work. If the information that is coming into the system is unreliable or incomplete, the primary example of this is the missing clinical question or incomplete clinical information. Therefore, the two key pieces of information that a radiographer needs to be make an informed decision with regards to authorisation/justification is missing and this introduces unreliability into the decision-making process, rather than reliability (Kahneman and Klein, 2007). Thus, time can be considered an actor, which if used as an input into a heuristic may be deemed as introducing noise, rather than a reliable contextual cue. Using the referrer may be seen as reliable actor in this particular instance. For example, in the data the referrer is often related to a clinic, which means that this is a more reliable input into the network.

The aim then is perhaps not to eliminate noise, but to identify its role in the making of decisions related not just to the authorisation/justification of X-ray requests, but also in the other decisions made within radiography and healthcare more widely. The protocolisation of the examinations undertaken and their rationale within radiography has perhaps already limited the variation that

may be seen without such algorithms, this would be in line with the implementation of protocols within the literature (Flynn and Hooper, 2020; Alipour, 2021). Research in other areas of decision making have found that using educational interventions such as gamification in learning and teaching has helped to improve the accuracy of the decisions that professionals make (e.g., Mohan *et al.*, 2017). However, these studies are generally based on the notion that there is a right and wrong answer that can be gleaned from the application of a certain framework. What is perhaps more interesting in this study is that there are times when there is not a right or wrong answer based on the information that is provided and that the 'correctness' of the answer is essentially unknown and may never be known. This is borne out in the discussions of the reporting radiographers within this study, as they frequently referred to experiential learning that had taken place, rather than analytical learning (Hackett and Taylor, 2014).

This differentiation between these two processes is seen within the data with the change from the reporting radiographers once they had begun reporting. This change is possibly to do with exposure and could be analysed as a move from 'rule-focused' to 'examine-focused'. The example of the radiographer who stated that essentially the information on the request meant that it was unjustified, but that the patient may have a disease which can be identified through the X-ray examination. There was also the reporting radiographer who stated that the patients were statistically not likely to have an identifiable pathology but that they don't want to be 'that person' that misses something. If this approach is pervasive within the reporting radiography staff, then it can be assumed that it is also there within the medical and non-medical referral staff who are requesting the X-ray examination (Li, Cheng and Liu, 2020). The research around this area does appear to validate this, although not within the radiology setting. Studies highlight the impact that previous experiences have and the unreliable use of availability heuristics within the nursing profession (Cioffi, 2001; Thirsk *et al.*, 2022). There can therefore be a link between each individual's *variety of experience*, and therefore the variety of availability heuristics *within the network* leading to a potential increase in noise. This link is apparent within the literature and has led some researchers to use the presence of heuristics as a proxy for noise (Araújo *et al.*, 2022) which itself, may lead to an overestimation of noise *if* the experiences within the decision-makers are similar.

Whilst the discussion here is related to noise and the decisions that radiographers make, it is interesting to note that in the context of clinical decision making of any kind, the ultimate goal of

not making *any* incorrect decisions is unattainable. Acceptable rates of accuracy, specificity and sensitivity[35] for the reporting of radiographic images sit at round 90-95% and this undoubtedly has some impact on patients, as these rates are not perfect (Abbasi, 2019). When considering the positive predicative values[36] (PPV) of mammography for example, the rate will vary depending on the population, but for the screening population within the UK's programme, the rates are estimated to be at round 10%, meaning that for every diagnostic decision made on a mammogram of positive, only 10% of these will be correct, and conversely around 90% will be incorrect, i.e., they are false positives (McCartney, 2012). The point being therefore that a perfect system, devoid of error, bias and noise, simply does not exist.

There is therefore a discussion to be had between the blurred edge of analytical and experiential decision making. The natural outcome of this is perhaps that this is simply something where there is a requirement to acknowledge that this is a legitimate concern; that is to say that radiographers operate within a noisy system. There is evidence that use of protocoled decision making reduces noise, and protocols are already in place within the radiography departments, as a requirement of *IRMER 2017*. Whilst the data analysis within this thesis and the wider evidence base is not clear, there is some evidence to indicate that awareness can be raised through further specific educational interventions on the nature of decision making within these complex spaces (Mohan *et al.*, 2017) although their efficacy may be undermined. Furthermore, the overall goal cannot be the elimination of heuristic thinking altogether, but to recognise where they may be failing and the extraneous factors that may affect the decision-making processes (Crosskerry, 2020). Whilst this is perhaps traditionally focused upon those engaging in post-registration education, there is a rationale for beginning this process within the pre-registration curricular. The current standards of proficiency indicate that registrants need to undertake informed decisions around patient care (HCPC, 2023) but perhaps educators need to make the psychological and social aspects of decision making, and decision-making processes, clearer within that curriculum.

[35] Accuracy in terms of radiology relates to the number of correct diagnoses made through the interpretation of the resultant radiograph. Sensitivity relates to the number of correct *positive* diagnoses made, and the specificity relates to the number of correct *normal* (or no disease present) diagnoses made.

[36] Predictive values are probability measures of whether a positive (or negative) result of a test will give the correct diagnosis. In the example above, for every 10 positive mammogram examination results (i.e., for a potential cancer) only one of these will be correct.

7.2 Boundaries within the Network and their Negotiation

One of the major findings of the thesis is that there is a complex interplay between different elements of network that can lead to other actors becoming enrolled within it, to ensure stability. This stability can therefore be seen as one that is constantly in a state flux, but nevertheless stable in terms of the sum associations holding together with the help of various actors, which are enrolled when needed. An adequate metaphor could be that of a gas at constant pressure and temperature. The element is stable; however, the atoms within it move around within it at great pace. However, this would be where this particular analogy would end in this case. For when pressure and temperature change or other elements are added, great change can occur within the system. Perhaps the human body is a better analogy, whereby the process of homeostasis provides a dynamic stability within the boundaries set within the system.

As the system is not perfect, and the boundaries within the system are not set, there are clear instances where the radiographer acts to justify the referral (rather than authorise) as per the *IRMER 2017; 2024* regulations. There is also the case of the radiographer acting as a 'proxy-referrer' within the system. This has been termed within this study as justification/authorisation. A single term that denotes the blurred boundary between these two roles; 'proxy-referrer' from the radiographer occurs in places where the radiographer cannot ascertain from the clinical information whether or not the X-ray request is justified, and the patient is present within the either the X-ray room or the department in general. This Actor-Network Theory account has looked at the associations that reside within the complex healthcare system that move the radiographer towards this approach, including the impact of space and time within the network, which affords the radiographer the opportunity to engage within this process. If the roles within *IRMER 2017; 2024* care considered as a boundary between different professions (albeit a potentially blurred one) then the work being performed here by the radiographer is boundary work and the X-ray request is the previously conceptualised boundary object. As the radiographer is acting as a 'proxy-referrer' they are not performing this role specifically, it should be made clear that the referrer has still made the referral, and the radiographer is not fully taking on the role. It is, however, an interesting way of conceptualising the radiographer and referrer working together, seeing their work as being a proxy for the referrer at that place and time. This can be further explained through the notion of boundaries and how the radiographer and referrer engage with and negotiate them.

The work that occurs within the boundaries here within the radiography network can be further conceptualised as collaborative boundary work (Langley *et al.*, 2017). This follows on from the discussion within chapter 3 around the different types of boundary work that occur and aligns further with what Meier (2015) described, defining interprofessional collaboration as a type of boundary work. However, whereas the patients were the boundary objects in Meier (2015), the X-ray request and the actions around it are the focus of this work. The collaborative actions of radiographer are apparent and are driven by the X-ray request. The radiographers are not asserting their authority over another healthcare professional when this boundary work is performed, nor are they actively encroaching on the referrer's role. There is a power that is being exerted by time and place/space; it exerts an effect on the radiographer, and the radiographer is looking to ensure that the patient receives the most appropriate care. Therefore, the boundary work being undertaken is for the benefit of the patient, not as a concerted powerplay to allow the radiographer to take on some of the tasks of the referrer. This may also have a subsequent further effect on the referrer as the referrer will not have to be disturbed with questions that can be reasonably answered through a discussion between the radiographer and patient.

There are occasions where the patient is not present, and the justification process can happen prior to the patient attending. This is most usually noted in the cases of GP referrals to the radiography department. These appear from the data to be seen as being less 'time-bound' by the radiographer. Occasionally the radiographer may be seen to be reading between the lines, drawing on colleagues' previous experience (including radiologists or reporting radiographers), previous imaging, previous reports, and the examination being requested. It is also worthwhile remembering that these elements are also drawn upon when the patient is present also, but the default question of reporting radiographers and radiologists in the data were '…is the patient here?' and then '…ask the patient?'

Whilst this may be termed or conceptualised as collaboration, it is perhaps not collaboration in the traditional sense. This is asynchronous collaboration; this can be conceptualised further and described as *pragmatic boundary work*. The referrer would in essence never know that the radiographer had expediated their request through gaining further clinical information from the patient, therefore collaboration in the truest sense of the word has not occurred. Throughout the literature there are often alternate terms for the work that is being conceptualised as boundary work such as boundary closure, boundary spanning, boundary breaching, boundary blurring,

competitive boundary work, and configurational boundary work, in conjunction with collaborative boundary work (Langley *et al.*, 2019; Lindberg, Walter and Raviola, 2017). All of the definitions of these different types of boundary work highlight the collective, social and symbolic nature of the work being undertaken. The work of the radiographer as a 'proxy-referrer' does not fit into the more competitive boundary work, where terms such as boundary closure or breaching may fit. Within the data there is nothing to suggest that the participants wanted to take on elements of the referrer role, quite the opposite, with some being extremely cautious of using such an approach. Therefore, the naming of the concept as 'pragmatic boundary work' encapsulates the emergent nature of the practices being undertaken, and the collaborative spirit in which it appears to have been actioned. Whilst all participants in the data used this approach, all participants rejected or questioned the referrer when it became apparent that the extra information that had been gleaned, regardless of the source, would not allow the X-ray examination to continue. This is perhaps the different between the 'rule-focused' and 'examination-focused' level noise within the system. This is the point at which the rule-focused would reject the request whereas the examine-focused would go to the referrer for the extra information that was required.

Building upon this, further interpretation of the boundary that lies between the referrer and the radiographer, and the boundary object (the X-ray referral) is required. Whilst the discussions with the patient may be termed pragmatic boundary work, the precedent has perhaps been set for the radiographer and referrer relationship from previous discussions with the examine-focused radiographers. The discussions often with the referrer do not focus on the patient but on what is being placed on the request. The participants in the data talked about giving the referrers 'cheat-codes' or nudges towards what information would be acceptable on the X-ray request. This practice appears to be indicative of collaborative boundary work and also matches with previous research focused on breaking down professional silos (Bhutta *et al.*, 2010).

Recent research into the attitudes of healthcare professionals towards interprofessional work has been highlighted as changing and generally, those attitudes of female and nursing/allied health professionals is positive towards collaboration (Ulrich, *et al.*, 2019) and this is seen within the data in this study. Some participants indicated that they understood what that there may be a reason that referrer (or in some circumstances) their consultant wanted the X-ray for that patient, but the junior doctor had been given a task to do without consideration for their current

abilities to interpret the form or give the radiographer the required information. The participants therefore approached the conversation from a perspective of helping them to learn, rather than from a 'rules must be followed'. Within the data the radiographers helped, gave hints, and understood that there was a need for a collaborative, patient-centred approach to ensuring that the patient was not delayed when passing through the radiography department. This approach was seen with all radiographers, even those who had questioned the veracity of the clinical information given by referrers and patients. Those radiographers with greater experience within the participants discussed this as the influence of their experience and of being perhaps a little more focused on the rules when they were first qualified. This links with data from Mudadi et al (2024) who indicated that staff with larger experience were more likely to strongly agree with a collaborative approach and the seminal work by Benner (2001) with those novice staff being more rule oriented.

The gaining of further information and acting as a 'proxy-referrer' was often documented within the radiology management system and read by the referrers. There is evidence to suggest that this approach ultimately also enhances the resultant report in terms of diagnostic accuracy (Castillo and Steffens, 2022) which may result not only from the increased clinical information (although this has been contested by some studies) but also from the radiologist or reporting radiographer not having to break their task (i.e., move away from the interpretation of the radiograph) to gain further clinical information (Degnan *et al.*, 2019). It may be questioned whether the radiographer is undertaking the boundary work in collaboration within the referrer or the reporting radiographer/radiologist. The data appear to show that the reporting radiographers at least encourage the taking on of this responsibility from the radiographers; a neat example of this are the numerous occasions in the data show that where there is incomplete clinical information or that information is contested, the question asked by the reporting radiographers was related to the patient and what they (the patient) report as being their symptoms.

The physical or work boundaries seen within the data collection can be seen on fig. 5, highlighting the difference between the radiographer and referrer space. Whilst there is a complexity to the nature of these boundaries, they can be visualised, and the trajectories of the work can be made apparent. Therefore, the work of the radiographer and referrer in ensuring that the request is processed correctly can be seen as crossing into both the referrer's domain (clinical information gathering) and the reporting radiographers' role in the production of the

radiology report. The work in this space is being implicitly sanctioned by reporting radiographers/radiologists, as this clinical information also allows their work to occur. It is worth noting that within the data analysis this approach is not explicitly codified within the protocol guide but was mentioned within the 'daily huddle' whereby any extra information that the radiographers thought would be useful should be identified on the radiology management system for the reporting radiographers or radiologists who would be undertaking the radiographic image interpretation. Whilst a 'daily huddle' is usually associated with improved communication and patient safety within specific contexts (Murphy, 2023; McKay *et al.*, 2024) there is another element of interest here, that of reinforcing implicit, non-codified *practice*. Without the undertaking of this work, the network would not look the way in which it does. The implications here are similar to that identified in Fenwick (2012) in that the protocols exist and are used as a basis for the further emergent practices to keep the system working. However, as Fenwick (2012) describes in her work, some may be uncomfortable with emergent practices and see the use of implicit knowledge, as is being practiced here, as potentially being unprofessional or outside of an individual's scope of practice.

There were occasions within the data were participants themselves acknowledged the difficulty of the situation that they were in, and one discussed their perception that the professional and regulatory bodies being heavy-handed with the application of *IRMER 2017; 2024*. However, all acknowledged the role that *IRMER 2017; 2024* and the protocols played in the protection of patients and recognised that they were willing to take responsibility for their actions. It may be said that the two participants who were reluctant to take on too much responsibility appeared to be more likely to move towards interrogating the referrer or asking for further guidance from reporting radiographers or radiologists (something that, at times, appears to frustrate these staff).

Boundaries are of course important across all working practices. They are often identified as being critical aspects of effective teamwork, including defined roles, within interprofessional working environments (Williams, Widdowfield and Cosson, 2015; MacNaughton, Chreim and Bourgeault, 2013). However, there is a certain dynamic nature to many professional roles and radiography is no exception. Therefore, it is apparent that the nature of the work perhaps requires a certain dynamism to be able to function (Mol, 2002; Jensen and Sandström, 2020). The work of the radiographer within the three roles identified within *IRMER 2017; 2024* is crucial to the effective functioning of the radiographic department. Further research may be required to

elucidate the impact upon patient care and patient outcomes, but the data analysis here indicates that there is the potential for a positive impact upon the patients experience and diagnosis through the radiographer navigating, and working, at the boundary of professional work.

The implications of the work that radiographers are doing with the boundary object are an example of the *emergent practices* that are being practiced. The collaborative work that is undertaken to ensure that the patient makes appropriate progress through the system can be seen as a workaround, the X-ray request is unboxed, which reveals a number of noisy actors. This leads the radiographer through a combination of *knowing in practice, sociomateriality of practices,* and potentially *historical and social* to bring into being new practices.

7.3 The Referrers and the Patient: A place to target in reducing noise?

The question posed for radiography departments, practitioners, and others is: how can noise be moderated for, or indeed reduced, within the system to further enhance the experience for the patient? A move towards the referral end of the chain may be a suitable answer, however, the remit of this work was not the point of referral. There has been some research in this area previously, through various iterations including the adoption of the integrated clinical environment (ICE) request system along with further information being provided to the referrers. Success has been observed within different modalities and for specific examinations through the application of specific guidance for certain common examinations or examinations where a specific set of criteria can apply. Increases in the number of appropriate examination requests have been observed in modalities such as MRI, for knee examinations (e.g., Mohammed *et al.*, 2021) and trauma cervical spine CT (e.g., Griffith et al, 2014). Referral guidance does appear to increase the efficacy and quality of the service provided by the radiology department, but this appeared to be within context specific circumstances as identified (Tay *et al.*, 2024).

Starting here would also push the locus for change onto the referrers, which may increase cognitive load on those responsible for referring to ensure the correct examination. It may be argued that guidance that covers the whole all conventional radiographic examinations for a specific department would be too large to be read, and whilst some departments have included the iRefer guidance or made this available for referrers, there is little evidence that this has much of an impact upon overall referral rates. Within conventional radiography, a multifaceted

approach in New Zealand/Aotearoa also appeared to yield positive results in terms of appropriate referrals, reduction in urgent referrals and a reduction in the overall number of examinations being undertaken (Holland, McGeoch and Gullery, 2017). The number of changes, the nature of the approach, and the length of time taken (7 years) highlight the complexity of the work undertaken. The approach highlighted the use of request criteria, along with specific clinical pathways, electronic referral, shared health records, improvements to workflow, quality improvement strategies, reporting guidance, and audits. The improvement in outcomes identified here is therefore due to both internal and external changes. The changes required may not be directly correlational to the UK context; the radiographers' working practices within a New Zealand/Aotearoa perspective can be seen as qualitatively different. This is especially true in terms of role demarcation and individual autonomy for radiographers, with New Zealand/Aotearoa 'lagging decades behind' (Unaç, 2022, p. 322) other countries in terms of the broader skill mix within medical imaging. Furthermore, the increasing complexity of documents like protocols influence the manner in which they are read, and implemented, potentially rendering them problematic within clinical practice; and the acknowledgement that things can fall outside of guidance (Baker, 2014). Therefore, as previously discussed from a radiographic perspective, it is not suitable to further curtail what can and cannot be requested. The approach should rather focus on the nature of the request itself, to ensure that clinical information and clinical question are complete.

There is also an implicit assumption within all of the work undertaken above regarding improvements to the radiology workflow; namely, that the measures indicated are useful proxies for service improvement. For example, in the data analysis for this research, the participants talked about making sure that the correct information had been written on the form, as well as whether or not the patient needed an X-ray examination. The participants occasionally discussed the so-called 'cheat codes' that referrers may use to ensure that the patient had an X-ray examination. This is where perhaps a 'form focus' is something that cannot be overcome either by the radiographer, radiologist, or referrer but something that is inherent within the system as it currently stands. Therefore, do the changes highlighted in the study from Holland, McGeoch and Gullery (2017) reflect a change in the manner in which the referrers are referring or have *they developed emergent practices* to adapt to the new system. The variation in the adherence to guidelines and protocols are already evident within the literature, with a number of different scoping and systematic reviews highlighting the variation that exists between practitioners (e.g., Kooijman *et al.*, 2011; Ebben *et al.*, 2013). Various factors are implicated in

the adherence to the protocols such as professional autonomy, previous experiences, attitudes and beliefs. This can be seen in the data within this research through the actions of the reporting radiographers in terms of their changing approach to justification and authorisation. The evidence base is primarily focused on the practical application of clinical guidance, rather than protocols that are enacted within a significant temporal space; that is to say that the time between the referrer creating the request and act of authorisation/justification is significant. The space between the two can also be significant as the referrer is more often than not within a different space to the radiographer (either within the hospital or, in the case of a GP referral not within the hospital at all). Throughout the data collection process the referring clinician was not seen within the department; this further corroborates previous research that has found that radiographers primarily work in a silo, consisting of other professionals with speciality in radiography (Strudwick and Day, 2014; Tannenbaum *et al.*, 2012)

This previous discussion highlights the significant effect of time and space within the radiographic arena and further highlights the, often asynchronous, nature of the work being undertaken. Whilst research on radiology interprofessional learning predominately focuses on the undertaking of specific examinations (e.g., Williams, Widdowfield and Cosson, 2016) research in terms of the time and space involved in justifying/authorising X-ray requests remains sparce and often focuses on the radiographic aspect (as in this research). As it currently stands, research around time and space is still bounded in terms of similar environments. For example, Oandasan et al (2009) focused on three different community sites and the structural environment with a focus on nursing administration tasks and how interprofessional working was difficult when space and time were not adequately structured. From this research and with the application of an Actor-Network Theory sensibility, environment (space) and time are both interpreted as independent actors. When one (or both) exerts a disenabling power then it can have negative impacts on both professional and patient outcomes and behaviours. Pullon et al (2016) observed the impact that the built environment can have on the interprofessional working of those within the primary care setting. The importance of space and belonging may also play a role in the manner in which people engage with each other, as space (or more specifically, place) is also implicated within this (Hawick, Kitto and Cleland, 2020). Therefore, it would appear that the impact of the physical and temporal distance may also play a role in how the referrers decide to engage with the referral process, in the same manner that the physical environment has potentially had an impact on the ability of radiographers to share knowledge with each other. This is undoubtedly an area which requires further investigation. To follow the

associations within the network to wherever they lead, whilst acknowledging the inherent limitations of the work being undertaken is a key aspect of the Actor-Network Theory approach (Latour, 2006). Whilst this was not possible within the current research, it certainly points to further associations within the wider network and the potential for future research to interrogate the referral process, in the same manner that this research has focused on the authorisation/justification processes.

7.4 Practices and Space – A site for future studies

In the data analysis the participants talk of the previous approaches and the fluctuation in the system. For example, when Stephani discussed the change in terms of how the viewing area was organised and that previously it had been easier to bring others in when making decisions. This can also be analogous to the sharing of practice that is associated with situated learning and communicates of practice (Lave and Wenger, 1991; Wenger-Trayner *et al.*, 2015). Communities of practice rest on three interrelated assumptions on shared practice, mutual goals and working together (Tummons, 2018).

A, perhaps rather simplistic, view may be taken that the ease of sharing knowledge has been impaired, and the physical environment has become an actor in terms of isolating the radiographer within the room in which they are working. This isolation removes the ease of knowledge sharing that is a required part of a community of practice (Alamantariotou *et al.*, 2014). Communities of practice as a concept has been, in general, relatively under-explored within the context of radiography (Ramazan, Graham and Hayes, 2024) perhaps the nature of the changing practices over the past 10-15 years in terms of the technology employed requires a more considered approach in terms of the dynamics of knowledge and practice sharing within certain elements of the radiographic work. The data from participants, field notes and further researcher reflections on the nature of the radiographers' work demonstrate that the organisation of the work has changed through the integration of direct-digital technology. The previous research around the move from daylight processors to computed and digital radiography has been explored within the literature (e.g., Tesche *et al.*, 2002; Platt and Strudwick, 2009; Hofman, *et al.*, 2015; Jones *et al.*, 2015). However, this focus has been primarily on the resultant image and associated factors such as the patients ionising radiation dose (Davidson, 2020). There is less of a focus on the impact on the working practices of the

radiographer, and how these affect (as identified within the data collected in this project) the working practices that are now taking place.

This work focuses on the practices of justification/authorisation, but there is a wider discussion to be had on the impact across all forms practice sharing, which is integral to the development and maintenance of effective communities of practice (Wenger, McDermott, and Snyder, 2002; Wenger-Trayner and Wenger-Trayner, 2015). If the ability to discuss, explore and share experiences upon a single fundamental aspect of the radiographers' work, then it does not seem to be too much of a leap to further ask what other aspects does this feed into. There is a possibility that this environmental change (radiographers being primarily within a single room) which is driven by technological advancement (the move from daylight/computer processors to direct digital imaging) may be having a wider impact on the workforce and how they experience tacit knowledge sharing (Panahi, Watson, and Partridge, 2016). The move towards digital imaging did increase the research around the potential for the increasing of dose (so-called dose creep) within the radiographic literature (e.g., Lewis, Pieterse and Lawrence, 2017; Davidson, 2020) and a focus upon the technical aspects of optimizing direct digital equipment (e.g., Tugwell-Allsup, Kenworthy and England, 2021). There was, and indeed is, relatively little discussion around the wider work impact that direct digital in particular could have on the organisation of the radiographer's work, and the subsequent effect of that organisation upon the learning that takes place within departments. For example, the work of Campbell, Morton and Grobler (2019) is perhaps the most prominent that discussed some of the work environment issues that surrounded this technological change (albeit within a South African context). It highlights some of the difficulties between radiographers of differing ages and the quality of the work produced through using direct digital equipment. However, even this work predominately discussed the technical challenges, rather than how the physical environment impacts the development of practices within a department. Similarly, the work of Hayre (2016a) is an ethnographic work which investigates the use of direct digital technology, without noting the effect of the physical environment in sharing knowledge of practices, and advocates to a certain degree an individualistic approach to radiation protection (pp. 222-3), rather than a sociomaterial one.

Therefore, this change in technical equipment certainly appears to have had an effect on the radiographer's technical knowledge of the equipment (Hayre *et al.*, 2017). Whilst the technical aspects of the examination were beyond the scope the current research, it would appear

plausible that if the sharing of knowledge and practice around one element of the patients' care has been impacted (i.e., authorising and justifying X-ray requests) then this may impact on the sharing of technical knowledge, as well as other practices.

By way of further elaboration, the 'viewing area' is perhaps a misnomer from this data as within the field notes there was very little in the way of viewing images taking place within this area. The viewing of the resultant images was performed by the radiographers primarily within the X-ray examination room (specifically within the controlled area). In terms of the historical and societal elements of practice the viewing area was a place where every radiographer's image was viewed, and again the wider group of practitioners would share knowledge, implicitly moderate work, and allow the building of relationships and sharing of professional accountability across the department (Jenkins, 1980). The radiographs which were produced were either displayed on light boxes across the department (when analogue machines were used) or on computer terminals within the viewing area (with the use of computed tomography). This open physical environmental space provided a communal hub whereby sharing knowledge and accountability was performed within a departmental setting. This environmental setting appears not to be used for this purpose. The viewing area now no longer provides a social space for sharing practices with emergent practices therefore being confined to within the X-ray room only.

There is perhaps a note here that a more communal workspace would be able to moderate these emergent practices as they occur, and whether these moderations would be warranted. This is also perhaps seen in the data with the participants who were more cautious of the authorisation/justification process. The sharing of practices and the opportunity to discuss elements of the work are fundamental to the moderation of the work undertaken. This does not however, mean that the artificial integration of a community of practice could be used by an organisation to regulate the actions of the radiographers within this regard. Communities of practice have demonstrated their ability to defy hierarchical structures within organisations (Cheng and Lee, 2014) and Wenger himself recognised that communities of practice can be as much a 'locus of inbred failures' as they are of achievements (Wenger, 1999, p. 85). However, a community of practice which shares similar interpretations of concepts such as patient safety and how these are operationalised may be able to further influence those on the periphery of the wider community.

It is, perhaps this shared conceptualisation, through shared practice that may be the point which needs some further expansion, as the data analysis in this research shows. The level noise indicates that there are two predominant approaches to the authorisation/justification of requests: 'examine-focused' and 'rule-focused'. These two different approaches which introduce the level noise into the system and represent the foci of different radiographers. One group predominately focusing on the patient in terms of how to ensure that they undertake the appropriate examination and the others focusing on the rules (in this case the protocols) and how these can protect the patient. These two separate conceptions of patient safety are in a way, moderated through the application of the protocol. However, as discussed previously, the protocol defines the outer limits of those requests that are either justifiable or not. It is when requests are submitted that do not adhere directly to the protocol, that the protocol becomes subverted by the individual radiographer's approach to authorisation/justification.

The possibility of leveraging communities of practice within radiography will require a further wholesale review of the processes of radiographic practice, and of knowledge sharing. The original studies of Lave and Wenger appeared to focus on those 'watercooler moments' where knowledge and practice would be shared (Lave, 2011). These still occur within the data, but it requires some further investment from the radiographers in terms of moving around the physical and environmental barriers that currently happen, more dependent on the request being submitted prior to the patient attending the hospital (which in turn introduces noise into the system). Within the data collected there was no mention from the participants of WhatsApp groups or online arenas where practices and knowledge could be shared. There was only a single record in the data of phones being used or looked at during the interactions with the X-ray request (which did not solve the query it was being used for - see p. 143) and therefore there is no apparent online community being used within a workplace environment. Whilst Wenger, McDermott and Synder (2001) advocate seven steps towards the introduction of communities of practice it may be preferable for radiographers and service managers to take into consideration the built environment and allow for the re-introduction of knowledge and practice sharing spaces. This would be in line further with the development of communities of practice as a concept and acknowledging that these types of fluid knowledge and practice sharing spaces do not simply appear without creating the physical spaces for them to happen (Li *et al.*, 2007).

7.5 Summary

This chapter has focused on drawing out the major findings of the research and relating them to the wider literature on Actor-Network Theory and also to the wider evidence base within radiography and healthcare. The nature of the boundary work within radiography is a key finding of the thesis and is an important aspect of the work that radiographers undertake. The conception of the authorisation/justification as a more accurate description of the work undertaken within the scope of *IRMER 2017* is important but equally as important is the work conceptualised within this thesis as that of the radiographer as 'proxy-referrer'. This is a potentially key part of the radiographer's role in terms of operationalising the *IRMER 2017; 2024* regulations. Without this role there would potentially be a negative impact on the impact of on patients' experience (such as heir timely diagnosis). It can therefore be implied that the boundaries between referrer, practitioner and operator are not set and are indeed blurred within the radiography department.

There are actors that move the radiographer towards this role, and these are conceptualised within the discussion as those elements of the request, time, space, and patient that allow the radiographer to undertake this role. The further conceptualisation here of this role as boundary work is important, but equally as important, is the reconceptualization of this being 'pragmatic boundary' work and whilst the apparent patient-centredness of the work points towards a collaborative approach, this is not collaborative in the truest sense, but rather a pragmatic approach.

The changing nature of technology has also influenced the manner of this work. The move from daylight processor to direct digital has not only changed the way in which radiographers perform their work with the patient, but it has also changed the temporal and physical environment in which this work is performed. Moving from the viewing area and into the X-ray room has removed some of the opportunities that radiographers have for sharing practices and sharing knowledge with each other. The use of communities of practice here as a conceptual lens through which to interrogate this change also asks an important question for the development of emergent practices and how these may develop over time.

The final chapter will summarise the work in total, reinforcing the contextual work that the radiographer undertakes, their interactions with other professionals, and the three major findings

of the research as identified above. The final chapter will also identify the limitations of this research and suggesting where the associations and actors can be traced to next.

Chapter 8: Identifying Ecologies in Radiographic Practice

"We demand rigidly defined areas of doubt and uncertainty…"

(Douglas Adams, *The Hitchhiker's Guide to the Galaxy*, 1979)

This chapter aims to summarise the key findings of this thesis. The focus throughout the research has been on a key, 'everyday' activity of radiographers: the authorisation and justification of X-ray examination requests. Whilst this process may be deemed by some to be mundane, the discussion of this process through an Actor-Network Theory lens has identified a plethora of actors that influence changes and ultimately, have agency. Some of these introduce noise into the decision-making processes, whilst others are enrolled into the network to maintain stability and counteract the noisiness of others.

The thesis summary chapter will give an overview of the whole; from conception, initially providing a brief overview of the role of the radiographer, the previous discussions about teamworking in radiology and decision making, through to discussing the concepts of noise and how this integrates and adds to the application of Actor-Network Theory within the thesis. This is key as it provides a unique opportunity to take a concept from the experimental cognitive psychological realm and move this into the real world. The chapter will then cover the overarching methodological discussions (i.e., using an adapted ethnographic approach) and provide an overview of the two main findings chapters, focusing on noise within the system and the *emergent practices* that can be seen within the ethnographic data.

This chapter then moves on to discuss the implications for radiographic practice, and for future research into not just the processes of authorisation and justification of X-ray requests but also for the wider exploration of changing working practices over the move from film-based/computed tomography and towards direct digital and flat panel detectors. The final part of the chapter and thesis will contain a critical reflection on the research journey, and wider development of the researcher.

8.1 Moving Back to the Start

The role of the radiographer was shown to be relatively underexplored within the literature within chapter one. The general definition as understood by most other healthcare professionals is one that involves the production of X-ray images for the purposes of diagnosis and treatment of

various acute and chronic conditions. However, as the chapter unpicks, there are a multitude (as in all work) of (f)actors that have an influence upon the roles being undertaken. There are regulatory bodies which govern what is within the remit of the profession (e.g., the Health and Care Professions Council (HCPC) Standards of Proficiency, 2023); separate professional bodies which exert influence in other ways around the role of the professional (e.g., College of Radiographers, 2022) and legislation passed through government (e.g., Ionising Radiation (Medical Exposure) Regulations, 2017; 2024).

Conceptualisation was required of these, and the current evidence base regarding teamwork in healthcare and decision making in radiography was discussed in chapter two. Recent discussions of decision making within the radiography profession was further discussed and highlighted that whilst decision making within conventional radiography was apparent, recent literature was primarily focused on a positivist paradigm. Previous research focused on the knowledge required to undertake such practices and the perceptions of radiographers gathered via survey methodologies. Whilst these studies showed interesting findings, relating the application of protocols and previous knowledge none of the previous studies focused on the work of the radiographer *in situ.* There are other studies which have employed an ethnographic approach (e.g., Strudwick and Day, 2012; Hayre, 2016a) however, this research appears to be the first to look at radiographers' authorisation/justification specifically using this focused ethnographic approach following the structured literature search, as other studies have utilised predominately survey methodologies (e.g., Chilanga and Lysdahl, 2024) or interviews (e.g., Sitareni *et al.,* 2023).

Further analysis and discussion are required on another unique approach employed within this work, that of using Actor-Network Theory as an approach and combining this with the application of noise (Kahneman, Sunstein and Sibony, 2021). These may at first appear to disparate partners; Actor-Network Theory is predominantly drawn from the work of Bruno Latour, Michel Callon, and John Law within a sociological context and the work of Kahneman, Sunstein and Sibony within the realm of experimental cognitive psychology. The application of noise in previous studies has looked at those non-human objects that may influence human decision making usually using an experimental paradigm, in artificial conditions (e.g., Grgić-Hlača *et al.*, 2024) or from a retrospective perspective (Cortes and Lawrence 2021). However, using an ethnographic, Actor-Network Theory informed approach means that there is a benefit to applying the concept of noise and Actor-Network Theory together; this helps the interrogation

of decision-making within the real-world setting, identifying potential non-human actors that are sources of noise.

To achieve this, the study took place using an adapted ethnographic approach to data collection (Hammersley and Atkinson, 2019). Over a three-month period, two weeks of non-participant observation, seven semi-structured interviews and documentary data collection took place within a district general hospital. The data was analysed using Reflexive Thematic Analysis (Braun and Clarke, 2021) along with an informed Actor-Network Theory (Latour, 2005) and noise (Kahneman, Sunstein and Sibony, 2021) to ensure that the associations between the actors within the network were identified. Actor-Network Theory allows sensitisation to the identification of the non-human entities within the network. Other concepts were also deployed within the data analysis meaning that entities such as boundary objects (Star and Griesemer, 1989) and boundary work (Lindberg, Walter and Raviola, 2017; Langley *et al.*, 2017) were useful in the conception of the practices that were being undertaken within the network. These practices are those which allowed the network to be both stable and dynamic.

Within the data these elements are apparent. Chapter five presented a detailed analysis of noise within the data collected. This was interpreted using Actor-Network Theory and allowed the identification of 'black-boxed' elements in the network, such as the X-ray machine, and crucially, the X-ray request. The X-ray request *could* be seen as a 'black-boxed' object, however, once pried inside it becomes clear that elements of the X-ray request may be considered as entities within the network that have action, which can be complemented or removed with the enrolment of other entities (Michaels, 2017). In chapter six these concepts are further enhanced through the integration of Reich and Hagar's six threads for professional practice (2014). These threads make apparent that the X-ray request produces *emergent practices* within the network. A key finding from the application of the six threads for professional practice is the notion of the *historical contexts* of the practices, for example, the removal of the paper request appears to have had implications for the practices of radiographers. Finally, in chapter seven, the implications of the data have been foregrounded to identify three key findings that can be drawn from the analysis and where these findings sit, particularly within the wider radiographic and professional practice literature. A summary of these is given below.

8.2 Three Keys to Unlocking, Unboxing and Understanding the X-ray Request

The practices that have been brought into being by the X-ray have been numerous and are not just dependent on the X-ray request themselves, but as the X-ray request has changed, so have the physical and technological environment within which the X-ray request operates. To understand what these are, a discussion of the three major findings of the work is required.

8.2.1 The Ghosts in the X-ray Request

In homage to 'ghosts in the machine' (Bhardwaj and Sra, 2023) the X-ray request as an entity has been problematised as part of this study and there are a number of entities here that can be said to be responsible for introducing noise (or variation) into the network (Kahneman, Sibony, and Sunstein, 2021). These were primarily related to the clinical information on the request and the often-absent clinical question that resided in the X-ray request. However, other entities were also uncovered such as the referrer name attached to the request and the referral source which also determined what happened to the X-ray request or the patient. This also allowed other entities to be enrolled into the network (such as other colleagues, the internet, etc.). These extraneous actors can be described as those which cause the enrolment of other actors into the network. Whether this is the radiographer seeking to enrol the Google in a search engine capacity, other radiographers, or a reinterpretation of the patient's symptoms through *emergent practices*. These *emergent practices* revolve around the request as a boundary object, meaning that these emergent practices can be seen as a type of boundary work being undertaken by the radiographer and the X-ray request. Therefore, once the X-ray request was 'unboxed' this research identified a number of different entities that make up the request, which if not aligned with other non-human actors (such as the protocol identified within the field notes or RCR iRefer (2024) document) caused a disruption within the network (i.e., lack of consensus) that required the enrolment of other actors into it. This enrolment of actors is an attempt within the network to reinforce the dynamic stability of it (Scoles, 2017).

The first source of noise identified within the participants practices was the radiographers themselves, or to be more specific, the hybridisation of the radiographers and the clinical information (Latour, 1994). Through a set of individual values and interpretations of what it means to be a radiographer (influenced in part, by the Standards of Conduct Performance and Ethics, Standards of Proficiency issued by the HCPC, and documents from the College of Radiographer) there are two distinct types of level noise are visible within the data. These have

been defined within this thesis as ‘examine-focused’ radiographers and ‘rule-focused’ radiographers. These two types reflect the different interpretations of what is best for the patient namely, that the assumption is that the patient will need the examination or that the dose of ionising radiation given to the patient should be kept as low as reasonably practicable and therefore the ‘rules’ (i.e., protocols/guidance) should be adhered to.

The X-ray request itself then introduces the predominant non-human actors that are a source of variability (i.e., noise) within the practices being undertaken. The actors within the X-ray request include the clinical information provided, the referral source, the (lack of) clinical question, and the individual referrer themselves. These are the actors that provide disruption into the network and introduce the constant flux of information. Within the data it can be seen that these actors lead to the enrolment of other non-humans (and humans) into the network. It is this process that provides stability into the constant flux, in line with Scoles (2017) interpretation of a dynamic stability. These other actors are a combination of humans (such as colleagues, reporting radiographers, and radiologists) who may in turn also enrol other non-human/humans into the network. Examples of these non-humans include the protocol, iRefer guidance, time and space, radiographs, radiology reports, and the SoR ‘Paused and Check’ poster.

These actors are enrolled into the network to provide stability to it when noise is introduced and keep the flow of work moving for the patient. Some perhaps could be said to introduce either further noise or are, at certain times, lacking the agency with which they are normally ascribed. Many of the participants discussed the protocol and most would state that they did not look at it ‘as often as they should’. This is also the case for the SoR ‘paused and check’ poster with few participants discussing it, but some clearly thinking that part of it was automatically performed by most radiographers. The major finding was that there are clear entities that are not directly related to the clinical information, which were those that also influenced the decisions of radiographers. These related to the temporal and the spatial initially. These included the presence of the patient; that is whether the patient was on site or not. This presence appears to have a temporal effect on the radiographer as it decreases the time to make a decision, perhaps drawing on the western, Eurocentric and ultimately capitalist interpretation of time as a commodity. Therefore, there is a perceived pressure of not wanting to ‘waste’ the patient’s time (Gonzalez-Lopez, 2005). The presence of the patient also allows the enrolment into the network of other factors, such as the patient’s symptoms, previous discussions, and further clinical information. All of these things allow the X-ray request itself to become a *dynamic* and

changing document, not something that is a static description of a patient in time, but something that allows further practices and work to occur upon the boundary object. It is also worth noting here that the presence of the referrer was not as usefully tapped into as the presence of the patient. Whilst there were instances of the referrer being contacted; this was normally seen when the patient was not also present. This indicated that the patient was the first point of contact for most of the participants (if spatially available).

The major source of dynamic stability within the network is the *emergent practices* that are used by radiographers to ensure that the network remains stable. Within this work, the interpretation of the network 'stability' is that patients are undergoing appropriate X-ray examinations, receiving appropriate diagnoses, and moving on to appropriate treatments that are informed by the radiographic examination and report. Whilst these outcomes do not form part of the focus of this thesis, it is apparent from the data previously discussed that the participants were focused on ensuring that the patients receive appropriate examinations and their consults, GPs, etc. are able to make informed decisions (Abbasi, 2019; Holland, McGeoch and Gullery, 2017; Castillo and Steffens, 2022). The emergent practices used by the radiographers, are a consequence of the agency of the human and non-human actors discussed above and it is these that allow the work to continue despite the lack of consensus between differing professional groups. This leads the radiographers to emergent practices on the boundary object and leads them to engage with boundary work.

8.2.2 The Boundaries of Emergent X-ray Practices

As the X-ray request was originally conceptualised as a boundary object, attention can then turn towards the boundary practices that are put into action by, and upon, this boundary object (Lindberg, Walter and Raviola, 2017; Langley *et al.*, 2017). The nature of the boundary work is a useful way of interpreting the emergent practices that the radiographer uses to ensure that the most appropriate action is taken for the patient at the most appropriate time.

The presence of the patient can have a huge influence on the practices that emerge due to the noise introduced by the lack of clinical information. Where the referrer may not be contactable either by time, space or both, this initiates the emergence of new practices as the radiographers do not want to hinder the patient's progression towards diagnosis. This hindrance does not mean that the X-ray examination proceeds despite, but that if the radiographer intuitively thinks

(Kahneman, 2012), that the examination may be justified then they will move towards practices that will initiate the examination or stop the referral process. These practices include not just the patient themselves, but the previous radiographic examinations, reports that are connected to the patient record, the patient's presence (regardless of if they have had a discussion with the radiographer), their symptoms, their referral expectations, and even other imaging that is performed during the examination.

The *emergent practices* performed when the referrer is not able to be enrolled into the network is an appropriate example of the performance of boundary work by the X-ray request and radiographer. Within the data analysis the most significant example is when the radiographer takes up the role of the 'proxy-referrer'. This is where a radiographer either attempts to reproduce the original discussion between the referrer and the patient or where the radiographer uses other non-human actors within this role such as the previous reports, previous radiographic examinations, current radiographic examinations, the referrer or the referral source.

Within the interaction with the patient, the radiographer is attempting to elicit further information to allow the examination process to continue without detriment to the patient's diagnostic journey. This example of boundary work is conceptualised within this work as being pragmatic and asynchronous in nature. Boundary work is seen as being conceptualised in a number of different ways, including that of contested work as well as collaborative work (Langley *et al.*, 2019). Here, this is collaborative in the sense of the radiographer wanting to further the diagnostic or therapeutic journey of the patient, without causing unnecessary delay. The data collected within this work clearly shows that the radiographer is not trying to move the boundaries that currently exist between the referrer, the practitioner, and the operator (*IRMER 2017; 2024*) but is rather collaboratively working at the boundary, essentially undertaking certain practices to enhance the asynchronous collaboration between referrer, practitioner, and operators.

8.2.3 Share and Share alike: Wider Implications of Direct Digital Radiography

The work being undertaken within the radiography department has changed over the last 20 years. The nature of the viewing area and X-ray room in particular have been vastly changed by the technological advancements within radiographic imaging. This started in the 2000s with

the move from daylight processors that involved the more practical application of photographic chemicals and towards a more digitised and instantaneous appearance of the radiographs (Tesche *et al.*, 2002; Platt and Strudwick, 2009). The impact of the technological advancement of direct digital imaging has been discussed at length within the radiographic research literature (e.g., Hofman *et al.*, 2015; Krupinski *et al.*, 2007; Jones *et al.*, 2015). Many opinion pieces and empirical studies have been performed to comment upon and assess the technical impact of direct digital. This literature was primarily focused on discussions around the effect of so-called dose creep, which is a result of the digital image production process ability to cope with over-exposure of the patient (and image receptor) to X-rays (e.g., Hayre, 2016b; Ma *et al.*, 2013; McFadden *et al.*, 2018; Davidson, 2020) and was therefore more technological in nature. However, what was missing from the literature, and to which the findings of this thesis allude to, is the impact of the environmental (or physical) changes and the effect that these have had on the working practices of radiographers.

The environmental changes have impacted the working practices from a historical perspective. The viewing area from a practical perspective was where the radiographers would look at their radiographs and often be the place where questions would be asked, criticisms of images elicited, and (rather more prosaically) stickers attached to physical radiographs. It was also within this space that questions about paper requests would be asked, and shown, to other members of staff (Strudwick, 2024). It may be meaningfully asked, what has happened to these shared spaces and what is the impact on sharing of knowledge and a sharing of practice? The *social and historical practices* have become disconnected from the current *emergent practices*. The social element of those practices could have been seen to have a pseudo-regulatory aspect of the team (Massingham, Fritz-Kalish and McAulely, 2020). A radiograph being on display for others to see could have come with suggestions for improvement and accountability.

The change to direct digital radiography has meant that radiographers have moved from viewing their images in a communal space to viewing the images in an isolated space (i.e., in the X-ray examination room). However, within the context of the data collected here, this also applies to the viewing and authorisation/justification of the X-ray request. Again, these requests were mobile, they were taken into and out of rooms. There were passed from hand-to-hand and often annotated by hand, as seen in the interview data. The X-ray request is now part of the radiology information system and requested via the ICE system. This means that there are some extra steps required if a radiographer wants to query a particular request card with the

patient, staff or other members of the wider radiographic team. They are ostensibly pushed into a conversation with the internet or other non-human actors. As a participant remarked, they had to 'move out of their area' to query discussions around the request or indeed the patient.

The findings demonstrate clear evidence of the isolated nature of the approach to radiography workflow now operationalised within the department. Radiographers' work now predominately takes place within the X-ray room. The viewing area is used for vetting which means that this sharing of knowledge and practice *can* take place with regards to the vetting of X-ray requests. This was evidenced in the research of the incident where a number of radiographers were vetting a GP request. This was a multiprofessional collaboration as a registrar was also shadowing radiographers that day. However, this was opportunistic in nature, the radiographers were already in the area. There were multiple instances of radiographers 'grabbing' the person who happened to be passing through and the reporting radiographers interviewed stated that if they were working in the reporting room that was closest to the viewing area that they were interrupted too much.

Whilst reporting radiographers may be seen as those who are leading the community in terms of their experience, further training, and expertise, there was a feeling amongst them that the radiographers in the department at times simply lacked confidence. There were statements such as 'they know this' and instances of a type of Socratic questioning happening to aid the radiographer making decisions. Perhaps this lack of confidence may be seen as a result of the isolated working that the radiographers engage with. The informal sharing of knowledge being disrupted by moving the majority of the work into a single area (i.e., the X-ray room) and the final authorisation process taking place in this mostly isolated place.

8.3 Future Directions for Research into Radiographic Practice(s)

Whilst this work focuses on the practices of radiographers specifically, there is a requirement for Latour that one must follow the associations (Latour, 2005) and perhaps this is the most important limitation of this work. The actors and their associations were not followed to the largest extent. Future research should focus on drawing these associations more thoroughly, particularly with regards to the referrers and the patients. Observations of the referral activities would have greatly enhanced this work and would have allowed some further insights from the

start of the referral process through to the follow-up meeting of referrer and patient post-examination.

There is also a wider implication that is apparent for this research, one which has implications for radiographic practice in general, and not just for the authorisation/justification of X-ray examination requests. The current way of organising the work of the radiographer within conventional radiography have not been fully explored nor their impact beyond the technical aspects. There is research around concepts such as dose creep (e.g., Horrocks and Violaki, 2015; Davidson, 2020) or capacity building though use of staff (Palmer, Snaith and Harris, 2018) within radiographic practice; but previous research has not explored the change to the impact of organisation of working practices through the introduction of this technology.

The removal of the primary space of the radiographer from the viewing area and into the X-ray room may be having wider implications for professional learning and development, not just for the pre-registration student but for the whole radiographic profession. The change has been driven by the changing physical environment through technological advancements within radiology. The move towards direct digital radiography and away from the computed radiography systems (and previously films and daylight processors) has removed the radiographer and their images from the viewing area and into a point of isolation, as identified within the data analysis in this work. The ability to stand and discuss images in an informal manner, the ability to have radiographs on ‘display’, the informal sharing of pieces of papers, have all meant that the radiographer is now isolated within their room and must actively move into an area to be able to communicate and share practices and knowledge. The role of those within the centre of a community of practice is all the more important as further effort may be required to overcome the physical environmental barriers put in place by the changing nature of radiographic work within the conventional projection radiographic sphere. Therefore, further emphasis and focus on this area of practice is required, through interrogation of wider practises or taking a communities of practice approach to the wider labour being undertaken within the radiography departments.

Whilst those who are seen as being experienced still lead the department, there has been an introduction of physical and communicative barriers to the practices that the radiographers undertake. These physical barriers have not been removed through the introduction of technology as seen through the development of work practices within other fields (Martin and

Omrani, 2015) but rather technological innovation has introduced barriers to the practices that were seen previously. The profession is approaching the end of the first 10-15 years of the adoption of the direct digital radiography (Seeram, 2019), a further analysis is required, not of the technical aspects of the work being undertaken, but upon the sharing, moderation and evaluation of emergent practices, as well as the sharing of knowledge that are part of the everyday work of the radiographer. Therefore, the result of the changing on working practices meaning that fewer opportunities for sharing practice and knowledge are impacting the confidence and work processes of the radiographer.

8.4 Recommendations for Radiographic Practice(s)

The research as presented here shows that the practices that the radiographer engages with when they are interpreting and acting upon the X-ray request are many and varied and have the potential to bring forth emergent practices that appear to ensure that the patient with which the radiographer is concerned receives the most appropriate course of action (within the gift of the radiographer). Collaboration, communication and the remaking of the network with new actors are key factors that allow the radiographer to move forward with the work. It is important to note that collaboration between the radiographer and referrer can happen asynchronously and that the referrer possibly does not know that collaboration has in fact taken place, as the collaboration moves forward through the enrolment of non-human actors. There are apparent pragmatic approaches built into the practices of radiographers that allow for this process to happen. The approaches identified here are not codified in any of the policies or procedures apparent within the departments, nor are the specifically mentioned within the standards of proficiency, or any other frameworks, for radiographers (HCPC, 2023; CoR 2022). This is significant, as this is different to the standard view of autonomy given to professionals in their daily work. It is different as it relies on a dynamically stable network of human and non-human actors. Whilst no system is perfect, a realisation must be given to the dynamic practices that take place to keep the system in place, and the patients diagnostic and treatment journey is at the centre of this.

Further codification of these practices may be required, to answer the question of whether the radiographer in these circumstances is covered by the more legal terminology of ‘custom’ rather than emergent practices. The argument being made here is that perhaps these practices are not ‘custom’ as they emerge from the specific context in which they are developed. The

‘custom’ is therefore the set of informal, uncodified rules that allow the practices themselves to develop, rather than the practices themselves. Codification of such practices may allow more streamlined implementation of working practices if appropriately codified allowing standardisation across either the workplace or professional group (Secchi and Camuffo, 2021; O’Meara & Kelliher, 2021). However, there are challenges to codification when attempting to develop a protocol (i.e., it is not possible to create a practice or protocol that will be able to deal with every single possible challenge that arises in the practical day-to-day running of a radiology department). The emergent practices that are put in place by the radiographers within this research are unique to a particular context, as the enrolment of actors into the network changes depending on the individual, patient, information on the request, and other factors. The aim through codification therefore would be to put in place something that could be suitably applied across different contexts. Recognition that the radiographer has these skills and are able to use them in the process of authorisation/justification would be useful, along with the shared knowledge and practices employed within the radiographic sphere.

The use of direct digital radiography is anecdotally ubiquitous within the NHS; however, no firm data can be gathered from the NHS National Imaging Data Collection. The NHS National Imaging Data Collection states that there are 3001 X-ray imaging units within the NHS in England as of the last count within 2022/3 (NHS England, no date) however, no data is available in terms of the types of digital equipment being used. If the equipment offer of current suppliers of medical imaging equipment are viewed (e.g., Siemens, 2024; Phillips, 2024) the emphasis is on flat panel detectors (direct digital imaging) and relatively little around the computed radiography systems. Given the current focus of medical device companies on direct digital there is a need to focus on working practices of the radiographer and how to create opportunities that afford the radiographers the ability to share knowledge and practices that develop within the radiography departments.

The impact of the reporting radiographer cannot be overstated from a radiographic practice perspective. Whilst the interrogation of their practice has been focused upon the extension into the role of the radiologist and their performance (Woznitza *et al.*, 2021; Culpan *et al.,* 2019) again, research and practice has not viewed their impact upon the roles of those around them. Research exploring reporting radiographers and how they impact the training of radiographers in terms of their approach to conventional radiography working appears to be under-represented. For example, Wood (2022) in their scoping review of the role of the reporting

radiographer highlighted within the literature that the role of the reporting was generally accepted and that there was a focus on teamwork, from a multidisciplinary perspective. The impact of the reporting radiographer on *their own professional group* (i.e., radiographers) was not addressed within the review. Likewise, Henwood, Booth and Miller (2016) also discussed the impact of consultant radiographers (not just reporting radiographers) highlighting that the development of new services was seen as a significant impact. However, there is no discussion on their impact on current services or on current radiographic practice. There are elements that have been put into practice across the profession, for example, reporting radiographers contributing to the clinical training of other professionals and radiographers in the realm of reporting specifically. This is where radiographers are training pre-registration students to interpret X-ray examinations, rather than their impact on undertaking X-ray examinations themselves, sharing practice, or underlying the importance of appropriately justified X-ray requests.

Previous research has, however, demonstrated that reporting radiographers feel that they have something to add in terms of the wider development of other members of their team (Ramazan, Aarts, and Widdowfield, 2023). Whilst this thesis has highlighted the reporting radiographer's perception that there is a lack of confidence within the department in terms of authorising and justifying X-ray requests (along with intimations from members of staff), it also highlighted the wealth of experience, expertise and knowledge that reporting radiographers bring to the workforce. The challenge for future research is to develop a radiographic practice that allows the space and time for knowledge and practices to be shared; that is to say, the environment within which radiographers work may be designed differently.

A final element that needs to be acknowledged is the potential role of artificial intelligence (AI) on decision making within radiology. In the UK there has already been a widescale roll out of chest X-ray examination reporting using AI (RCR, 2025) and other applications of AI have been seen in the planning of computed tomography scans (e.g., Demircioğlu et al., 2024; Golbus *et al.*, 2024). AI has been used to assess whether X-ray referrals for brain CT scans (Potočnik *et al.*, 2024) and lumbar spine MRI (Alanazi *et al.*, 2022) are justified in relation to the clinical information and clinical question provided; these AI models have also been assessed in the ability to cope with missing clinical information (Potočnik *et al.* 2022). Comparison has also been made with ChatGPT and Gemini with specifically created AI programmes (Potočnik *et al.*, 2025). However, the next possible stage of development may be that large language models

and machine learning models would then be employed to write the referrals, rather than to assess them. However, further advancing an Actor-Network Theory sensibility, the current focus of the above research appears to be on comparing the human and non-human. Perhaps the focus of research should switch to assessment of the radiographer/AI or referrer/AI hybrid in terms of the assessment of the referrals, rather than a focus on AI versus radiographer/referrer.

8.5 Reflections on the Research Journey(s)[37]

This research process began in 2014 as a vague idea and notion that I had to investigate the working practices of justification of X-ray requests. This had always interested me as a radiographer and I had at that time recently worked on a manuscript with an MSc Diagnostic Radiography student during my first post in academia (Williams, Widdowfield and Cosson, 2015). This work, which from my perspective as an author focused on the reading and coding of the interview transcripts as part of the analysis process, led me to think about the things that had happened to me as a radiographer in clinical practice and the practices of others that I had witnessed. Initial discussions with the post-graduate tutor were favourable and I met my first director of studies in January 2015 and began the PhD journey in October of that year.

As with every journey the road was not smooth and in 2017 my original director of studies left the university following a reduction in the professorial staff. This led to a period of looking for a suitable supervisor to advise on taking the project through the ethical approval process, which had begun at this point with initial discussions with the chair of the Research Ethics and Governance Committee. Fortunately, a new supervisor was found and the PhD moved into the Business School as this was where the new supervisor was located.

The journey of obtaining ethical approval and engaging with three different organisations (the university, the Health Research Authority, and the NHS trust) was itself an interesting and thought-provoking period. The differences of opinion around this study were vast and the discussions with the chairs of the ethics committees, my supervisor and I had interesting and often emotionally charged discussions, which are not necessarily unusual in terms of the ethical process (Franklin *et al.*, 2012). The outcomes and processes which were the focus of these

[37] Within this section a decision has been made to discuss these reflections using the first person, rather than the traditional third that has been predominately used across the thesis (excluding the positionality statement). This decision has been made due to personal nature of the reflective practice taking place here. This part of the thesis is drawn from my reflexive notes made during the research process.

meetings are reflected in the discussion of ethics within this thesis (Chapter 4). What perhaps surprised me most at this stage of my researcher career was that the emphasis was not necessarily on the moral and physical safety of the participants, but on the safety of personal identifiable information of the patients (i.e., it was more of a governance issue that drove the research discussions, than a fundamental ethical dilemma). This process led to a discussion with the Confidentiality Advisory Group (CAG) a group within the Health Research Authority that deal with non-consensual access to patient data for the purposes of research. My own ethical standpoint was that I was not 'collecting' any patient data but needed to be cognisant of the data I may be exposed to and to let the patients within the department know that I was there. The majority of discussions around anonymity and confidentiality focus on the data as presented within the research and not necessarily the inadvertent exposure of researchers to other information in the process of data collection (Pietilä *et al.,* 2019). The chair of the ethics committee's position was that once I had seen the patient information, I had effectively collected it, as once it was seen, I could not unsee it.

This led to discussions with the university's patient, carer and public involvement group. This is a group of current patients and service users who were consulted on the methodology of the research and how these issues could be dealt with. There was a consensus within the group that as long as the patients were informed of my name and that I was there, then there would not be an issue. They drew parallels in the session of them waiting for their prescription to be issued in the pharmacy, in terms of the potential for personal identifiable information being available for others. The overall opinion of the HRA proportionate review group was very favourable and asked only that if I did go into the X-ray room with the radiographer, I would use the same process as a student on placement would; explaining who I was and what my purpose was. On reflection, I do wonder whether this, and the subsequent poster that was the result of the patient, carer and public involvement focus group was enough to ensure that the patients were fully informed that I would be exposed to, but not collect, their data. I did not collect any information about patients, and they were not identifiable by myself during the research, and I deliberately did not look over the shoulder of participants while they were vetting requests but rather asked them to talk to me about the information they were seeing and what they were doing.

Following the collection of data in early 2019 my then second supervisor (who was acting up as my director of studies at the time) went on long term sick leave, eventually leaving the university

during the COVID-19 pandemic. This was the hiatus period of the research where it took a back seat to the pandemic, work, and eventually a new supervisory team was found in early 2023. Some authors have described the PhD journey as one of being lonely, and potentially, isolating; however, the process for me, as for others, is ultimately a rewarding one (Mesuwini, 2024). The work has reflected some of the dynamic stability outlined above, and perhaps the nature of doctoral degrees as a whole, with different directions being taken by researchers, guided by what they have found, discovered and their own personal and social circumstances (McAlpine, Castello and Pyhaltö, 2020). Over the past two years the work has further developed, as the annual monitoring and supervisory discussions influenced the analysis. The integration of noise (Kahneman, Sunstein and Sibony, 2021) has impacted upon the direction of the research and has allowed the concepts of noise and heuristics to be looked at through an Actor-Network Theory lens. This was interesting to me as these primarily psychological principles have been reinterpreted through the anthropological and sociological lens of Actor-Network Theory. This has led to a different application and understanding of these concepts. There is perhaps more work to be done around the interrogation of epistemological and ontological assumptions of heuristics and noise, which may yield some further insights from the radiographic perspective, as outlined in the discussion chapters.

My final comment is in relation to the reflexive diary, which began at the start of the journey, and outlined my initial reasons for undertaking this particular issue. The reflexive diary is an intensely private thing for me, as it contains my thought processes, my thinking about certain subjects (which are sometimes not immediately related to the work). The reflexive diary is an intensely personal thing, but I think that it should be – foregrounding the subjectivity that is inherent in all work of this nature (Olmos-Vega *et al.,* 2022). Whilst interpretations of the things of interest need to be made apparent, Actor-Network Theory's commitment to the empirical cannot be understated at this point. I found the process of removing myself from dualist stances on ontology and epistemology difficult, coming to the personal conclusion that reality is indeed singular, but that we must be clear to others about the practices that make a particular fractious part of it evident. I think that this is a key element, that what individual experience, are the results of the doings and sayings within reality (i.e., *practices*). Therefore, practices make up reality and influence the experience of it. The reading of Ann-Marie Mol's (2002) work was a pivotal moment for me in the development of this work. The notion that what we may conceive of as a single entity is in effect different where different practices are enacted. Coming from a more positivist background throughout my education and training (I have a previous

undergraduate degree in Pharmacology as well as my radiography degree) I found these concepts of ontology and epistemology initially extremely challenging and at times counterintuitive, something which is not an usual experience for students at all levels (Pascal and Brown, 2010; Lee-Johnson *et al.,* 2023). This was further complicated through the addition of fractal to the realist/relativist positions. The introduction of this third way of thinking about ontology in particular was, however, interesting to me from a practice perspective. The realisation that ontologically practice creates reality was interesting, as I had always found relativism a difficult concept as it is, effectively internalised. Therefore, the fractal/pluralist approach to ontology seemed to better fit my own empiricist leanings. We can view practices empirically, as it is what people do and say, rather than their interpretation of what happened. That does not mean that I am impervious to phenomenological approaches, just that for this particular approach it did not seem to fit.

8.6 Summary

The journey of research is never a linear event and the journey of the X-ray request through the radiography department is no less so. The dynamic stability of the actors that hold the X-ray request together has been outlined within this final chapter. Recognition of the multitude of actors that play a role in the development, maintenance, and dynamic nature of the network have been outlined. Whilst the X-ray request *may be seen* as a single entity, through Actor-Network Theory, it is possible to identify the different disparate actors that reside within it and that have the agency to change the interpretation of the request.

This research has practice implications for radiographers, both at the 'coalface' and wider in terms of how the work of radiographers should, or could, be organised. The research has revealed that the work of the radiographer that surrounds the X-ray request is influenced by not just the clinical information, but also by the influence of noise and the potential use of heuristics. This work has also highlighted the role of the radiographer under *IRMER 2017; 2024* is more nuanced and flexible than previous guidance and professional discussion give credit for. The conceptualisation of the '*proxy-referrer'* role emphasises the practices that radiographers use, or indeed create, to ensure the smooth running of the service for both patient and referrer.

The wider impact of the change in work organisation uncovered within the data analysis here should not be ignored. As previously discussed, this movement of work from the viewing area

and into the X-ray room may be having a wider impact on the manner in which knowledge, skills, and practices are shared, developed, and (re)constructed within the departments. The sharing of good practice and knowledge may indeed be being hampered through the introduction of physical environmental drivers. The environmental changes are being put into practice through the adoption of new technology, which in turn may be being driven by the increasing requirement to examine more patients (NHS England, 2024).

The further exploration of these working practices with new technologies is one of the future directions of research, as this research seeks to make its own Actor-Network Theory association with the wider aspects of radiography, as both a practice and a professional project. This research is perhaps the first step for radiography to make in moving away from trying to establish itself through the investigation of advanced practice and lean into the interconnected nature of the practices that are undertaken within the radiography department. This does not mean that radiographic research and researchers have not investigated the authorisation/justification practices of radiographers previously. However, this research has been predominately underpinned through survey and interview research. Ethnographic studies within radiography have been a relatively recent occurrence (e.g., Strudwick and Day, 2014; O'Regan *et al.*, 2019; Hayre *et al.*, 2018) and the addition of Actor-Network Theory's sensibilities will aid in the unpicking of the fundamental interconnectedness of the work undertaken and its interconnectedness to the wider radiographic evidence base. This research project is perhaps the first part of a wider journey of unravelling the intersections between the radiographer, the patients, the practices, and the wider profession.

The unpicking of radiographers' practices with the X-ray request alone has further implications for how other aspects of the radiographers' work is performed within the different environments. Through bringing in extra elements of Latour's work (such as *AIME*), boundary objects, boundary work, and the threads of practice, this has enabled the reader to see the working practices of the radiographer in a new way. The *emergent practices* that are developed to overcome challenges in the noise introduced within the network, the technological changes that have led to different and unexpected practices, and that these are built on previous practices are all new and interesting findings that influence the experiences of both the radiographer and patient.

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Appendices

Appendix A – Participant Information Sheet

Unique Study Number:

Participant Information Sheet: Radiographers and the Justification of the X-ray Request

Researcher – Mark Widdowfield

I would like to invite you to take part in this research study; before you decide please read the following information and discuss it with others if you wish. Please contact me if you have any questions, you will find my details at the bottom of this information sheet.

What is the purpose of the study?

The study aims to explore how radiographers work across professional boundaries with colleagues from other disciplines, looking in particular at how X-ray requests are justified. This entails looking at processes such as how radiographers or referrers they make these decisions, what they use to help them, what information they consult, different professional experiences of the process, etc.

This research will also be used in part fulfilment of a Doctor of Philosophy (Ph.D.) award from Teesside University.

What will happen to me if I take part?

If you contact me to participate, you will be contacted to organise a time to go through the research (if you wish) and to sign your consent form for the observation part if you want to participate. This is also an opportunity to ask any questions that you might have about the research. We would not anticipate this to last longer than 10-15 minutes (30 minutes maximum).

The actual research has two phases. On observation phase and an interview phase.

Observation Phase

I will observe you working during your shifts. I will not be 'on your shoulder' during your interaction with patients (i.e. they will never enter the X-ray room, never see the X-ray request, and never see the patients radiograph) but will be within the viewing area of the department. I will make notes on your interactions with the environment, healthcare professionals, and the X-ray request.

The interest lies not with 'who said what' but with the general issues raised and how these situations are handled. This period will last for approximately 2 weeks (maximum) depending on your shift patterns. I would like to observe your whole shifts over this two-week period. You are also asked during this phase that you do not use any patient identifiable information in front of me.

Interview Phase

You will then be invited to an interview and you will sign another consent form for this. The interview will take approximately 60 minutes and will take place within the hospital at a time

convenient to you (this can be either before or after a shift). These interviews will not take place in the department, so as to keep your involvement in the research confidential. The questions will be open ended, allowing you to expand on any points that you see fit. The interview will be audio recorded. This audio file will be kept on a secure server within the university whilst it is being transcribed (see below for more information). Once transcribed it will be deleted from the secure server.

Why am I being invited to take part?

You are a radiographer working within general X-ray who regularly justifies requests for X-ray examination according to IR(ME)R 2017 and your local protocol.

Do I have to take part?

No. It is up to you. If you do take part, you can change your mind at any time until we began to analyse the data. This will be 2 weeks following your interview. You can do this by contacting me and stating your Unique Study number that will be written on the top of this document prior to the observation period beginning. We would then destroy the data collected from you and remove you from the study. You don't have to tell us why you have decided not to take part (or withdraw) but if you do that would help us to understand the choices people made.

If you are interested in taking part, please contact me (Mark Widdowfield: details below) with your contact and availability details. I will contact you to arrange a time for you to meet at the hospital and go through the consent process prior to observing you in the department (i.e. before you start your shift).

Mark Widdowfield: m.widdowfield@tees.ac.uk or Tel: 01642 384931

What are the possible disadvantages or advantages and benefits of taking part?

We don't think there are any advantages for you. You may feel embarrassed if you decide to discuss an incident that happened to you, but you do not have to share any information that you do not feel comfortable to do so.

Confidentiality will be maintained by the use of the unique code number that you will be given. However, an exception to this will be if you reveal any information on poor or dangerous clinical practice. Should any abusive or unprofessional behaviours or actions be disclosed and/or discovered then confidentiality will be breached by the researcher and the PhD supervisor will be informed (in the first instance) and if deemed appropriate further action may be taken.

What will happen to the information collected about me?

All data will be stored securely at Teesside University for the duration of the research; once the interview is transcribed no personal information (demographics for example) will be kept. During transcription, your Unique Study Number will link you with the information connected until the two weeks following your interview. After the two weeks, the document linking your Unique Study Number (given to you when you consent to take part) to your interview data will be deleted and your transcribed interview data will be stored anonymously. All findings will be reported using a pseudonym.

It is anticipated that the research will be published in an academic journal and quotes may be published from the interview, using these pseudonyms.

If you wish, your name and email address will be kept in a separate file so that the researcher can inform you of the study's findings, if you would like this information. The document containing your email address will be deleted when the study reaches conclusion, no later than October 2022.

Who has approved this study?

Before any research goes ahead it has to be checked by a Research Ethics Committee. They make sure that the research is fair. This project was approved by Health Regulatory Authority Research Ethics Committee and a Research Ethics Committee at Teesside University.

Who is organising this study?

This study is organised by the Teesside Business School at Teesside University.

Who can I contact for more information?

If you would like to take part in the research or have any questions, please contact:

Mark Widdowfield

Room H1.19, Centuria Building

Teesside University,

Middlesbrough,

TS1 3BA, UK

Tel: 01642 384931

Email: m.widdowfield@tees.ac.uk

The Chief Investigator for this study is:

Chief Investigator

Dr Malgorzata Ciesielska

Tel: 01642218121

Email: M.Ciesielska@tees.ac.uk

Thank you for reading this information sheet and for considering whether to take part in the study.

Appendix B – Participant Consent Forms

B1 – Observation Consent Form

Radiographers and the Justification of the X-ray Request **– Observation Consent Form**

Name of researcher: Mark Widdowfield

Please put your initials in the boxes to indicate your agreement with the corresponding statements.

1. I have read and understood the information sheet (appendix C1) for the above study and have had the opportunity to ask questions. ☐
2. I consent to the researcher being present during my work. ☐
3. I consent for the researcher to make field notes regarding my activities during the observation period. ☐
4. I will ask the researcher to leave the viewing area if I am required to discuss patients using their identifiable information. ☐
5. I know that I have the right to withdraw at any time up to 2 weeks following my interview without giving reasons and without any of my rights being affected and all data will be deleted. ☐
6. I understand that my field notes will be kept until the end of the study in an anonymised form. ☐
7. I understand that my data will not have my name or anything identifiable in it but will be linked to me by a Unique Study Number which will be stored separately from the data and deleted two weeks following my interview or my withdrawal from the study. ☐
8. I wish my name and email address to be kept by the researcher to inform me of the findings of the study and understand that this information may be kept until October 2022. ☐
9. I agree to take part in this study. ☐

---	---	---
Name of Participant	Date	Signature
---	---	---
Name of Researcher	Date	Signature

B2 – Interview Consent Form

Radiographers and the Justification of the X-ray Request **– Interview Consent Form**

Name of researcher: Mark Widdowfield

Please put your initials in the boxes to indicate your agreement with the corresponding statements.

1. I have read and understood the information sheet for the above study and have had the opportunity to ask questions. ☐

2. I consent to the interview being audio recorded. ☐

3. I know that I have the right to withdraw at any time up to 2 weeks following my interview without giving reasons and without any of my rights being affected and all data will be deleted. ☐

4. I understand that my field notes and interview transcript will be kept until the end of the study in an anonymised form. ☐

5. I understand that my data will not have my name or anything identifiable in it but will be linked to me by a Unique Study Number which will be stored separately from the data and deleted two weeks following my interview. ☐

6. I wish my name and email address to be kept by the researcher to inform me of the findings of the study and understand that this information may be kept until October 2022. ☐

7. I agree to take part in this study. ☐

| --- | --- | --- |
| Name of Participant | Date | Signature |

| --- | --- | --- |
| Name of Researcher | Date | Signature |

Appendix C – Interview Guide

Introduction to the researchers from the participant. Discuss confidentiality, they should not mention anyone by name, and if they do, this will be redacted from the interview transcript.

Double check consent and that the participants are happy to proceed.

(Please note: the final question (6) is intended to elicit a concluding remark and identify what the participant thinks is important.)

1. Tell me about your experiences, in general regarding the justification of X-ray requests.
   - First time experiences
   - Student days
   - Stand out experiences
   - General issues

2. Could you describe your thought processes using a real example if you want, when you receive a request that is incomplete or challenging?
   - Tell me your initial thoughts
   - When do you consider asking for help?
   - How do you think…?

3. What are your initial feelings when you receive an X-ray request that may require further investigation?
   - Why do you think you have this reaction?
   - What resources do you use?
   - How do you use them?

4. How did/do you come to a decision?
   - What do you use (either 'real' or abstract)
   - How do you use it?
   - Can you explain to me your thoughts here?

5. Are there any external factors that you think influence the decisions that you make?
   - Anything outside the department over which you have little or no control?

6. What advice would you give a newly qualified radiographer about justification of an X-ray request?
   - Why?
   - What do you feel is important?
   - What has changed since qualifying?

- What do you think is different now?

Appendix D – Ethical Approvals

D1 – Permission to Conduct the Study

To: Widdowfield, Mark <M.Widdowfield@tees.ac.uk>
Cc:
Subject: (220124) Radiographers and the Justification of the X-ray Request - X NHS Foundation Trust Notification of Capacity and Capability Confirmation

SENT ON BEHALF OF X, R&D MANAGER

Dear Mark

RE: IRAS 220124
Confirmation of Capacity and Capability at South Tyneside NHS Foundation Trust

Full Study Title: Interprofessional working in radiology: radiographers, referrers and the X-ray request

This email confirms that X NHS Foundation Trust has the capacity and capability to deliver the above referenced study.

Please find attached our agreed Statement of Activities as confirmation.

We agree to start this study on a date to be agreed when the sponsor gives the green light to begin.

Could we please ask that you use X NHS Foundation Trust ODS code - xxxxx, for all recruitment mapping purposes in LPMS.

Please Note:
The first approach to all potential study participants must be facilitated by the Trust Local Collaborator, X (HP Lead). Can I also bring to your attention, that until you are in receipt of either a Trust Honorary Research Contract or a Letter of Access, you will unable to commence any research activities within the Trust.

If you wish to discuss further, please do not hesitate to contact me.

Kind regards
X
Research Governance Facilitator| X NHS Foundation Trust
Tel: x Ext. X | Email: x
Web: X
Main office: X
Please note my working days are Tuesday, Wednesday a.m., and Thursday

Part of X

IMPORTANT NOTICE: This email and any attachments are intended solely for the use of the intended recipient and may contain privileged and confidential information. If you are not the intended recipient, you are hereby notified that any distribution or copying is strictly prohibited. If you receive this e-mail in error, please notify us as soon as possible and destroy the document. Any views or opinions expressed are solely those of the author and do not necessarily represent those of X NHS Foundation Trusts.

D2 – Letter of Access

COPY

NHS

NHS Foundation Trust

Hospital

Our ref:
Please reply to:
Direct Dial:
Email:

7 January 2019

L

Private and Confidential
Mr Mark Widdowfield

Tel:
Fax:
Tel. from outside UK only:

Dear Mark
Letter of Access for Research - Inter-professional working in Radiology: Radiographers, Referrers and the X-ray request

This letter confirms your right of access to conduct research in xxxxxxxxxx NHS Foundation Trust for the purpose and on the terms and conditions set out below. This right of access commenced on 3 January 2019 and ends on 31 May 2019 unless terminated earlier in accordance with the clauses below.

You have a right of access to conduct such research as confirmed in writing in the letter of permission for research from this NHS organisation. **Please note that you cannot start the research until the Principal Investigator for the research project has received a letter from the R & D Department giving permission to conduct the project.**

The information supplied about your role in research within xxxxxxxxxxx NHS Foundation Trust has been reviewed and you do not require an honorary research contract with this NHS organisation. We are satisfied that such pre-engagement checks as we consider necessary have been carried out.

You are considered to be a legal visitor in xxxxxxxxxxx NHS Foundation Trust premises. You are not entitled to any form of payment or access to other benefits provided by this NHS organisation to employees and this letter does not give rise to any other relationship between you and this NHS organisation, in particular that of an employee.

While undertaking research within xxxxxxxxxxx NHS Foundation Trust, you will remain accountable to your employer **Teesside University** but you are required to follow the reasonable instructions of the Research Lead in this NHS organisation or those given on her/his behalf in relation to the terms of this right of access.

Where any third party claim is made, whether or not legal proceedings are issued, arising out of or in connection with your right of access, you are required to co-operate fully with any investigation by this NHS organisation in connection with any such claim and to give all such assistance as may reasonably be required regarding the conduct of any legal proceedings.

You must act in accordance with xxxxxxxxxxx NHS Foundation Trust policies and procedures, which are available to you upon request, and the Research Governance Framework.

You are required to co-operate with xxxxxxxxxxxx NHS Foundation Trust in discharging its duties under the Health and Safety at Work etc. Act 1974 and other health and safety legislation and to take reasonable care for the health and safety of yourself and others while on xxxxxxxxxxxx NHS Foundation Trust

Providing a range of NHS services across X.

premises. You must observe the same standards of care and propriety in dealing with patients, staff, visitors, equipment and premises as is expected of any other contract holder and you must act appropriately, responsibly and professionally at all times.

If you have a physical or mental health condition or disability which may affect your research role and which might require special adjustments to your role, if you have not already done so, you must notify your employer and the Trust (R&D Team, R&D Team, xxxxxxxxxx NHS Foundation Trust, Room xxxx) prior to commencing your research role at the Trust.

You are required to ensure that all information regarding patients or staff remains secure and *strictly confidential* at all times. You must ensure that you understand and comply with the requirements of the NHS Confidentiality Code of Practice (http://www.dh.gov.uk/assetRoot/04/06/92/54/04069254.pdf) and the Data Protection Act 1998. Furthermore you should be aware that under the Act, unauthorised disclosure of information is an offence and such disclosures may lead to prosecution.

You should ensure that, where you are issued with an identity or security card, a bleep number, email or library account, keys or protective clothing, these are returned upon termination of this arrangement. Please also ensure that while on the premises you wear your ID badge at all times, or are able to prove your identity if challenged. Please note that this NHS organisation accepts no responsibility for damage to or loss of personal property.

We may terminate your right to attend at any time either by giving seven days' written notice to you or immediately without any notice if you are in breach of any of the terms or conditions described in this letter or if you commit any act that we reasonably consider to amount to serious misconduct or to be disruptive and/or prejudicial to the interests and/or business of this NHS organisation or if you are convicted of any criminal offence. You must not undertake regulated activity if you are barred from such work. If you are barred from working with adults or children this letter of access is immediately terminated. Your employer will immediately withdraw you from undertaking this or any other regulated activity and you MUST stop undertaking any regulated activity immediately.

Your substantive employer is responsible for your conduct during this research project and may in the circumstances described above instigate disciplinary action against you.

xxxxxxxxxx NHS Foundation Trust **will not indemnify** you against any liability incurred as a result of any breach of confidentiality or breach of the Data Protection Act 1998. Any breach of the Data Protection Act 1998 may result in legal action against you and/or your substantive employer.

If your current role or involvement in research changes, or any of the information provided in your Research Passport changes, you must inform your employer through their normal procedures. You must also inform your nominated manager in this NHS organisation.

Yours sincerely

X
Divisional Human Resources Manager

cc X Research Governance Facilitator,
HR Department, Teesside University

D3 – IRAS Approval

	Submission	Status	Date Created			
▼	IRAS Form 220124/1255622/37/633	2000 REC Decision Made - Favourable Opinion	03.10.2018 15:27	Print as PDF	Save as XML	Documents

Organisation Name	Event Date	Event Description
Application to conduct research in NHS/HSC (incl. Ethical Review when required)	25.10.2018 13:57	Submission status: **2020 Approval Outcome** Description: *Approved*
Application to conduct research in NHS/HSC (incl. Ethical Review when required)	05.10.2018 15:23	Submission status: **2000 REC Decision Made - Favourable Opinion** Description: *Decision Made - Favourable Opinion*
Application to conduct research in NHS/HSC (incl. Ethical Review when required)	03.10.2018 15:27	Submission status: **2100 Resubmission Received** Description: *Your resubmission has been received. Your initial submission has been made valid is awaiting a decision.*
Application to conduct research in NHS/HSC (incl. Ethical Review when required)	03.10.2018 15:27	Submission status: **1000(RF) Submission Pending** Description: *Submission created.*

▶	IRAS Form 220124/1241859/37/367	2501 Document Submissions Enabled	22.08.2018 12:57	Print as PDF	Save as XML	Documents
▶	IRAS Form 220124/1236832/37/778	2500 Submission Allowed	07.08.2018 14:54	Print as PDF	Save as XML	Documents

D4 – Teesside University Ethical Approval

From:

Sent: 18 January 2019 20:49

To: Widdowfield, Mark <M.Widdowfield@tees.ac.uk>;

Cc:

Subject: Re: Application Ref: SSSBLEC169

Hello,

That's great, happy to approve this now.

X, I would be very grateful if the system could be updated to reflect the approved decision and this email chain and attachment added to the original application - many thanks!!

All the best,

X

From: Widdowfield, Mark

Sent: 15 January 2019 07:23:55

To:

Cc:

Subject: RE: Application Ref: SSSBLEC169

Hi

As part of the approval process for my study, the following condition was stated.

Conditions of approval:

APPROVED SUBJECT TO CONDITIONS:

- Requires honorary contract and confidentiality agreement

I have attached above a 'Letter of Access' from the trust and an email trail below, in which they state that an honorary contract is not required. Also as X has since left the university, I have included X as my current Director of Studies.

If you need anything else please let me know.

Cheers, Mark

Appendix E – Information Poster for Patients

Research in your X-ray Department: Radiographers and the Justification of the X-ray Request

What type of research?

There is currently a research project underway within the X-ray department.

It is looking at the way in which radiographers work with other staff.

It is being undertaken by Mark Widdowfield, a PhD student at Teesside University. He has an honorary contract with the trust and has signed a confidentially agreement.

Other Information

This study is being undertaken by a PhD student of Teesside University and is fully supported by the department and the trust. Ethical Approval has been granted by Teesside University and the local Health Regulatory Authority ethical committee.

Will it effect me?

The research will not effect you directly. You will not see the researcher, as they are within the viewing area of the department. This study will not affect your examination time, your results or the time you spend within the department.

Steps have been taken to minimise the researcher being able to identify you personally. This has been performed through where the researcher is in the department. This stops them from seeing personal identifiable information and seeing you during your exam.

The researcher may however, overhear conversations regarding your care. It is not possible to identify any person in particular prior to these discussions happening.

What if I have concerns?

If you would like the researcher to leave the department for your time here, please let either the receptionist or your radiographer know. The researcher will then leave the department. You will not be able to be identified by the researcher.

If you would like to know more about the research, please contact either the researcher (ask to speak to Mark Widdowfield) or the Chief Investigator for the study who is Dr Gosia Ciesielska at Teesside University whose contact details are below.

Dr. Gosia Ciesielska
Email: M.Ciesielska@tees.ac.uk
Tel: 01642 218121