Towards a Human Capabilities Ontology in Enterprise Architecture

by

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A THESIS

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I declare that the above thesis is the outcome of my own work, research, and investigation. All sources that have contributed to this research or that I have utilized and quoted have been clearly indicated and acknowledged by using complete references. I also declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.

_____ _____

Signature **Date**

Abstract

This thesis aims at understanding and formalising human capabilities in enterprise architecture (EA). It begins by justifying why it is important for EA research and practice to consider human capabilities, and then proceeds to construct a computational ontology that defines human capability concepts and relationships in the EA domain. The research is motivated by the need to mainstream humans and their capability concerns into EA research and practice by creating mechanisms that would allow EA to function in an environment where the demand for equity, justice, sustainability, and progressive ideals is high.

This research is in response to a call for more research from a holistic perspective of EA that takes into account shifting economic, environmental, and human conditions. Based on Amartya Sen's human capabilities approach (HCA), which asserts that the true value of any developmental initiative lies in its potential and outcome to promote human capabilities, this research seeks to answer questions like what roles do or could human capabilities play in EA, what human capabilities should EA practices account for, and whether or not a human capabilities ontology can support EA practice.

Within a design science research (DSR) approach, literature review, thematic analysis, framework synthesis, and ontology modelling are deployed to create the ontology artefact. A panel of experts from banking and finance, as well as higher education, were engaged to validate the ontology. The surveyed experts agreed that the ontology adequately reflects key human capability concepts and relationships pertinent to EA. They also acknowledged that the concepts are valid for a diverse user group.

In addition to contributing to the paucity of literature at the interface of EA and human capabilities, this research promotes human capabilities-conscious EA practices. Both theoretical and practical applications of EA and the HCA stand to benefit from the ontology. By supporting a shared understanding of human capabilities in the EA domain, the ontology might enable enterprises and their stakeholders to develop a common vision for a sustainable future.

Keywords: banking and finance; design science research (DSR); enterprise architecture (EA); higher education; human capabilities approach (HCA); ontology; sociotechnical system; stakeholder; thematic analysis

Dedication

To

Tsige Gebresillassie, Abebe Kassa, Wondimeneh Abebe, and Kelewework Woldetsadik.

Your prayers, my linchpin.

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Ermias Abebe Kassa

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Epigraph

As often as you wish to know what is to be avoided or what is to be sought, consider its relation to the Supreme Good, to the purpose of your whole life. For whatever we do ought to be in harmony with this; no man can set in order the details unless he has already set before himself the chief purpose of his life. The artist may have his colours all prepared, but he cannot produce a likeness unless he has already made up his mind what he wishes to paint. The reason we make mistakes is because we all consider the parts of life, but never life as a whole.

— Seneca, *Moral Letters to Lucilius*

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List of Abbreviations

Abbreviation	Full Form
AEF	Alternative Evaluation Framework
CQ	Competency Question
CSD	Capability-sensitive Design
CSR	Corporate Social Responsibility
CuD	Cultural (capability) Dimension
DP	Design Principle
DSR	Design Science Research
EA	Enterprise Architecture
EcD	Economic (capability) Dimension
EO	Edinburgh Enterprise Ontology
ESS	Ecosystem Services
(H)CA	(Human) Capabilities Approach
HEI	Higher Education Institution
HRC	Human Relations Capabilities
HuCEAOn	Human Capabilities in Enterprise Architecture Ontology
ICT4D	Information and Communication Technology for Development
InD	Informational (capability) Dimension
OBO	Open Biomedical Ontology
OOPs!	Ontology Pitfall Scanner
OWL	Web Ontology Language
PhC	Physical Capabilities
PM	Process Model
PoD	Political (capability) Dimension
PsD	Psychological (capability) Dimension
PWD	People with Disabilities
RDF(S)	Resource Description Framework (Schema)
SDG	Sustainability Development Goals
SoD	Social (capability) Dimension
SPC	Social/Political Capabilities
StC	Self-transcendence and Meaning Capabilities
TOGAF	The Open Group Architectural Framework
UN	United Nations
UNSDG	United Nations Development Goals (Ontology)
UPON	Unified Process Ontology
VSD	Value-sensitive Design

Publications from the Dissertation

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1. Introduction

This thesis introduces the concept of human capabilities into enterprise architecture (EA) and proposes a novel ontology of human capabilities apposite to the domain. The ontology and its foundational framework capture essential concepts, definitions, and relationships of human capabilities that need to be considered in EA research and practice. The aim of the ontology is to serve as a knowledge base for EA practitioners and a springboard for researchers to conduct further investigations.

In this chapter, I provide a brief introduction to the thesis, concentrating first on the motivation and problems that arise from the purely technical focus of traditional EA practice and the critical necessity to account for the human component. That is followed by a description of the objectives, central questions, and justifications for the research undertaking. The outline of the research design is then given, accompanied by a presentation of the thesis layout.

1.1. Background

An *enterprise* is defined as a consciously constructed sociotechnical system composed of people, material, technology, information, and knowledge that interact to attain a common mission (Hoogervorst, 2009; G. R. Jones, 2013). The social and technical elements that make up the enterprise are in continuous interaction between themselves and with the environment in the performance of the enterprise's essential functions to achieve stakeholder goals (Daft, 2007; Giachetti, 2010).

Minoli (2008) extends the definition to include organizations that are tied by a shared goal as in, for example, a company and its supplier, two or more government departments, or different agencies of a government or governments crossing boundaries. Minoli's (2008) *extended enterprise*, which binds the organization with its external stakeholders like customers and suppliers, is in line with this understanding of the enterprise. Hence, the enterprise can be commercial enterprise or company in pursuit of profit for its owners, a local or national government setup to serve the citizenry, a not-for-profit organization working to serve humanity or the natural environment, a supply chain arranged by two or more enterprises to coordinate the production and delivery of products and services, or a virtual organization that may only have a temporary existence to tackle a challenge or exploit an opportunity (Giachetti, 2010).

One can argue that organizations are instrumental in implementing policies and as such serve the purpose of development in every aspect of a society. They are essentially the facilitators of human endeavour and instruments of innovation created with the goal of achieving higher levels of efficiency and effectiveness (Daft, 2007; Farazmand, 2002). Enterprises sustain, promote, and change the social, economic, and political life of the societies they operate in.

Hence, enterprises have to negotiate their current and future environment in search of the optimal position they need to hold with respect to social, economic, political, environmental, and other issues (Giachetti, 2010). Particularly, in this day and age, enterprises need to cope with the fast-changing world, dynamically adjusting and aligning their strategies. EA comes into scene with the demand for such a dynamic grand strategy (Gorkhali & Xu, 2017; Hoogervorst, 2009).

EA is the blueprint that drives business and information technology decisions in an organisation or organisations that share the same or similar vision and mission (Jonkers et al., 2006; Saint-Louis et al., 2017). The oft-cited definition by the *ISO/IEC/IEEE 42010-2011* standard described *architecture* as the fundamental organisation of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution.

Architecting involves understanding the current enterprise in the context of the ever-changing ecosystem within which it operates, creating a holistic vision of the future, generating and evaluating alternatives, and selecting a future architecture to realize the envisioned future (Kang et al., 2010). EA uses accepted enterprise design and governance principles to create an optimal link between the organisation, technology, and the environment in both current and possible future states (Jonkers et al., 2006; Lapalme et al., 2016). Architecting culminates in an implementation plan that accounts for available resources and a time horizon for completing the transformation (Lankhorst, 2017; Saint-Louis et al., 2017).

The fundamental role of EA is to align the organisation's mission, vision, goals, and strategy with its data, application, and technological infrastructure (Ballangee, 2010; Kotusev, 2016; Shanks et al., 2018). According to Hewitt (2019), by planning and implementing EA, the enterprise architect helps contain entropy that naturally dissipates through the organization. The architect archives this by stating a rallying vision, a writing a roadmap that leads to the vision, garnering support for that vision through communication of guidelines and standards; and creating clarity with respect to the effectiveness and efficiency goals.

Internally, the role of EA is to integrate operations and to elevate the quality of deliverables while allowing for innovation. On the other hand, its external role is to respond to competitor challenges, governmental directives, and societal expectations (Jonkers et al., 2006). EA also serves as a platform for stakeholder collaboration and communication, helping capture and represent stakeholder expectations (Chen et al., 2008).

By playing those internal and external roles, EA contributes towards construction of systems that interface seamlessly with one another and that are resilient to internal and external changes in the foreseeable future (Nuryatno & Dobson, 2015). Thus, EA necessitates not only a

thorough understanding of the present but also the ability to predict the future. That is why EA is often equated with strategic thinking (de Vries & van Rensburg, 2009).

1.2. Problem Definition

Since its inception, EA has undergone numerous transformations, later iterations expanding on and subsuming prior conceptions and practices. In its formative years, EA's main preoccupation was how to architect technology to achieve increased productivity and profitability in the work place (Lapalme, 2012). As it progressed, EA shifted its focus to enterprise integration or translation of strategy to action (Lapalme, 2012). In its current incarnation, EA is conceptualized as a means for enterprise innovation, agility, and sustainability (Hoogervorst, 2004; Lapalme, 2012; Villarreal, 2013) and research interests incline towards integration, standardisation, and elaboration of its non-technical and theoretical foundations (Panetto et al., 2016; Romero & Vernadat, 2016a, 2016b; D. Simon et al., 2013).

Several researchers have emphasised the importance of approaching EA from multiple perspectives (Bernus et al., 2016; Lapalme et al., 2016; Panetto et al., 2016). For instance, Lapalme et al. (2016), in a more extensive treatment of EA prospects, emphasised the need for a holistic analysis of EA that considers changing economic, environmental, and human conditions. They argued that since the modern enterprise operates in the most complex organisational environment – the *turbulent field* – its exclusive actions are not sufficient to withstand any pushback from the environment (F. Emery & Trist, 1965). They concluded that an enterprise must thus be conscious of the consequences of its actions on humans, society, and the environment it operates in (Hatch, 2011).

Although the focus of EA has shifted from technology to organisational concerns, it is still more commonly identified with information technology than with business (Op 't Land et al., 2009; D. Simon et al., 2013). The implication, as noted by Kloeckner and Birkmeier (2010), is that the human element still receives minimal attention in enterprise architecting.

Even where the organisational concern is visible, enterprises tend to prioritize shareholder interests over those of other stakeholders (Hoogervorst, 2017). In fact, stakeholders such as employees, customers, and others have been instrumentalised to the point where they are viewed as extensions of technical tools used to achieve economic benefits for the organisation (Hatch, 2011).

Korhonen et al. (2016) labelled the widespread failure of enterprises to care about humans and the planet as a "maladaptation of superficiality" (p. 275). This form of maladaptation occurs, for example, when organisations design EA for short-term economic gains

while paying little to no attention to long-term human and ecological sustainability. The manifestations of maladaptation may include exploitation and diminished individual agency.

Consequently, several researchers pointed in the direction of centralising the human element in organizational research and practice. For instance, R. A. Buchholz & Rosenthal (2002) emphasised the need for a holistic understanding of the human element in its intractable relationship with value-laden sociotechnical elements of the organization. In a similar vein, Hoogervorst (2017) emphasised the need for a shift in the conceptualisation of enterprise design towards "the humanization of enterprises and the affordance of meaningful work" (p. 44). Korhonen et al. (2016), on their part, argued that active ecological adaptation must be sought to afford people to pursue well-being, human growth, and social development in these turbulent times.

Therefore, there is an urgent need to mainstream humans and their capability concerns, their *beings* and *doings*, into EA research and practice (Burger & Christen, 2011). Developing mechanisms that would allow EA to operate in a setting where there is a strong need for well-being, justice, sustainability, and moral values is an important challenge (Bernus et al., 2016; Lapalme et al., 2016).

In this regard, there have been several attempts in recent years to bring human values and morality into the design of technology. Brey (2015) catalogued four major approaches and several research outputs that target technology design and its implications for human *well-being* (human conception of the good), concluding that all the design approaches confirmed the premises that it is possible to design for well-being and technological artefacts are capable of promoting or enhancing human well-being.

Of the four approaches Brey (2015) covered, I set out to investigate the potential of the human capabilities approach (HCA) for application in EA design and evaluation (Oosterlaken, 2012b, 2013; Sen, 1999). The HCA rests on the assumption that people's ability to achieve and promote well-being depends on a number of basic capabilities that allow them to engage in activities that advance their well-being and welfare (Nussbaum, 2000; Robeyns, 2006; Sen, 1993). It contends that providing resources alone is not enough since individuals have different abilities to convert resources into valuable beings and doings. Their capabilities are tempered by individual as well as social and environmental conversion factors (Alkire, 2007; Sen, 1993).

In this research, I propose that EA must go beyond providing technological affordances to incorporate human value within, and whenever possible, in the face of personal and environmental constraints. The proposal can be translated into a large research program that could investigate the process and product aspects of human capability concerns in EA. However, within the confines of this academic research, developing a preliminary conceptual framework

and ontological representation is prioritized, in addition to introducing the concept of human values and capabilities into EA practice.

1.3. Objective and Research Question

This research is aimed at *exploring*, *describing*, *framing* and *formalising* human capabilities in EA planning and evaluation. It begins by providing evidence from the extant literature to substantiate the propositions (**P**) that:

- **P-1.** EAs are patterns of sociotechnical systems.
- **P-2.** EAs have the objective of promoting the values of all stakeholders.
- **P-3.** Sustainability is a critical criterion in EA design.
- **P-4.** Promoting human capabilities is an ideal that EA should promote.

These claims constitute the culmination of a chain of evidence-based reasoning beginning with the justification for the existence of the enterprise. They collectively show that the goal of EA is to promote human capability, and hence EA design should be aimed at enhancing human values for a good life.

The four propositions then set the stage for the fifth premise, which is

- **P-5.** There is a need for a common terminology to promote human capabilities in EA practice.

These five propositions, taken together, constitute the foundation for the computational ontology I propose. According to Kang et al. (2010), the absence of a common ontology prevented humans and systems from having a shared understanding of EA. This lack of common ontology effectively denies enterprises and other stakeholders from developing a common vision for a sustainable future.

Thus, the objective of this research is to first justify the role of human capabilities in EA and then to develop a human capabilities conceptual framework and ontology for the domain based on relevant concepts, theories, models, and practices. The motive is to inspire EA research and application that consider human capabilities.

The premise that EA stakeholders—primarily customers and employees— are only engaged as instruments to accomplish certain objectives of the promoters of enterprise systems is what spurred this objective. The contemporary thinking that accounts for the choices of all stakeholders as part of satisfying corporate social sustainability (CSR) goals justifies this research endeavour (Amini & Bienstock, 2014; Blackburn, 2015). The study builds on the EA and corporate governance thinking that the modern stakeholder is someone who works not only to

attain corporate objectives, but also their own personal objectives (FirstPost, 2009; J. Morgan, 2014).

With the stated primary objective in mind, the research aims to answer the following core research question (**RQ**) and accompanying sub-questions (**SQ**).

RQ. How can we model a human capabilities ontology that would support EA practice?

SQ-1. What roles do human capabilities play in EA?

SQ-2. What human capabilities should EA practices account for?

SQ-3. How can we support EA practice by designing a human capabilities ontology?

SQ-4. To what degree is the designed human capabilities ontology usable and useful for enterprise architects and information systems practitioners?

While SQ-1 provides justificatory knowledge to establish the research on a firm pedestal, SQ-2-4 partially address the *epistemological* and *scope problems* of design for well-being (Brey, 2015; Van de Poel, 2012). The epistemological problem is concerned with what conception of well-being to design for and how to determine this (Van de Poel, 2012). In contrast, the question of how to delineate the people whose well-being shall be taken into account and the potential effects on well-being are addressed by the scope problem (Van de Poel, 2012).

One of the technical challenges raised by Kloeckner & Birkmeier (2010) in incorporating the human dimension into EA is how to capture and implement capabilities that are not reflected in the formal roles of the stakeholders in the organisation. This question could be answered provisionally using the arguments of Dietz (2006), Hoogervorst (2017), and Korhonen et al. (2016). The modern organisation must be adaptive since it operates in a turbulent and complex environment (Dietz, 2006; Korhonen et al., 2016). Dietz (2006) and Hoogervorst (2017) posited that a conceptual or ontological model that is coherent, comprehensive, consistent, and concise is required to manage this complexity. However, one can only hope to meet these ambitious and dynamic goals through successive iterations. Korhonen et al. (2016) supported the agile iterative notion by rejecting upfront, detailed, complex, documentation-centric, and prescriptive EA designs. Therefore, the plan should be to design for dynamism (Dietz, 2006).

Another challenge in using the HCA for design is human diversity. Humans value different things at different times and the set of valuable capabilities may vary from one person to the next. However, I subscribe to the belief that there exist a basic set of capabilities universal to all (Austin, 2020; Nussbaum, 2000). It would thus be interesting to account for these universal values and provide a taxonomy as well as conceptual relationships for use by practitioners and researchers.

This research proposes the use of dynamic ontologies to capture the ever-changing and diverse human capabilities in enterprises. Ontologies facilitate the creation and use of a dynamic capabilities compendium, which may help chart the evolution of human capabilities over time. It is hoped that the development of such a human capabilities ontology will help future efforts in researching, planning, implementing, evaluating, and documenting EAs (Alkire, 2008).

1.4. Ontologies in Enterprise Architecture

An ontology, in the specialized sense used in knowledge management, is "the explicitly articulated and shared concepts of a knowledge community or domain " (Buchholz, 2006, p. 694). As Gruber (1993) indicated, every knowledge base is founded on an abstract conceptualization of a domain of interest. It is this conceptualization that ontologies formally and explicitly articulate. Ontologies are then used by people, databases, and applications to share domain information. Thus, ontologies define *domain conceptualizations* which are *formal*, *explicit*, and *shared* (Gruber, 1993; Hadzic et al., 2009).

In the computing disciplines, ontology refers to the *representational primitives* – the terms and properties used to define a concept, and the relationships among the terms which are employed to model a domain of interest (Gruber, 2009; Raad & Cruz, 2015). Ontologies may mean glossaries, taxonomies, database schemas, data models, data dictionaries, or axiomatic formalizations (Lehmann & Voelker, 2014; Raad & Cruz, 2015). Regardless of the detailedness or formalism introduced, ontologies are built based on consensus made between domain experts with regards to the objectives and level of conceptual representation required using conventional, standard representation language.

The information explosion observed in all knowledge areas in the last three decades prompted the use of ontologies as technologies of the semantic web (Milton, 2008). Ontologies have found applications in diverse fields as medicine, finance, engineering, law and business, as well as in specific tasks such as information retrieval, annotation and automatic indexing of digital documents, knowledge management, and artificial intelligence applications (Slimani, 2015; Tudorache, 2020).

Ontologies are central to EA practice (Bailey, 2007; Kang et al., 2010). First and foremost, ontologies explicate a shared understanding of a knowledge domain (Tudorache, 2020). Kang et al. (2010) indicated that ontologies help in forming a shared understanding of EA concepts, components and relationships, which enables integration and collaborating with other enterprises. People as well as software agents share the domain knowledge to answer questions, interoperate with other systems, and reuse knowledge bases (Gruber, 2009; Lehmann & Voelker, 2014).

Secondly, ontologies could function either as a component of a bigger IT system or as a generic structure of knowledge organisation (Milton, 2008). While an ontology generally may serve as a foundation for a knowledge model or knowledge base, it may also have a more specific function of integrating, filtering, and presenting information as a component part of a bigger system (Milton, 2008). This ontological function becomes increasingly obvious in the implementation layer.

Additionally, ontologies help in validating conceptual models of the real world supporting the design phases of EA (Shanks et al., 2003). A realistic representation of EA views is possible through ontologies and the fact that the ontological representation is computable means that analysis of the consistency and completeness of the EA models is possible (Bailey, 2007; Holt & Perry, 2010).

Importantly, ontologies aid in the adoption and adherence to principles, rules, and regulations. Leenheer (2009) contended that ontologies can become the embodiment of principles, rules, and regulations allowing for an easier regulatory certification process of the systems they are part of. According to Leenheer (2009), such ontologies enable both the codification of law and the compliance of computer applications with a wide array of such laws and principles. This aspect of ontologies can be viewed as encompassing human principles and values that, similar to laws and regulations, constrain EA design.

1.5. Outline of the Research Design and Thesis layout

The design science research (DSR) approach is used as a scaffolding for this multi-method study. To establish the research setting, I first employed a blend of concept analysis and systematic-like literature review of the EA domain. This is followed by the development of a conceptual framework by thoroughly examining and synthesising various HCA operationalisations. The ontology is then developed using the conceptual framework and populated through a thematic analysis of organizational documents and the academic literature. Finally, the ontology is evaluated using an online verification tool, and experts assessed its utility and usability. The ontology's generalisability is projected through case studies and descriptions of potential application scenarios.

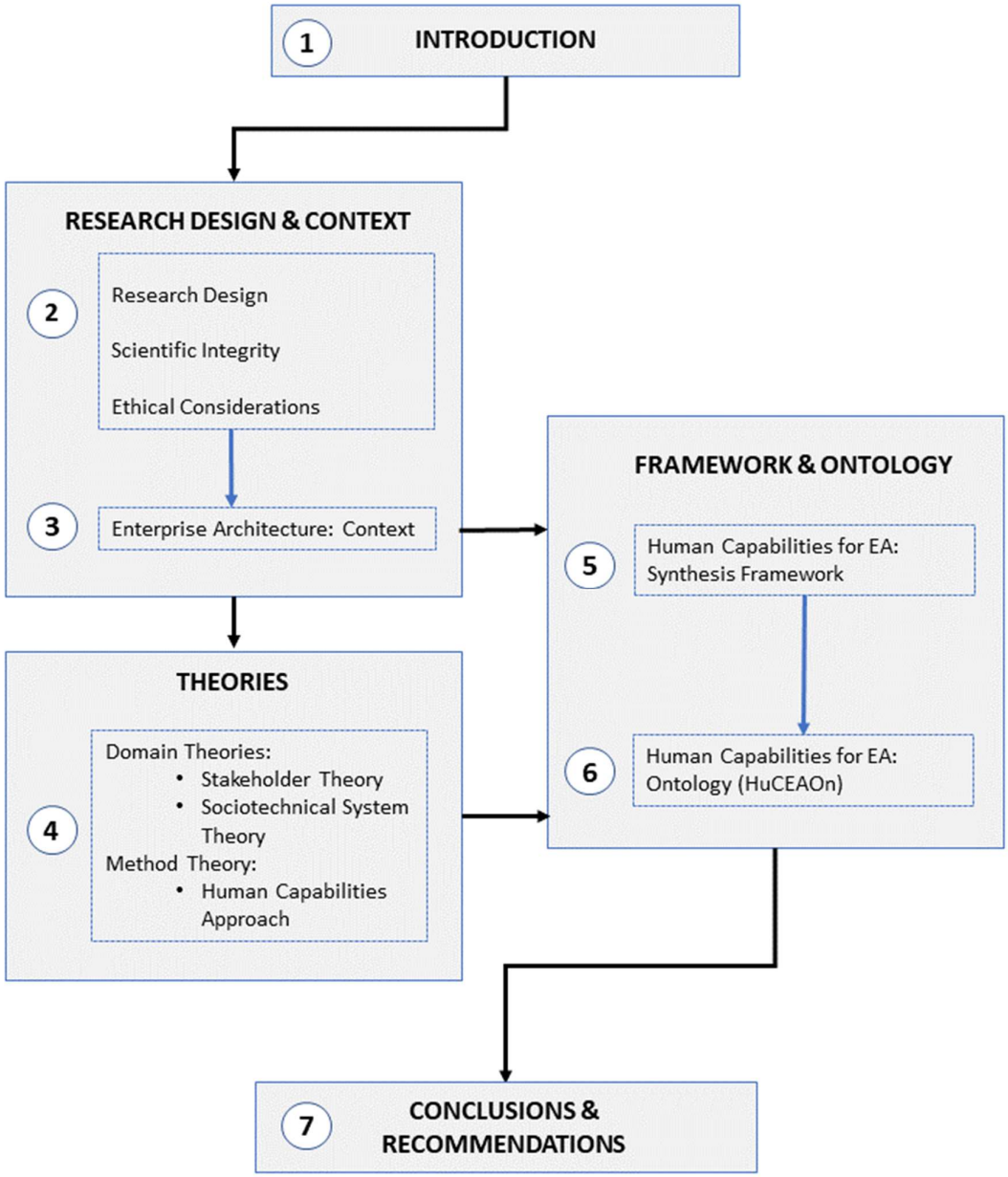
While this chapter covered the background and motivation of the research as well as the problem and questions I set out to address, the remainder of the thesis is structured as follows:

- In Chapter 2, the research design, which includes the strategies, paradigms, theories, processes, methodology, and data collection, analysis, and evaluation methods is discussed.

- The literature study is presented in Chapters 3 and 4. Chapter 3 presents a conceptual analysis of the EA domain, focusing on explaining the research setting. Chapter 4 examines the domain and method theories used to build the theoretical framework of the study.
- In Chapter 5, a conceptual framework of human capabilities for EA, which is one of the proposed design artefacts, is presented accompanied by cases accentuating its operational range.
- Chapter 6 is a presentation of the human capabilities ontology for EA. The process of designing, implementing, and evaluating the ontology are covered, along with a brief background information on ontology development.
- Chapter 7 summarizes the results, contributions and limitations, and research projectability before moving on to the conclusions and recommendations.

Figure 1 illustrates the structure of the thesis.

Figure 1
Thesis organisation



Note. This diagram illustrates the logical structure of the thesis. The human capabilities for enterprise architecture framework/ontology that emerged from this investigation is referred to by its acronym.

2. Research Design

In Chapter 1, I introduced the research domain and motivated the research undertaking. I showed that there is a knowledge gap in situating human values and capabilities in EA, and I argued that developing a computational ontology could help researchers and practitioners reach a common understanding of the universal human values that EA must account for. The core objective of the research was stated as developing a human capabilities ontology for the EA domain based on relevant concepts, theories, models, and practices. This research seeks to answer how we can model a human capabilities ontology that would support EA practice. In this chapter, I will outline the research design deployed to answer this central research question.

2.1. Introduction

Research design refers to both the procedure and the outcome of a research project's execution. Taking a nuanced process-oriented stance, Cheek (2008) defined research design as the concerns relevant to the theoretical, methodological, and ethical aspects of the particular research endeavour.

According to Blaikie (2010), a researcher must address the *what, why* and *how* of the research problem without being dogmatic about particular decisions. The answers to these three process questions will yield a guidebook that serves as a blueprint for carrying out the research enterprise. This blueprint is also known as research design (Blaikie, 2010). Hence, in this thesis, research design refers to both

- the process that defines research questions, strategies, paradigms, concepts, theories, data sources, data gathering and analysis procedures, techniques and tools, as well as to scientific and ethical principles that ensure the integrity of the researcher and the research (Blaikie, 2010; Blaikie & Priest, 2019; Schensul, 2008); and
- the technical document (this chapter) produced as a matter of course.

The components of the research design are laid out in Table 1, following Blaikie's (2010) outline.

Table 1
Elements of the research

Research Design Questions	Location
What will be studied?	Section 2.2
Why will it be studied?	Section 2.2 and 2.3
How will it be studied?	Sections 2.6 to 2.8
What is the research strategy?	Section 2.4
What are the ontological and epistemological stances?	Sections 2.4 and 2.5
What is the source of data?	Section 2.9
What are the data collection and analysis techniques and tools?	Section 2.9

Research concepts are not defined consistently across disciplines or among writers. The definition of a research methodology, approach, or paradigm is contested by the authors of academic texts. It is unclear, for instance, whether a case study is a paradigm, a methodology, or merely a sampling technique. This form of confusion is a result of authors' limited emphasis on the topic they are aiming to elaborate on, or, in other situations, their wish to elevate a particular concept with which they are personally associated (Blaikie, 2010). Regardless, definitional precision is necessary. In this chapter, I aim to provide precise descriptions of the research concepts utilised throughout the thesis. The use of less specific terminology is avoided wherever feasible. Accordingly,

- *Research purpose*, distinct from the researcher's personal goal, is the statement of intent of the research undertaking, that is, to either explore, describe, explain, or predict the domain of interest under investigation (Blaikie, 2010; Dresch et al., 2015).
- *Research question* refers to the query the researcher posits about the topic of interest and tries to answer through the research undertaking. In general, research questions fall under *what*, *why*, or *how* questions.
- *Research objective* is the contribution the research seeks to make; in this instance, design of an artefact.
- *Research strategy* is a reference to the bias of the researcher towards scientific methods of knowledge construction (Blaikie, 2010; Dresch et al., 2015). A research strategy may be deductive, inductive, abductive, or retroductive.
- *Research paradigm* represents the theoretical, ontological, and epistemological convictions of the researcher, which includes, among several others, positivism, interpretivism, and critical realism (Blaikie, 2010).
- *Research approach*, also known as research methodology, refers to the system of conceptual principles, rules of practice, as well as protocols for carrying out research (Dresch et al., 2015; Peffers et al., 2007). I define the *research process,* what Dresch et al. (2015) calls *work method*, as the set of logical steps followed to reach research goals. On the other hand, I understand *research methods* to mean the particular ways of data gathering, analysis, synthesis, and modelling.

In this thesis, the words *goal* and *aim* may be used interchangeably, and often in lieu of *objective* and *purpose*, without any special meaning beyond what respective usage contexts convey.

2.2. Research Question and Purpose

As indicated in Chapter 1, the primary objective of this study is to develop an ontology for human capabilities that is grounded on concepts, theories, and practices pertinent to the domain of EA practice. The motive is to further EA research and practice through the development of an ontology for human capabilities. Through this research, I aim to sensitize practitioners to the need for and potentials of embedding human capability conception in the design and evaluation of EAs. In addition, I would like to outline possible directions for future research that examine theories, methods, and tools for incorporating human capability consciousness in EA design. In reaching these aims, I wish to inspire the communities of research and practice to design and adopt formal mechanisms that would allow EA to function in an environment where the demand for equity, justice, sustainability, and relative progressive ideals is high (Bernus et al., 2016; Lapalme et al., 2016).

In this research, I propose to position human capabilities conscious EA as a logical extension to the enterprise ecological adaptation school (Lapalme et al., 2016). As the ecological adaptation view takes root, EA research interests are orientating towards the integration, standardization, and elaboration of EA's non-technical and theoretical foundations (Panetto et al., 2016; Romero & Vernadat, 2016b; D. Simon et al., 2013). The need for a holistic treatment of EA to account for changing economic, environmental, and human conditions is also emphasised by several researchers including Bernus et al. (2016), Panetto et al. (2016), and Lapalme et al. (2016).

Furthermore, I introduce the HCA as an integrative framework to promote a human-centric EA approach. I seek to envision, explicate, relate, and advocate for human capabilities conscious EA (MacInnis, 2011; Nussbaum, 2000; Sen, 1999).

The research design for this study is guided by DSR approach. According to Thuan et al. (2019), DSR questions fall under "way of knowing, way of framing, and way of designing" classes (p. 346). These inquiries correspond to the *what*, *which*, and *how* questions, respectively. While *what* questions target knowledge accumulation, *how* type questions address the issues of representation, process, implementation, use, and evaluation of the artefact. On the other hand, *which* questions, attempt to identify and define the components of the artefact and the requirements, principles, and properties that put constraint on the design, implementation, and use of artefacts. *Which* type questions are *what* questions but with a limited functional domain.

For example, there may be a limited number of ways of organising an ontological model from a certain number of concepts.

Within an overarching research question that aims to answer *how we can model a human capabilities ontology that would support EA practice,* this research seeks to answer the following four sub-questions.

SQ-1. What roles do human capabilities play in EA?

This knowledge question is answered through the review of the relevant literature. Propositions are put forward that justify the place of human capabilities in EA.

SQ-2. What human capabilities should EA practices account for?

This question is answered by analysing and synthesising relevant theoretical frameworks. *Concept analysis* and *framework synthesis* are deployed to answer this question.

SQ-3. How can we support EA practice by designing an ontology of human capabilities?

This question is addressed by designing an ontology of human capabilities relevant to EA research and practice.

SQ-4. Is the ontology for human capabilities usable and useful for enterprise architects and information systems practitioners?

This knowledge question is answered by assessing expert opinions on the relevance and usability of the developed ontology through a questionnaire survey and interviews.

2.3. Research Purpose

Research may have one or more of four purposes: *explore*, *describe*, *explain*, or *predict*. The exploration purpose is most appropriate when the domain of interest is insufficiently investigated or novel. Description entails explication of the research domain in terms of variables and relationships, which could be accompanied by an explanation of the causality of phenomena. Based on such causal explanation, the researcher may be able to anticipate or predict future occurrences of phenomena. An often-neglected research purpose is *prescription*, which is associated with applied design and action research (Dresch et al., 2015).

This research has three important purposes: to explore, to describe, and to prescribe. I aim to investigate the problem domain, explain the notions of human capabilities in EA, and then develop (prescribe) a synthesis framework and ontology for human capabilities in EA. The proposed human capabilities ontology extends the enterprise architecture ontology by introducing the concepts of human agency and capabilities into the design dimension.

2.4. Research Strategy

Although the term *strategy* is used in a variety of ways in the research methodology literature, I embrace Blaikie's definition (2010) as "the logic used to generate new knowledge" (p. 9). Later Blaikie and Priest (2019) referred to the strategies as *logics of inquiry*. The logics of inquiry are not the methodologies, such as action research or survey, but rather the broad paths followed, depending on the interest of the researcher, to reach a conclusion or to validate a particular hypothesis. Accordingly, one may follow one or more of the four mutually non-exclusive logics of inquiry (strategies): *deductive*, *inductive*, *abductive*, or *retroductive*. Each is, however, more suitable for a particular research question and research paradigm.

SQ-1. What roles do human capabilities play in EA?

This question gives context to the study and is answered through the review of the extant literature in organisational management, information systems, and EA. In answering this question, I justify the place of HCA in EA through logical argumentation and conceptual analysis. Using the deductive strategy to answer this question, I first hypothesise that human capabilities are central to EA, and then identify seed concepts, define tentative search terms, and collect data helpful to providing context and justification to the study.

SQ-2. What human capabilities should EA practices account for?

The second question is answered using an inductive strategy involving the collection and analysis of qualitative data from organisational sources and the literature. The inductive strategy has been found to be appropriate for answering *what* research questions aimed at gathering characteristics and patterns (Blaikie, 2010; Blaikie & Priest, 2019). A cautious realist ontology and a conventionalist epistemology are the selected assumptions for inductive strategy (Blaikie, 2010). Cautious realism asserts that reality has an independent existence. However, reality cannot be discerned directly and therefore a critical attitude must be adopted to compensate for sensory flaws and biases. Conventionalist epistemology contends that a prevailing account of an observed phenomenon is the result of general consensus among the scientific community, rather than a true account based on conclusive empirical evidence or irrefutable rational arguments.

SQ-3. How can we support EA practice by designing an ontology of human capabilities?

SQ-4. Is the ontology of human capabilities usable and useful for enterprise architects and information systems practitioners?

The third and fourth questions call for the design, implementation, and evaluation of an artefact. Following the proposal by Dresch et al. (2015), the design, development, and evaluation of the ontology follow a combination of deductive and inductive strategies. The artefacts were proposed immediately before the design, development, and evaluation (Dresch et al., 2015). However, the strategy of induction was followed in building the foundational synthesis framework, and later in populating the ontology artefact.

To provide a consistent transition from the second research question, a cautious realist ontology and conventionalist epistemology are applied in this phase, together with deductive and inductive strategies.

2.5. Research Paradigm

Ontological and epistemological assumptions lie at the core of social research. Blaikie and Priest (2019) argued that the philosophical assumptions and logics of inquiry must be made explicit and open for investigation. Accordingly, I made the following paradigmatic assumptions with regard to the inquiry.

SQ-1. What roles do human capabilities play in EA?

This question is directed at comprehending the current state of human capabilities understanding in EA and outlining the justifications for human capabilities in EA. A theory-oriented systematic-like literature review is undertaken to answer the question. Though literature studies rarely follow a stated paradigm, I have borrowed aspects of critical realism to conduct the literature study (Edgley et al., 2016; Okoli, 2015). The following points delineate the paradigmatic inclinations of the literature study.

- Choice of research questions to guide the review (Edgley et al., 2016).
- Choice of literature reflecting the multi-paradigmatic nature of the research (Edgley et al., 2016; Okoli, 2015).
- Use of knowledge-directed investigation as a prelude to improving the state of practice
- Use of multiple research approaches to address the research problems (Edgley et al., 2016; Okoli, 2015).

SQ-2. What human capabilities should EA practices account for?

The research paradigm followed with reference to the second question can be considered as interpretivist (Gregory, 2011). Within the interpretivist mould, critical realism is selected as the research paradigm. Nuryatno & Dobson (2015) used this paradigm to study the social aspects of EA implementation. While it underscores the profundity of language and social relations in causing and reinforcing social structures, critical realism has the emancipatory role of improving the human experience (Leung & Chung, 2019; M. Wilson & Greenhill, 2004).

SQ-3. How can we support EA practice by designing an ontology of human capabilities?

SQ-4. Is the ontology of human capabilities usable and useful for enterprise architects and information systems practitioners?

Despite the lack of clarity regarding the selection of a research design paradigm in artefact design, many have chosen positivism (Baskerville et al., 2009; Carlsson et al., 2011; Gregory, 2011). The selection of the positivist epistemology by many researchers, according to

Gregory (2011), might be because artefacts are *real* in existence. For this study, critical realism was chosen following (Carlsson et al., 2011) and (Kotze et al., 2015). As Carlsson et al. (2011) stated, critical realism asserts an objective ontology and a subjective epistemology, positing that reality exists independently of our cognition. Nevertheless, it recognizes that facts and observations are inherently influenced by theoretical perspectives. Carlsson et al. (2011) also claimed that the open systems perspective of critical realism meant that the resulting design theory and knowledge should be considered provisional. Since I consider the artefacts to be real, evolving (and hence, provisional), and open to interpretations, critical realism seems like a good fit for this research.

2.6. The Design Science Research Approach

What I call research approach may elsewhere be identified as methodology (see Schensul, 2008, for example). The term methodology is often used inconsistently to mean methods, paradigms, and even the overall research design (Blaikie, 2010). While I concur with Gregory (2011) that DSR cannot be placed at the level of a research paradigm, I do not make any distinction between methodology and approach. This stance is consistent with Peffers et al.'s (2007) definition of design science research methodology. Thus, I consider DSR to be a research approach or methodology, situated below research paradigms but above methods (Gregory, 2011).

The information systems discipline is interested in understanding the interactions between the human, the technical, and the organisational. Beyond understanding the interactions between the constituent parts, information systems is interested in the design of organisational and technical artefacts for the effective and efficient realisation of human goals (S. T. March & Storey, 2008). Hence, although behavioural research is still commonly employed in the field of information systems, the DSR approach is gradually gaining traction as a respected research approach (Hevner et al., 2004; Iivari, 2005; S. T. March & Storey, 2008).

DSR is the "design and investigation of artifacts" that interact with a sociotechnical context to solve or improve a problem situation in the domain context (Wieringa, 2014, p. 3). DSR is called problem-focused since it is concerned with understanding a problem domain, developing solution(s) to problems, and/or evaluating the informational, technical, and organisational solutions proposed for the problems (S. T. March & Storey, 2008). Wieringa (2014) argued that it is the interaction between the context and the artefact, rather than the artefact itself, that can lead to an improvement in the problem context. DSR must therefore answer both knowledge and design questions. In this respect, one may begin by answering a knowledge question and then go on to identifying the design problems to be addressed through artefact building. Alternatively, design of an artefact may lead to knowledge questions.

This study employs an adapted DSR approach prefaced and foregrounded by a qualitative grounded theory-lite approach. The DSR approach is deemed appropriate since ontology (an artefact) development is the primary objective of this particular research. The DSR approach can be served by the grounded theory-lite approach as the latter provides for an iterative gathering and evaluation of data, which will be the basis for the ontology development goal of this research (Al-debei & Fitzgerald, 2009; Gregory, 2011). Thus, involved in my applied endeavour is the conceptual study necessary to identify the most essential human capabilities relevant to EA research, planning, and evaluation. As part of the knowledge-driven research preceding the design, a detailed literature review and analysis of EA planning documents (principles, strategies, etc.) is completed.

Another way in which DSR goes after knowledge questions is through pre- and/or post-implementation evaluation of the artefact (Niederman & March, 2012). In addition to the tool-based continuous quality assurance process throughout the ontology development lifecycle, I have completed an ex-post evaluation of the ontology using questionnaires and interviews.

Iivari (2015) made a distinction between two types of strategies of DSR. In the first strategy the researcher builds a *meta-artefact*, which serves as a proof of concept in the general problem domain and can later be instantiated to solve specific domain problems. The researcher relying on the second strategy, on the other hand, sets out to solve a specific domain or client problem through the construction of an artefact. Considering the Iivari's (2015) characterization of the two strategies, I conclude that this research broadly aligns with Strategy 1. Some distinctive features of *Strategy 1 DSR* are presented in Table 2.

Table 2

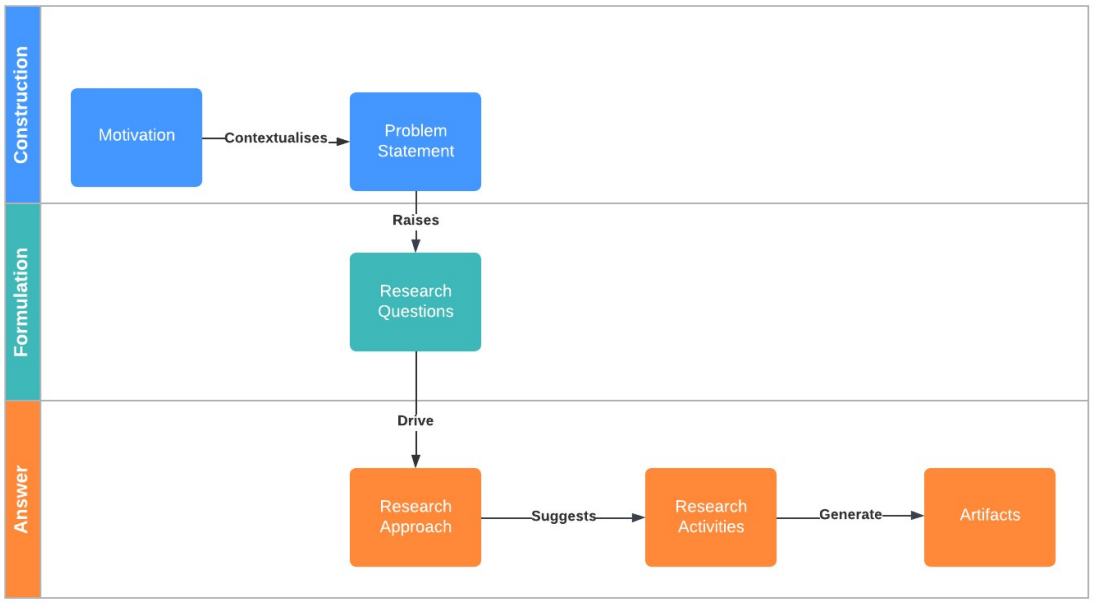
Evaluating strategy 1 DSR based on select criteria

Criteria	DSR Strategy 1 Characteristics
Research–client relationship	A client may be involved, but not necessarily
Major problems to be addressed	A general problem (a class of problem), more or less informed by specific problems in practice
Artefacts built	Conceptual IT meta-artefact as a DSR contribution; possibly a real system implementation (instantiation) of the conceptual IT meta-artefact
Primary role of the real system implementation	Instantiation as a proof of concept and possibly used in the evaluation
Nature of the target IT artefacts	A priori designable system
Typical nature of the IT meta-artefact	A new, innovative concept for a software-hardware system or a new innovative systems development approach, method, or technique
Major process driver	The constructed meta-artefact as a general solution concept, to be tested and evaluated on the field
Research methods	Constructive (in building the meta-artefact) Empirical (in the evaluation) Laboratory experiment Field experiment Field study Case study Action research
Generalisation	Included in the problem statement

Note. Adapted from "Distinguishing and contrasting two strategies for design science research" by J. Iivari, 2015, *European Journal of Information Systems*, *24*(1), pp. 108-111 (https://doi.org/10.1057/ejis.2013.35). Copyright 2015 by Taylor & Francis Group.

Thuan et al. (2019) proposed a DSR framework with three major components (see Figure 2). The construction component provides context to the problem and seeks to identify the problems to be addressed by the study. In the formulation component, the researcher outlines the problems in the form of research questions. In the final component, answers to the research questions will be produced in the form of knowledge and artefacts. This framework corresponds to Blaikie's (2010) description of a research process wherein the researcher, irrespective of the research purpose, begins by framing the problem, outlining the questions to be addressed, and assembling and deploying the research methodology. In contrast to Blaikie's (2010), Thuan et al. (2019) highlighted that the construction and evaluation of an artefact constitute significant purposes within a DSR process.

Figure 2
DSR framework



Note. Adapted from "Construction of Design Science Research Questions" by Nguyen Hoang Thuan, Andreas Drechsler, and Pedro Antunes, 2019, *Communications of the Association for Information Systems*, *44*(1), p. 336 (https://doi.org/10.17705/1CAIS.04420). Copyright 2019 by Association for Information Systems.

In this thesis, I followed the broad outline offered by Blaikie (2010), Thuan et al. (2019), Wieringa (2014), Dresch et al. (2015) and Peffers et al. (2007). While the latter four serve as guides for the DSR process, I found the organisation of social research design concepts in Blaikie (2010) and to be more perceptive, revealing, and less perplexing.

2.7. Concepts and Theories

A list of theories pertinent of information systems research was identified from the literature. The main criterion for selecting a theory was the level of proximity or pertinence to the concept of human capability consciousness. Accordingly, two domain theories, i.e., stakeholder theory and sociotechnical system theory were selected.

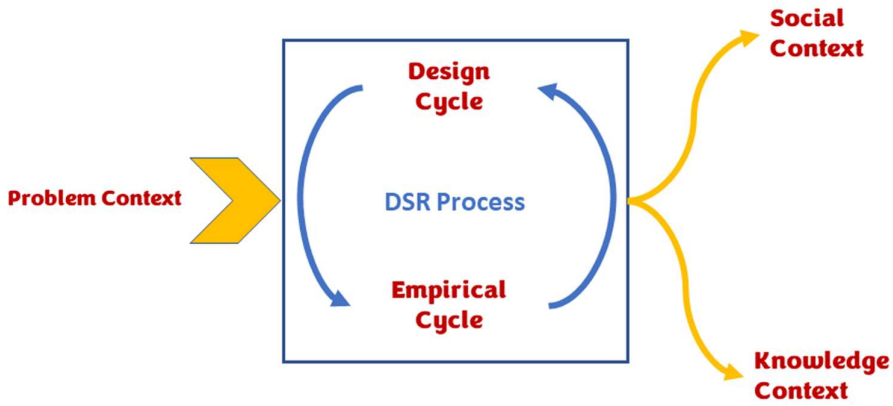
The HCA (Sen, 1999) is used as method theory, although it is better understood as a paradigm than a theory or model. The HCA has been utilised widely in information systems research, particularly in information and communication technology for development (ICT4D) and technology design studies (see Section 4.5 for review of exemplar studies). As Bertland (2009), and Renouard (2011) demonstrated, the HCA can also be deployed to assess initiatives in a business setting. However, the application of the HCA in EA planning and governance is yet to be thoroughly investigated.

The foundational concepts relevant to the research, such as enterprise, enterprise architecture, human capabilities, and computational ontologies, are briefly introduced in Chapter 1.

2.8. Research Process

According to Wieringa (2014), DSR is implemented as an iterative process of problem solving and knowledge accumulation. The researcher/designer first seeks to understand the problem context for which the artefact is being designed. Understanding of the social context is followed by two distinct yet intertwined problem-solving activities – designing an artefact and answering knowledge questions about the artefact. The two activities are undertaken iteratively, the output from one influencing the other activity. The end result of the DSR project would then be to improve the social context as well as to add to the knowledge base. Figure 3 is a graphic illustration of Wieringa's (2014) DSR model.

Figure 3
DSR model



Note. The graphic depicts DSR as an iterative design and knowledge accumulation process intended to change the social (problem) and scientific context.

In a DSR, understanding the social context can be accomplished through an empirical process of interviews, focus groups, questionnaires, observations, etc. In a context where the problem is generic, other techniques such as literature review and simulation can be deployed first to understand the problem domain.

The researcher/designer goes into solving the problem and adding to the knowledge base through an iterative process of design and empirical investigation. These two activities lie at the core of DSR and are informed by data, theories, and insights coming from diverse knowledge areas. The design activity and the empirical activity would add individually and jointly to the knowledge context, in addition to their usefulness in improving the problem context.

2.9. Research Methods and Techniques

In this section, I present the various methods and accompanying techniques of data gathering, analysis, synthesis used to accomplish the study. Although some consider DSR as a research method (Dresch et al., 2015, cited a few), as I have indicated in Section 2.6, I opted to characterize it as a research approach or methodology rather than as a method. Thus, in this section, what I present as method are those particular ways of data gathering, analysis, synthesis, and modelling which I deployed within a DSR frame.

2.9.1. Review of the Literature

Review of the literature is an integral part of research design (Blaikie, 2010). The literature review is the process which yields the product that constitutes the synthesis of all previous relevant works. It is where the researcher creates the link between his work and the works of earlier researchers (Ridley, 2012).

The literature review provides the background to the research. The concepts, models, theories, methods, and tools of the research are defined, critiqued, and contextualised through the literature review. Wallace & Wray (2021) noted that the literature review helps the researcher in answering the "central" and "theoretical" questions of the study as well as to "justifying the methodology" to be deployed (p. 37). The literature review in this work is undertaken to serve those same purposes. In particular, I aim to achieve the following goals by means of the literature review.

1. Introduce relevant terminology and provide definitions to clarify how terms are being used in the context of the research.
2. Provide a multidisciplinary background and backing for the research.
3. Underline the significance of this research by providing supporting evidence for its objectives.
4. Present the current state of the research area, highlighting the issues that attracted attention in the extant literature.
5. Describe the relevant theories and concepts which underpin the research.
6. Describe related research in the field and show how this research challenges and extends previous related works.

2.9.2. Thematic Analysis

Several authors have used the inductive grounded theory as a synthesis process for qualitative reviews (Dresch et al., 2015). Grounded theory originated because of the quest to understand the theory generation process. Before the rise of grounded theory, social researchers were mainly

engaged in proving theory instead of generating it (Länsisalmi et al., 2004). Grounded theory suggests that one can generate theory through an inductive process of gathering data and comparison of the same with emergent patterns of analysis (Blaikie, 2010).

One of the goals of this particular research is the development of an ontology of human capabilities, which is considered to be "content theory" (Chandrasekaran et al., 1999, p. 20) or "taxonomic theory" (Larkins & McKinney, 1980, p. 13).

The grounded theory approach, as originally conceived by sociologists Barney Glaser and Anselem Strauss (1967), is a fully fledged research approach with its own data collection, analysis, and interpretation techniques, tailored to address specific types of research questions. However, according to Charmaz & Belgrave (2012), grounded theory comes in a variety of flavours, and as Braun & Clarke (2006) noted, many studies that claim to adhere to the grounded theory approach are merely approximations, with only a few meeting the stringent requirements of the fully fledged grounded theory approach. In light of this, the thematic analysis method I employ is comparable to grounded theory in that it is grounded in data and adheres to the coding procedures of the latter. The suggested human capability ontology, however, is simply a content or taxonomic theory and hence only partially aligns with the theory generating objective of grounded theory research. Braun and Clarke (2006) called such a minimalist application of the approach *grounded theory-lite*. My method can only be classified as "lite" because I have no aim of strictly adhering to the procedural elements of grounded theory and neither a stated nor inferred objective of generating a fully developed grounded-theory analysis.

The literature review conducted as a preface to the DSR is used to create context for the research. It helps to concretise the problem domain. As such, I have taken it as a separate research undertaking requiring its own data analysis method. I deployed the method of concept analysis to create context for the problem domain, i.e., EA. Widely used in the medical sciences, concept analysis is a relatively structured review technique that helps to illuminate a certain concept distinctly from associated concepts through its constituents, distinguishing characteristics, and applications (Fitzpatrick & McCarthy, 2018).

To populate the ontology with concepts, a qualitative analysis of scholarly and grey literature was undertaken via the codebook-oriented template analysis technique (Braun et al., 2019; King, 2004; King & Brooks, 2016). Template analysis is a generic, theory-agnostic thematic analysis techniques, which has found wider use in organisational and management studies (King & Brooks, 2018a, 2018b). King and Brooks (2016) presented several cases to show the application of the technique in the wider domain of organisation and management studies. It has also been used in information systems research (Lapointe & Rivard,

2007; Wainwright & Shaw, 2007). The technique's pragmatism, capacity, flexibility, and simplicity made it suitable for my research (Nawi et al., 2015; Sabani et al., 2019).

Template analysis involves familiarisation with the data sources, preliminary coding, producing an initial template, applying the template, and finally, interpreting the themes. A valuable feature of template analysis is that it allows the iterative discovery of themes through the application of deductive a priori codes to domain discourse and subsequent enrichment and expansion via inductive backward passing.

Grounded theory-lite, in particular thematic analysis, is recommended when the research question is less focused on "why," when data collection procedures other than interviews are employed, when the researcher is inexperienced, or when resources are limited (Braun & Clarke, 2006).

2.9.3. Synthesis Methods

A preamble to the construction of the human capabilities ontology is a synthetic framework that guides the process. I create a synthetic framework based on theories, models, and approaches pertinent for human capabilities consciousness. The framework synthesis began with the creation of a deductive a priori framework based on literature, and then went on to inductive procedures to enhance the framework (Barnett-Page & Thomas, 2009; Carroll et al., 2013).

Framework synthesis is compatible with critical realism, which posits that our perceptions and beliefs mediate our knowledge of reality (Barnett-Page & Thomas, 2009).

2.9.4. Modelling

Modelling is defined as the process of organising knowledge pertaining to the data and behaviour of a given system (Uhrmacher, 2006). It is an abstraction and aggregation process that results in a simplified representation of the system under consideration (Butterfield et al., 2016). The objective of such a model is to comprehend the behaviour of the system and afterwards to build a system that better serves the problem domain (Uhrmacher, 2006).

One of the most essential artefacts that emerged from the DSR process is a model of the solution specification. The conceptual and theoretical analysis and synthesis described in earlier sections form the basis for the modelling of the ontology of human capabilities that I construct as part of this research. I provide a detailed description of the modelling process in Chapters 5 and 6.

2.9.5. Evaluation and Assessment

A critical component of any DSR is evaluation and validation. According to S. T. March & Storey (2008), artefacts produced from a DSR need to be evaluated and assessed in terms of their outcome. The researcher engages domain experts to validate the effectiveness, efficiency, and efficacy of the artefacts in the problem domain.

In this research a set of analytical and descriptive methods are used to evaluate the ontology (Hevner et al., 2004). The ontology is first evaluated with a set of standard criteria using automated tools and researcher judgement. That is followed by engagement of practitioners to evaluate the ontology for its utility, goal contribution, limitations, assumptions, and reusability (Johannesson & Perjons, 2014; Osterwalder, 2004). Interviews and questionnaires were used to assess the artefact from expert perspectives.

Questionnaires can be highly efficient for gathering the opinions and perceptions of many stakeholders about an artefact. However, the answers are often superficial and do not allow a researcher to gain a deep insight into the views of individual respondents (Patton, 2002). Hence, I supplemented the questionnaires with interviews. Interviews are effective instruments for gathering stakeholder opinions and perceptions about the use and value of an artefact (Brönnimann, 2022; Schultze & Avital, 2011). The ability to ask follow-up questions during an interview also lets researchers dig deeper into stakeholder perspectives (Nathan et al., 2019). Results from interviews must however be interpreted critically because they might be influenced by the perspectives, interests, and competences of the respondents and are susceptible to false positives (Patton, 2002; Schultze & Avital, 2011).

The use of a combination of these methods provides for a comprehensive assessment of the artefact (Patton, 2002).

2.9.6. Data-Gathering Techniques

A mixed method approach was used of qualitative data collection including interviews, questionnaires as well as thematic analysis of organisational documents and literature (social artefacts). A core component of the data collection was literature based, which can be considered as a social artefact in its own right.

Two types of data collection have been used in this research. First, public domain textual data were collected from internet sources. The data were used to extract ontological concepts. Such generic data were then supplemented by domain-specific data from the higher education and finance domains. In what can be called a collective case study, data from higher education (representing the public-social sector) and banking (representing the private – business sector) were used to improve the projectability of the work (Henderson, 2011).

In the evaluation and assessment phase of the development process of the ontology, both quantitative and qualitative data were collected.

2.10. Scientific Integrity and Ethics

2.10.1. Scientific Integrity

Integrity in research constitutes the personal integrity of the researcher and the institution as well as the scientific integrity of the research itself. For a researcher, integrity entails a dedication to intellectual honesty and personal accountability for their activities as well as adherence to a variety of legal and ethical principles and procedures that define acceptable research conduct (National Research Council, 2002).

2.10.1.1. Empirical Cycle

Transferability, dependability, conformability, and credibility are the criteria used to evaluate qualitative research (Suter, 2012). The objective of qualitative research generally is to take specific real-world phenomena and to create an in-depth of understanding of the world based on context. Hence, *generalisability* akin to laboratory or quantitative research is not expected (Kivunja & Kuyini, 2017; Suter, 2012). I made "thick" descriptions of the qualitative component of the research to improve its transferability (Cruzes & Dybå, 2011; King et al., 2017). A blend of qualitative and DSR approaches were used to improve the validity of the research while the inclusion of business as well as public sector cases improves generalisability.

Dependability, also called *reliability*, refers to the repeatability of the research (Suter, 2012). Triangulation and establishment of audit trails were used to improve the dependability of the research. I used ATLAS.ti for thematic analyses of literature, organisational documents, and interview scripts. ATLAS.ti is a valuable tool for establishing coding consistency, tracing the process of theme generation, and preserving data. As part of compliance with the honesty principle, all materials used in this research are retained for future referencing and auditing. ATLAS.ti facilitates the retention of the raw data as well as the knowledge generated as part of the process.

Although it is desirable to minimize bias in qualitative research and DSR, the entire concept of problem-solving is value-laden, making *confirmation* difficult (Kivunja & Kuyini, 2017). For example, in selecting human capabilities approach as a method theory, I committed to a certain worldview. I have shown the contrasts but have not endorsed or treated them extensively, on par with the HCA. Therefore, I subscribed to a narrower view of confirmability to mean objective reporting. Validation targeted at measuring the usefulness and effectiveness of the ontology was undertaken using questionnaires and interviews. To achieve confirmability, I

attempted to report the findings from the validation component of the research as authentic as possible (Kivunja & Kuyini, 2017).

According to Suter (2012), *credibility* is the most important criterion for qualitative research. It refers to the believability of the findings. I used triangulation, stakeholder validation, and establishing an audit trail to improve the credibility of the work. Thematic coding was used for data reduction with audit trails established in the ATLAS.ti environment. Appropriate data displays and conclusions were also made in the form of novel human capabilities in the EA framework (Suter, 2012).

2.10.1.2. The Design Science Research Cycle

Typically, the goal of DSR is to create an artefact to provide a solution to a local need, situating the solution in time, space, culture, and discourse (Gregory, 2011). Design and development of an ontology generally falls under applied design research, which Wieringa (2014) calls "middle range" science (p. 9). According to Wieringa (2014), unlike the basic sciences, middle-range sciences, including DSR, do not make ideal and universal generalisations, but instead confine themselves to the real world and try to make "existential generalizations," making realistic assumptions about the domain of interest (p. 10).

An ontology, just like any other artefact, is "embedded in some time, place, discourse, and community" (Gregory, 2011, p. 117). It is only one of the many possible representations or abstractions of a knowledge domain and as a result of which its universal generalisability is compromised (Gregory, 2011). While this assertion is largely true, generalisability is an ideal to vie for. In this research, the problem taken up is a universal one. Concerns of human capability and sustainability are recognised universally and there is a growing consensus among world communities with respect to the centrality of these issues in human endeavours (Andersson et al., 2012; Deneulin, 2011; Nussbaum, 2011; Wanderley, 2001). Second, the artefact is developed based on theoretical and empirical insights from universal sources. The artefact can be integrated easily into any EA effort anywhere in the world. Third, the artefact can be updated with inputs from other works. I acknowledge that, owing to logistical problems, the evaluation undertaken is done only in one geographic locality. This could, however, be remedied in the future by soliciting the inputs of people from all over the world.

2.10.2. Research Ethics

At UNISA, obtaining ethical approval prior to data collection is a prerequisite. Accordingly, UNISA has granted ethical approvals for both the human participation (validation) and

secondary data components of this particular project. Appendix E includes copies of the certificates of ethical clearance issued by UNISA for the conduct of this research.

All principles and mechanisms put in place, by UNISA in particular, and by the research community in general for the purpose of ensuring the privacy and security of research participants have been upheld. In particular, where human involvement is sought, utmost care is taken to ensure that participation is voluntary and based on informed consent, and that no harm is brought to the participants (Johannesson & Perjons, 2014). Intellectual property rights are respected during data collection, and I give due acknowledgment to all sources cited in this study.

Another aspect of research ethics is the objectives in reporting research results. I report the results without distortion, with full commitment to scientific objectivity to the research undertaking.

In compliance with UNISA's doctoral research procedures, the manuscript is checked for inadvertent plagiarism before submission.

2.11. Chapter Summary

In this chapter, I presented the research design, which addressed the *what*, *why* and *how* of the research problem. The objective was to create a guidebook for carrying out the research enterprise. Accordingly,

- One central research question and four sub-questions have been forwarded with the aims of exploration, description, and prescription.
- A blend of inductive and deductive procedures has been designed to be implemented in a manner suited for each research question.
- Based on the assumption that the envisaged artefacts are real, evolving, and open to interpretations, I have established critical realism as the most appropriate research paradigm for this research.
- As the primary objective of this research was the development of a computational ontology, the DSR was selected to guide the development process.
- In a scheme of data, theory, and methodological triangulation, multiple theories, data sources as well as gathering, analysis, and synthesis techniques have been proposed for use.

In the following chapter, I will describe the EA environment, which provides the context for the envisaged human capabilities ontology. In an effort to legitimise the research, the social and ethical conception of EA is emphasised by explicating its significance from a multidisciplinary perspective.

3. Enterprise Architecture – Context

Chapter 2 presented the research design employed to answer the research questions. To reiterate, the main research question comprises four sub-questions, each focusing on distinct aspects. The first two sub-questions are empirical while the latter two are design specific. In this chapter and the next one, I will specifically address two aspects of the contextual design knowledge required to develop the human capabilities framework and ontology for the EA domain. This chapter is an exposition of the research's context, with a particular emphasis on EA.

I have used a blend of concept analysis and systematic-like literature review to define EA from multidisciplinary and multi-theoretical viewpoints in order to gain a deeper understanding of the domain and to inform the research process. Although this opportunistic approach may offer insights into the research direction, it does not pretend to be a systematic literature review in the vein of Saint-Louis, Morency and Lapalme (2019).

3.1. Introduction

EA is the blueprint that drives business and information technology (IT) decisions in an organisation or organisations that share the same or a similar vision and mission (Gorkhali & Xu, 2017; Jonkers et al., 2006). According to Lapalme et al. (2016), EA is an integrative concept that binds the sociotechnical organisation, built from interacting components, with its ever-changing environment using accepted enterprise design and governance principles. Alternatively, EA can be understood as an abstraction of the interactions among the enterprise, its environment, and technology in current as well as in possible future states (Jonkers et al., 2006).

Even though there are several descriptive definitions of EA, a good many of them gloss over the essential elements that constitute EA. What is it to be architected? Why do we call this effort "architecting"? What is an enterprise and what makes enterprise architecting similar, if at all, with building or music architecture? Where is the place of the human component in architecting? These and related considerations will assist in framing EA as a human-centred endeavour with the ultimate goal of elevating humankind.

The domain literature has been updating the definition and scope of EA, taking full cognisance of the dynamism in societal and technological developments. We have witnessed that the EA literature started in a specific technical domain and rapidly expanded to account for strategic and innovative interests of the enterprise. The EA definition by Gartner (2020), for example, places EA properly within the context of organisational dynamics. The focus is on the holistic biases of EA in steering the organisation towards achieving its goals.

The divergence in definitions of EA and the resultant fragmentation of the EA literature in its scope and purpose is reported by several researchers (Lapalme, 2012; Saint-Louis et al., 2017). In a novel systematization of the EA literature, Lapalme (2012) suggested three schools of thought which could help us to capture the nuances of the divergent definitions. One can see the progression of EA thinking and practice through the elaboration and sophistication of the definitions provided by the three schools of thought for the concept and practice.

Initially, EA was driven by technical approaches inspired by engineering and architecture methods (Spewak & Hill, 1993). The focus was on IT architecture and the view was relatively mechanistic and reductionist (Korhonen & Poutanen, 2013). In the sociotechnical systems view, the aspiration was to create positive synergy between the technical and social constituents of the system and to yield joint optimisation of the needs of both individuals and the organisation (Handley, 2019). The ecological adaptation school extends the previous two views to embrace the ecosystemic concerns of society in order to achieve innovation and sustainability (Lapalme, 2012). The focus is therefore shifting towards value systems (Korhonen & Poutanen, 2013).

EA is a synergistic concept that is much more than its constituents. Therefore, one needs the tools of analysis and synthesis to show the various dimensions of the elements of EA in play. The literature review and concept analysis are informed by the thesis that EA is a managerial, social, technical, as well as human undertaking. In this chapter, I attempt to:

- clarify the meaning of EA from a multidisciplinary perspective;
- identify the perspectives of EA in the academic literature; and
- accentuate the human and social conception of EA to justify the research.

3.2. What is Architecture?

The Oxford English Dictionary (OED, 2019a) defined *architecture* as "the art or science of building or constructing edifices of any kind for human use." Derived from the Latin *architectura* and the Greek *arkhitekton*, which translate to "chief creator," architecture originated in the "vernacular art of building" (Westfall, 2015, p.7).

Architects, typically differentiate between building and architecture (Roth & Clark, 2014). A humble construction such as a cottage or shed that serves merely a utilitarian purpose is termed a building, yet imposing structures such as the cathedrals of Italy are regarded architecture. Despite the common belief that architecture is nothing more than the ornamentation of a structure, aesthetic appeal alone does not constitute architecture. Architecture has both a material (structural and functional) as well as a symbolic (aesthetic, ethical, political) significance. Ruskin's definition of architecture in Table 3, for instance, elevates the place of philosophy and ethics in the material domain.

Table 3
Sample definitions of architecture

Source	Definition
Roth & Clark (2014)	"Architecture is the science and the art of building" (p. 5).
Ruskin (1849)	"Architecture is the art which so disposes and adorns the edifices raised by man for whatsoever uses, that the sight of them contributes to his mental health, power and pleasure" (p. 7).
Norman Foster in Rosenfield (2014)	"Architecture is an expression of values – the way we build is a reflection of the way we live. … At its most noble, architecture is the embodiment of our civic values" (para. 23).

The renowned architect Norman Foster elaborates at length on how architecture is, primarily, a reflection of human values (see Table 3). Similarly, the definitions compiled by Quintal (2019) reveal that architecture has both a material (structural and functional) as well as a symbolic (aesthetic, ethical, political) significance. Simply put, aesthetic appeal alone does not constitute architecture.

According to Hewitt (2019), architecture places limitations on the design space. For instance, Vitruvius, a Roman architect from the first century who authored *De architectura*, the first accessible book on architecture held that a good structure must meet the three criteria of *firmitas* (structural durability), *utilitas* (functionality), and *venustas* (attractiveness) (Hewitt, 2019). Similarly, the 19th century British Christian romantic John Ruskin proposed seven principles to uphold in architecture, which he referred to as the lamps of architecture: sacrifice, truth, power, beauty, life, memory, and obedience (Baljon, 1997). While Vitruvius showed the material and aesthetic foundations of architecture, Ruskin elevated the place of philosophy and ethics in the material domain.

While the traditional conception of architecture was restricted to the building of individually standing physical structures, the term has been extended to cover a wide range of domains that could not have been anticipated originally (D. J. Nightingale, 2009). We now talk about music architecture, naval architecture, urban architecture, system architecture, and, of course, EA, to name but a few.

Within this broader scope, architecture can signify the art and science of designing an artefact, the blueprint (design) for an artefact, the product of such a design, or broad underlying principles such as style and inclusiveness (Jonkers et al., 2006). Consequently, it is the architect's

responsibility to create a blueprint of the entire structure and its ecosystem, keeping in mind the intended purpose and any design limits imposed by principles (Jonkers et al., 2006).

3.3. And What Exactly is an Enterprise?

The term *enterprise* comes from the Latin *prender* (to take) and reached English via the French *entreprendre*, which meant "something undertaken" (OED, 2018). Simply stated, the enterprise is an undertaking launched by an *undertaker* who is called the *entrepreneur* – someone with the initiative to venture, the knack to organise and lead, and the courage to take risk (Frederick et al., 2016). The undertaking might be in business as well as in science, technology, and other social ventures like sending humans into outer space or setting up community-support organisations.

Extensionally defined, the term *enterprise* refers to an organisation, firm, corporation, or business without significant distinction (Haines et al., 2005; Hoogervorst, 2009). *Firm* is the widely used term in the economics literature, although *organisation* is commonly used in social and organisational studies. In business studies, the terms *corporation* and *company* are in common use. However, the enterprise engineering and architectural literature insists on using the term enterprise, even if what is basically referred to is the organisation or organisations.

Companies and their suppliers, multiple government agencies working together, or government agencies working across international borders are all examples of the kinds of entities that the enterprise definitions provided in Table 4 aim to include. The boundary of an enterprise is set where the common goal shared by its constituents fades. Minoli's (2008) concept of the extended enterprise, which binds the organisation with its external stakeholders such as customers and suppliers, is in line with this understanding of the enterprise.

Table 4
Some definitions of enterprise

Source	Definition
Giachetti (2010)	"… a complex, socio-technical system that comprises interdependent resources of people, information, and technology that must interact with each other and their environment in support of a common mission" (p. 4).
Hoogervorst (2009)	"… enterprise is an intentionally created entity of human endeavour with a certain purpose" (p. 4).
ISO/IEC/IEEE (2015)	"… group of people and facilities with an arrangement of responsibilities, authorities and relationships EXAMPLE Company, corporation, firm, enterprise, institution, charity, sole trader, association, or parts or combination thereof" (p. 7)
(Lankhorst, 2017) Lankhorst (2017)	"… any collection of organisations that has a common set of goals and/or a single bottom line" (p. 2).
Rebovich Jr. (2016)	"… an entity comprised of interdependent resources (e.g., people, processes, organisations, technology, and funding) that interact with each other (e.g., coordinate functions, share information, and allocate funding) and their environment to achieve goals" (p. 34).

Furthermore, the enterprise – as in enterprise software or enterprise computing – is a referent of the *bigness* of the organisation's scale and complexity (Giachetti, 2010). In the context of EA, the enterprise is an all-encompassing concept which accommodates all the ranges of complexity of an organisation – from a simple project to a programme; from an organisational unit like a department to an amalgamation of organisations working around a common mission or goal; and even the virtual organisation (Giachetti, 2010; Minoli, 2008).

There are several types of enterprises. For example, Giachetti (2010) distinguishes them by their mission as businesses, government entities, not-for-profits, and virtual enterprises (such as short-lived projects and programmes). In addition, we can distinguish a network of firms as a fifth type of enterprise developed when organisations desire to collaborate to achieve a common purpose. Manufacturers, for instance, integrate with their suppliers and logistics operators to create a supply chain; smaller colleges create affiliations with bigger universities; and banks interoperate; all creating an enterprise of enterprises.

According to Giachetti (2010), all enterprises are human-made systems composed of human and material components interacting to achieve a goal or goals within their ecosystem. Giachetti's (2010) definition of the enterprise as a goal-directed sociotechnical system emphasised the three fundamental constituents of a system, namely elements, interconnections, and a reason for existence (Meadows & Wright, 2015). Similarly, Daft (2007) emphasised the four important characteristics of the enterprise which are: (a) being a social entity despite the extended use of technology; (b) goal-directedness; (c) intentionality of design; and (d) having environmental interrelation.

Particularly, Daft (2007) recognised the conscious and intentional design of an organisation as the basis for determining the methodology of organisational design. The enterprise is characterised as a multi-minded body, the members of which share values that are enshrined in a shared culture and who are in a voluntary association to seek goals that are linked with both personal and group objectives (Rebovich Jr., 2016).

Thus, one can define the enterprise as a sociotechnical system which humans, in their struggle to survive and thrive, have created to achieve a goal or a set of goals. As a system, the enterprise is in constant interaction within itself as well as with the environment to achieve effective coordination of internal functions, to share information, and to allocate resources (Giachetti, 2010).

In this thesis, the word *enterprise* assumes two related yet slightly different meanings. In the first generic sense, an enterprise is an organisation created by humans to attain their efficiency and effectiveness goals (Hoogervorst, 2009). The word *organisation* can sometimes appear in lieu of enterprise within this broader context. The second refers to the specialised sense in which the word is used in EA. In this sense, the enterprise can be an organisation, a set of organisations, or even an organisational unit tied together to serve a strategic purpose (Hoogervorst, 2009). This meaning is inferred whenever the word is used in connection with architecture.

3.4. Enterprise Architecture – Common Definitions

As a result of our understanding of the two terms that comprise EA, it is possible to interpret it as referring to refer to the architecture of the enterprise or the general statement of the principles that guide the design of the organisation. Nevertheless, EA is more than what its constituent elements describe. Some relevant descriptions of the term are provided in Table 5.

Table 5
Selected definitions of EA

Source	Definition
Gartner (2020)	"… a discipline for proactively and **holistically** leading enterprise responses to disruptive forces by identifying and analysing the execution of change toward desired business vision and outcomes. EA delivers **value** by presenting business and IT leaders with signature-ready recommendations for adjusting policies and projects to achieve targeted **business outcomes** that capitalize on relevant business disruptions."
Giachetti (2010)	"… describes the **structure** of an enterprise, its decomposition into subsystems, the **relationships** between the subsystems, the relationships with the **external environment**, the terminology to use, and the guiding **principles** for the design and evolution of an enterprise" (p. 102).
ISO/IEC/IEEE (2011)	"… fundamental concepts or properties of a system in its **environment** embodied in its **elements**, **relationships**, and in the **principles** of its design and evolution" (Section 3.2).
Lankhorst (2017)	"… a **coherent whole** of **principles**, **methods**, and **models** that are used in the design and realisation of an enterprise's organisational **structure**, business **processes**, information **systems**, and **infrastructure**" (p. 3).
Ross et al. (2006)	"… the organising logic for business processes and IT infrastructure reflecting the **integration** and **standardisation** requirements of the company's operating model" (p. 47).
Shah & Kourdi (2007)	"… an **integrated** and **holistic** vision of a system's fundamental organization, embodied in its **elements** (people, processes, applications, and so on), their relationships to each other and to the environment, and the **principles** guiding its design and evolution" (p. 36).

Note. Emphasis mine.

Based on analysis of the definitions in the literature, I tentatively conclude that EA is ecosystemic, synergistic, strategic, stakeholder-focused, and regulative. In Section 3.5, I delve more into EA's distinctive characteristics.

3.5. Enterprise Architecture – Views

In the preceding sections, I examined EA through its constitutive terms. It is, however, more appropriate to try to discern the ontology or whatness of EA by revealing its formative characteristics. Multiple viewpoints on EA have been presented by researchers and practitioners. The conceptual analysis of the literature shows that the most prominent views emphasise the

holistic, strategic, stakeholder-focused, regulative, and ecosystemic characteristics of EA. In this section, I explore these viewpoints.

3.5.1. Enterprise Architecture as System Blueprint

As learned from thousands of years of artefact building, particularly in the built environment, descriptive representations that answer the what, how, where, when, who, and why of the artefact under construction provide a holistic view of the thing early in the development process, allowing environmental adaptation with a minimal cost burden (Kappelman, 2010). Architecture – also known as preliminary design – provides such a holistic view in civil engineering and related fields. Architecture abstracts the solution domain within normative constraints or design principles and serves as the foundation for detailed design (Chen et al., 2008).

Hoogervorst (2009) conceded that EA is more commonly understood as a blueprint than as anything else. In a similar vein, Smolander et al. (2002, 2008) indicated that the system blueprint metaphor of architecture is the most widespread, particularly among programmers and system implementers.

According to Zachman (2010), architecture represents the essential description of the object or system one sets out to build. We need such a descriptive representation because, as Zachman stated, one cannot build what one cannot articulate. Furthermore, system maintenance and upgrade are only possible if one has the system's architecture (Zachman, 2010).

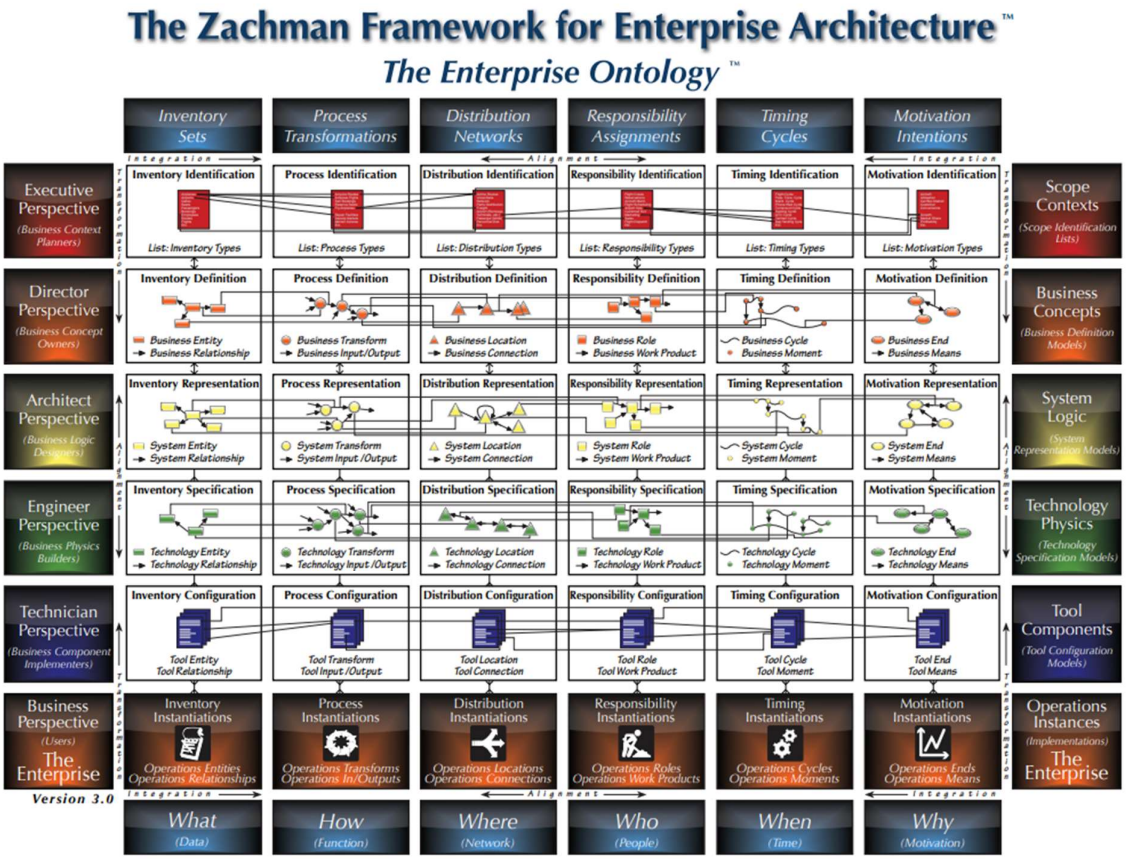
The well-known Zachman framework, depicted in Figure 4, is a representation of EA as a set of plans or blueprints that represent the viewpoints of system stakeholders with respect to the wh-questions addressing the system. EA could thus be understood as a system-level abstraction which captures the relatively stable essentials (abstractions) of the enterprise, guiding implementation of components (Jonkers et al., 2006; D. J. Nightingale & Rhodes, 2015; Smolander et al., 2008). In EA, systems thinking enables the collection, analysis, and synthesis of the essence of the enterprise. This, in turn, facilitates the smooth transfer of information from the architect to the implementer, ensuring optimal and successful system transformation (D. J. Nightingale & Rhodes, 2015).

EA focuses primarily on four enterprise aspects: business, data, application, and technology (Lankhorst, 2017; Pankowska, 2013). The business domain is a reification of the organisation with its structure, processes, strategies, and governance architecture. The data and application architectures refer, respectively, to data assets and business applications. On the other hand, the technology architecture is concerned with hardware and network platforms. While the Open Group architecture framework (TOGAF) represents these four aspects of the enterprise via

reference models, the earliest of the EA frameworks (Zachman) presented in Figure 4, specifies models for each of the views and contexts.

Figure 4

The Zachman framework for enterprise architecture (version 3)



Note. From Zachman international, by J. A. Zachman, 2011 (http://zachman.com). Copyright 1987-2011 by J. A. Zachman.

Even though some like Hewitt (2019) argued that the blueprints that are produced in EA are not "actual blueprints" (p.8) and that the term itself is a misappropriation, one can safely state that EA is a description of the system-wide organisation and business context in which software or any technological component operates (Chen et al., 2008).

Nightingale (2009) made the observation that the role of the enterprise architect is more akin to that of an urban planner than to a building architect who works primarily in greenfield environments. The diversity and complexity of environmental elements impacting the work of the enterprise architect and urban planner are significantly larger than those influencing the work of the building architect. Nightingale (2009) said, the enterprise architect "design[s] for change to be implemented in a functioning complex system within a living ecosystem" (p. 8).

3.5.2. Enterprise Architecture as Product

In the built environment, the plan as well as the product are commonly recognised as architecture. The conception of the architecture, both as design and product, conforms to the definition of architecture suggested by Dietz (2006) and Hoogervorst (2009).

Slightly different from this is what Zachman (2010) asserted about the meaning of architecture. He claimed that buildings like the Roman Colosseum are not architecture. They are the results of architecture, which is composed of descriptive representations or blueprints. Zachman argued that the product is an instance of the architectural template.

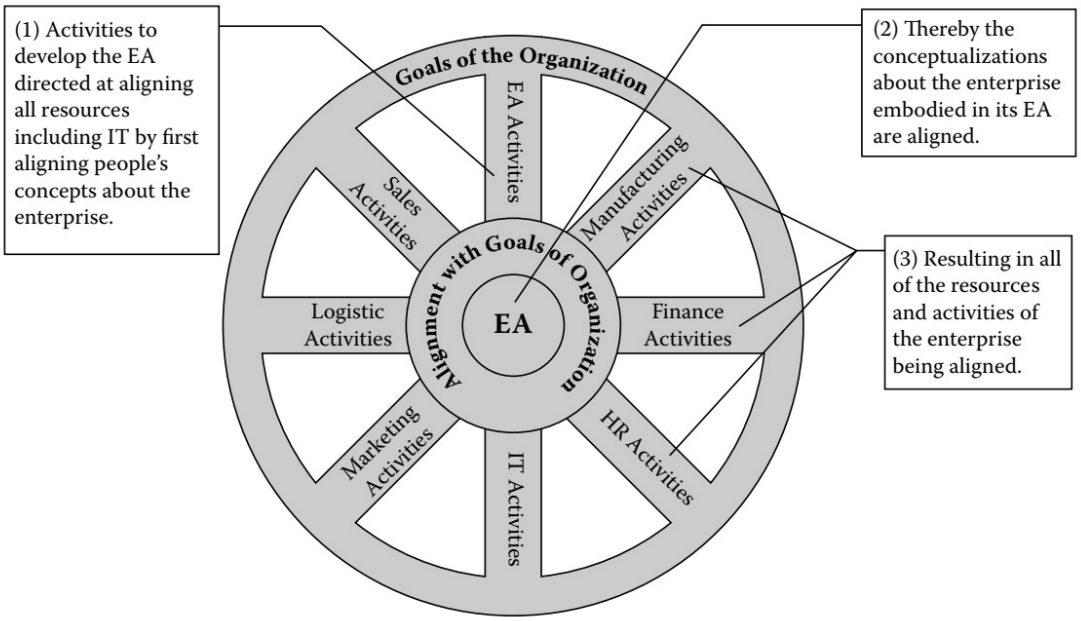
For all practical reasons, the distinction between the instances and their templatic class is quite hazy. The finished output cannot be the same as the descriptions that generated it. Yet, it is from the abstracted descriptions that the end result is built. Therefore, it would not be far from the truth to call the Colosseum architecture. EA, by the same analogy, may be seen of as the final product of architectural design. The product (architecture) is modelled after the blueprint; hence, organisations need to establish the purposes, guiding principles, inputs, and processes that go into making the architecture.

3.5.3. Enterprise Architecture as Strategy

As defined by Rebovich (2016), a strategy is the "way an agent responds to its surroundings and pursues its goals" (p. 46). Essentially, IT strategy must align with business strategy. According to the *enterprise wheel* model depicted in Figure 5, the role of EA is to align IT with the various activities of the enterprise and its strategy. The hub of the model represents EA, which is the logical description of the entire system. From this logical representation, the physical realisations emanate, such as activities, infrastructures, and resources (Kappelman, 2010).

EA provides the comprehensive macro level transformational agenda which, effectively, is an elaboration of the enterprise's strategy (Greefhorst & Proper, 2011). All programmes and projects of the enterprise pass through a rigorous strategic planning process under the EA masterplan. Strategy, as a future-looking rational positioning of the enterprise, should be elaborated upon to lead to implementation (Lapalme, 2012). The strategy is transformational in the sense that the status quo is deemed insufficient, and a better future position is sought, which can only be reached through drastic changes in vision, mission, capabilities, and operations.

Figure 5
The enterprise wheel



Note. From The SIM Guide to Enterprise Architecture (p. 4), by L. Kappelman, 2009, CRC Press. Copyright by Taylor and Francis Group, LLC. Reprinted with permission.

EA is strategic as far as it commits the enterprise to the future. EA facilitates the alignment of the enterprise with possible future realities. In order for this to happen, continuous environmental scanning is required, as the enterprise ecosystem is in continuous flux. According to Nightingale & Rhodes (2015), architecting is fundamentally innovative, and demands a forward-looking stance.

Hewitt (2019) defined the work of the architect as comprising "the set of strategic and technical models that create a context for position (capabilities), velocity (directedness, ability to adjust), and potential (relations) to harmonize strategic business and technology goals"(p. 11). He argued that this definition establishes the right balance between technology-centredness manifested in some organisations and the business obsession in some others. Since architecture is a game of trade-offs, the architect must determine what is sufficient to satisfy, by discovering the important concerns for a particular system and the conditions for satisfying them sufficiently (Hewitt, 2019; J. Klein & Weiss, 2009).

An assertive display of the EA as strategy view is to be found in Ross et al. (2006), who, in their book entitled *Enterprise architecture as strategy*, outline how organisations can navigate through four organisational EA maturity phases while realising operational models through EA. They portray EA as a business issue that is about integrating and standardising business processes.

Pankowska (2013) made the subtle distinction between architecture and strategy. She argued that architecture is a relatively static picture which is made operational by strategy. Rather, a proper view of EA is one which encapsulates the static (blueprint), dynamic and prescriptive aspects of the enterprise – one which captures the enterprise both in its steady state and in motion. As Pankowska (2013) said, EA is a strategic perspective which defines what is to be done and how.

3.5.4. Enterprise Architecture as Principles

From the Latin *principium*, principles are statements of foundational tenets that govern behaviour and action (OED, 2019b). Principles are high-level specifications of value that constrain decisions and business cases, whether in the built environment or in business. Principles, according to Minoli (2008), "are founded in the beliefs and values of the organisation and expressed in language that the business understands and uses" (p. 51).

Architecture limits the design space by addressing major design considerations that go beyond the boundaries of a project (Greefhorst & Proper, 2011). This is consistent with the earliest meaning assigned to terms such as "computer architecture" or "operating system architecture" (van Bommel et al., 2007). Similarly, the architectural principles of Vitruvius and of Ruskin place normative design restrictions on the architect operating in the built environment (Baljon, 1997; Hewitt, 2019).

EA places normative limits on design. Hoogervorst (2009) argued that the very purpose of architecture is to provide normative guidance to the designer. According to Hoogervorst (2009), architecture itself is nothing but "a consistent set of design principles and standards that guide design" (p. 128). The *normative principles* we have in EA are contrasted with the *scientific principles* that are commonplace in the areas of science and technology since the latter are meant to represent "laws or facts of nature underlying the working of an artificial device"(Proper & Greefhorst, 2010, p. 62) .On the other hand, Dietz (2006) asserted that the architecture of the enterprise is the normative limit placed on design. He refers to the actual designs of EA as *enterprise ontology*.

Van Bommel et al. (2007) and Proper & Greefhorst (2010) made a distinction between the *regulative* and the *designing* perspectives of EA. The designing perspective depicts EA as a system blueprint while the regulative perspective views EA as placing normative restrictions on design. Similarly, TOGAF, which is one of the most popular EA frameworks, acknowledges that architecture can refer to the principles governing the design and evolution of system components, as well as to the formal description of the system that guides its implementation (Pankowska, 2013). EA principles can thus be understood as sustainable (enduring) normative statements of

value that influence structures, processes, systems, and infrastructures of the organisation. They serve as beacons in directing behaviour (Pankowska, 2013; van Bommel et al., 2007). In this view, EA is about prescribing what the system should look like rather than about describing what it is (Hoogervorst, 2009).

EA principles are expected to be *specific*, *measurable*, *achievable*, *relevant*, and *time-bound* (SMART). In addition, the principles must be *understandable* or devoid of ambiguity, *categorical*, and *exacting*, so as to cover all conceivable decision scenarios, *consistent*, to avoid contradictions with other principles, and *stable*, to ensure the long-term viability of systems based on them (Greefhorst & Proper, 2011; Proper & Greefhorst, 2010; van Bommel et al., 2007) . We can therefore conclude that the resilience of EA may be found in its guiding principles (Greefhorst & Proper, 2011; Hewitt, 2019).

3.5.5. Enterprise Architecture as Sustainability

Sustainability, derived from the Latin *sub-tenere* ("to uphold'), is a normative ethics concept concerned with the effective use of finite resources in the interests of present and future stakeholders (Heinrichs et al., 2016). Sustainability carries a normative as well as an active progressive meaning (Heinrichs et al., 2016). In its passive connotation, sustainability signifies keeping or maintaining stability, and in its active form, it suggests progressing towards an ideal condition (Pankowska, 2013).

The goal of sustainability thinking is to strike a balance between fulfilling the needs and wants of individuals, on the one hand, and sociocultural diversity, equity, transparency, and generational and intergenerational justice, on the other (Ballet et al., 2011; Baumgärtner & Quaas, 2010). It is premised on the fact that natural resources are finite and, unless they are utilised with the interests of present and future generations in mind, economic upheavals and environmental calamities will materialise, thereby destroying the social fabric (Heinrichs et al., 2016).

Sustainability accounts for the economic, social, and environmental goals of the enterprise and/or the society at large (Blackburn, 2015; Montiel, 2008). Economic sustainability is about achieving long-term success in the business goals of the organisation (Dyllick & Hockerts, 2002). Ecological sustainability aspires to extend the longevity of the natural world through the informed use of resources (Dyllick & Hockerts, 2002). Social sustainability, on the other hand, maintains that organisations need to secure the overriding consent of the society under which they are operating (Dyllick & Hockerts, 2002; Lapalme et al., 2016).

Sustainability must therefore be investigated from economic, social, and environmental viewpoints at the individual, organisational, and society levels (Pankowska, 2013). Decisions

made by an individual, organisation or society impact the economic conditions or livelihoods of current and future stakeholders at local, national, and global levels. Individual decisions may also impinge on the social and cultural life of stakeholders as well as on the well-being of living and non-living natural systems.

From a moral and strategic vantage point, the concept of sustainability is "universal" since sustainability challenges are felt all around the world (Heinrichs et al., 2016). Consequently, nearly all nation states aim to achieve the United Nations's (UN's) sustainability goals. Similarly, many organisations all over the world have included sustainability into their mission statements in recognition of their responsibilities for ecological, economic, and social sustainability.

In the EA domain, Lapalme's (2012) ecosystem view proposes to extend EA to the enterprise environment to account for the needs and aspirations of all human and non-human stakeholders (Drews & Schirmer, 2014). By providing mechanisms for aligning sustainability strategies with IT capabilities, EA enables organisations to develop and to wield a holistic plan of environmental, social, and economic sustainability (Pankowska, 2013; Sutherland & Hovorka, 2014). They asserted that the use of EA ensures transparency, credibility, comprehensiveness, and consistency for corporate sustainability. However, the promise of EA for corporate sustainability has not been not fully realised (Pankowska, 2013; Sutherland & Hovorka, 2014).

3.5.6. Enterprise Architecture as a Worldview

In a philosophical treatment of the subject, Mentz et al. (2014) asserted that EA is to enterprise what a worldview is to the world. The following definition of worldview is from Sire (2015):

> *A worldview is a commitment, a fundamental orientation of the heart, that can be expressed as a story or in a set of presuppositions (assumptions which may be true, partially true or entirely false) which we hold (consciously or subconsciously, consistently or inconsistently) about the basic constitution of reality, and that provides the foundation on which we live and move and have our being. (p. 141)*

First used by Immanuel Kant (1724–1804), the concept of a worldview is used in the natural and social sciences as well as in humanities (Sire, 2015). A worldview – also known as Weltanschauung, is the philosophy, mindset, outlook, ideology, faith, or even religion of an individual or society. A worldview is not, however, a mere statement of disparate and independent beliefs. Similar to a puzzle which only gives a complete picture when ordered in a particular organisation, a true worldview is achieved only when the beliefs one holds are interrelated, interconnected, and unified (Dewitt, 2018).

As every individual has a worldview, so every organisation has an EA – whether that is expressed formally or otherwise. Through the explication of the epistemology, metaphysics, teleology, theology, anthropology, and axiology of an enterprise, a worldview could provide a fundamental and comprehensive (re)statement of its EA. However, EA is more of a paradigm than an individual worldview as it is shared by a group of people or a community (Rousseau & Billingham, 2018). EA is thus the shared worldview of an enterprise's stakeholders.

EA is not exactly the models, narrations, stories, and presuppositions as which it is usually portrayed or represented although all of these are required at some level. Perhaps this disposition or commitment of the essence of the organisation is represented in the organisational mission, explicit or implied. It is not what one sees basically in the patterns of behaviour of the organisation; rather, it is the motive behind that pattern. The fundamental orientation of the organisation is ground motive for its existence.

The underlying assumptions on which one constructs EA may or may not be true. They can also be held consciously or unconsciously, consistently or inconsistently. One cannot claim exactness in their knowledge of the enterprise itself. Regardless, EA is an ontological assumption or commitment about the enterprise.

EA as a worldview model is equivalent to the ontological model of Dietz (2006).The enterprise ontology is defined as the implementation-independent abstract representation that captures the essence of the complex organisation in a coherent, comprehensive, consistent, and concise way (Dietz, 2006; Hoogervorst, 2009). Furthermore, as an individual's worldview evolves over time, so should the EA of an organisation. The enterprise worldview model – the enterprise ontology – remains true to the nature of the enterprise by keeping pace with its dynamic nature (Dietz, 2006).

3.6. Overlapping Concepts and Borderline Cases

A few other concepts are frequently mixed up with EA, which can lead to some confusion. These are examples of notions that either overlap or are on the cusp of being distinct. When trying to sketch out the boundaries of the area of interest, it is helpful to be familiar with such concepts. In this section, I will deal with four of these, namely enterprise engineering, enterprise information system, system architecture, and software architecture. Illustrative definitions of these terms are provided in Table 6.

Table 6
Concepts that bear similarities with EA

Concept	Definitions
Enterprise engineering	"Enterprise Engineering is defined as the body of knowledge, principles, and practices to design an enterprise. The key of the definition is to design, which is considered the characteristic, defining activity of engineering. Moreover, an enterprise is not designed just once, but an enterprise is, to varying degrees, redesigned many times until its eventual retirement" (Giachetti, 2010, p. 3).
Enterprise (Information) Systems	"The technology-implemented part of the IS of the enterprise…. integrated systems that support the entire enterprise, and include ERP modules, decision support (business intelligence, data mining, etc.), integrated databases, business process integration, supply chain management and customer relationship management" (Bernus et al., 2016, p. 2).
System architecture	"The system architecture describes how the information technology components are organized into an overall system" (Giachetti, 2010, p. 383).
Software architecture	"The software architecture of a system is the set of structures needed to reason about the system. These structures comprise software elements, relations among them, and properties of both" (Bass et al., 2022, p. 3).

As a starting point, it would be helpful to distinguish between engineering and architecture. Engineering is the designing and constructing of artefacts based on design specifications (Saenz et al., 2009). According to Bass et al. (2022), architecture is an abstraction while engineering is implementation. Architecture provides the general descriptions or implementation principles for sociotechnical systems. Engineering, on the other hand, executes these plans and has traditionally focused on technical system components. Enterprise engineering incorporates systems theory and engineering concepts and specifications into the design and implementation of EA. If we consider architecture to be the strategy, then engineering is its implementation. To all intents and purposes, the two responsibilities are complementary.

Enterprise information systems are the many software modules that provide interoperability throughout the functional domains and supply chain of an enterprise (Bernus et al., 2016). EA plans for the business, data, application, and infrastructure needs of the enterprise. Enterprise information systems are therefore the outputs of this planning process.

Associated with enterprise information systems is the concept of software architecture. In TOGAF and other EA frameworks, software architecture is identified as a major viewpoint along with business, technology, data, and security architectures. Software architecture is an aspect of EA that abstracts the software process and its behaviour (L. Bass et al., 2022). Smolander, Hoikka, et al. (2002) admitted that the conventional definition of a software architecture is limited to high level abstraction of the software components but indicated that it

spans to fit the contextual views of stakeholders, and at times, even covers the EA domain. I will nonetheless maintain the original focus on software architecture as a constituent of EA.

Chen et al. (2008) differentiated between Type 1 and Type 2 architectures. System architectures (Type 1 architectures) deal with the design of a system, e.g., the system part of an overall enterprise integration. On the other hand, enterprise reference projects (Type 2 architectures) deal with the organisation of the development and implementation of a project such as an enterprise integration or other enterprise development programme. They identified EA frameworks such as the Zachman framework as Type 2 architectures aiming at structuring concepts and activities/tasks necessary to design and build a system. System architecture could therefore be considered as one component of EA (Giachetti, 2010).

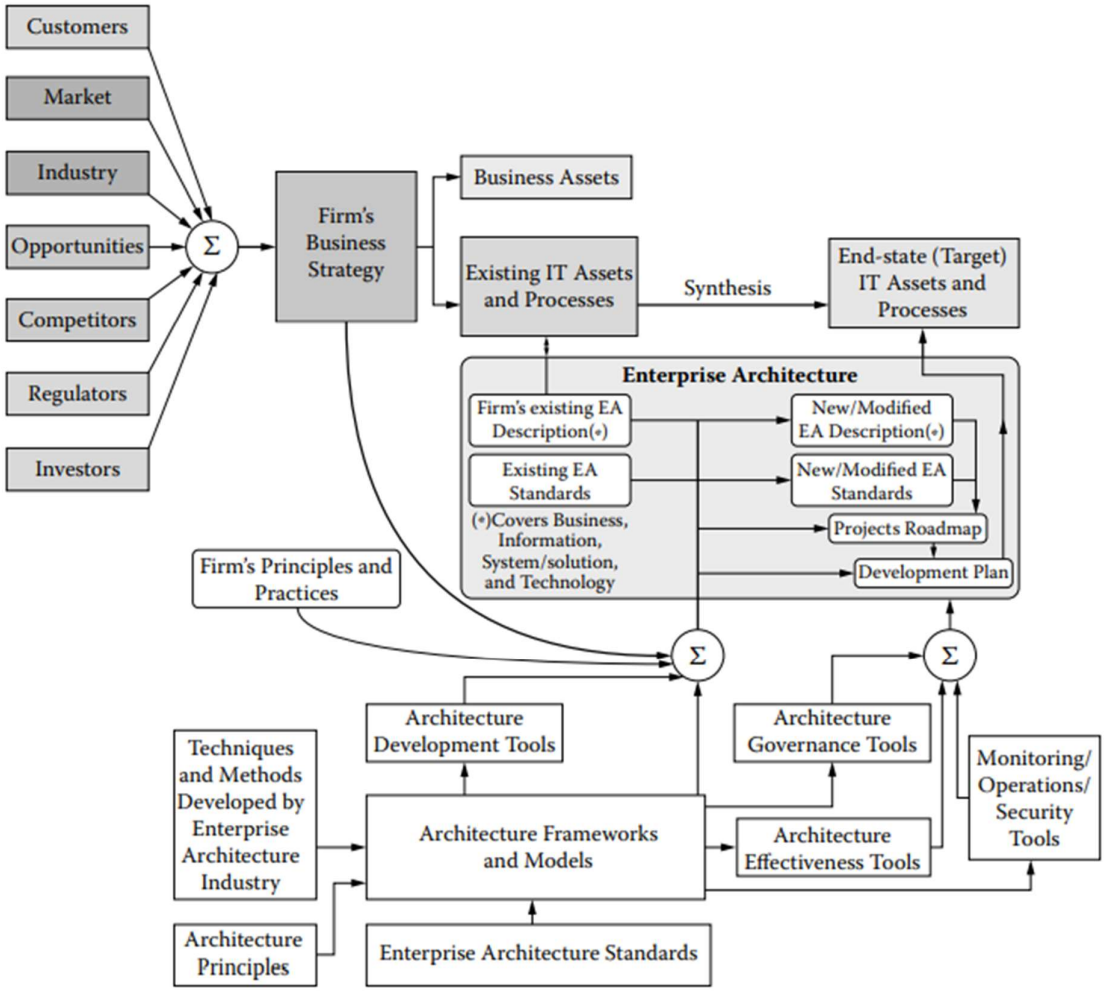
3.7. Antecedents and Consequences

It is impossible to provide a comprehensive description of a concept without discussing its causes and effects. In this section, I will give a brief account of the sources and outcomes of EA.

Architecting is the act of creating a blueprint for the enterprise to follow in order to achieve its desired vision for the future. It comprises analysing the current enterprise in the context of its dynamic operating ecosystem, constructing a holistic vision of the future, producing, and assessing alternative solutions, and selecting a future architecture to actualise the envisioned future.

According to Lankhorst (2017), the antecedents of EA are principles, methods, and models. On the other hand, Minoli (2008) identified business strategy, principles and practices, architecture tools, frameworks, models, standards, governance and control tools, and existing business and IT assets as inputs of the EA planning process. Figure 6 is Minoli's (2008) depiction of EA in its environmental setting.

Figure 6
EA in its environmental context



Note. From *Enterprise Architecture A to Z* (p.10), by D. Minoli , 2008, Auerbach Publications. Copyright 2008 by Taylor & Francis Group, LLC. Reprinted with permission.

In the intermediate phase, architecting culminates in an implementation plan that accounts for available resources and a time horizon for completing the transformation (D. J. Nightingale, 2009; D. J. Nightingale & Rhodes, 2015). The outputs of EA are organisational structures, business processes, information systems, and infrastructure, which may bring about individual, organisational, and societal transformations (Lankhorst, 2017; Minoli, 2008).

3.8. Enterprise Architecture – Retrospect and Prospect

It is important to revisit the historical progression of EA not only to understand the genesis of the practice but also to map out its path of development along the lines of greater technological sophistication and heightened concern for human needs.

The term architecture was first used in computers and related disciplines in the 1960s, although only in the context of hardware and software design (van Bommel et al., 2007). The

modern history of system architecture began in various disciplines at the same time in the 1990s (Bernus et al., 2016; Lapalme et al., 2016). Researchers and practitioners in industrial engineering, in particular, have left a visible imprint on systems architecting.

In the last two decades of the second millennium, system architecting evolved from a tool in the hands of control engineers to a toolset in the hands of organisational strategists and information systems professionals. The scope of system architecting has expanded from small, usually relatively closed, systems, to larger and more open ones. The consequence is the flourishing of architecting in enterprise management with the emphasis shifting from *control* to *management*, giving birth to what is now called EA (Bernus et al., 2016).

Although the first EA framework was not published until the second half of the 1980s, business systems planning was already at full throttle beginning in the 1960s, contemporaneously with system architecture (Kotusev, 2016). Since then, EA has been developing in several distinct yet interrelated fields including industrial engineering, organisational theory, computing, and information systems.

While John Zachman is widely regarded as the father of EA research in information systems, one cannot ignore the contributions of earlier thinkers in systems science, operational research, and other related fields (Kappelman, 2010; Kotusev, 2016). Later researchers and practitioners built on the Zachman schema to develop more elaborate frameworks, techniques, and tools. EA is now a rapidly evolving discipline, with well-established frameworks such as TOGAF, GERAM, and MDA; description languages such as IDEF, UML, and BPMN; and a plethora of technologies built on these frameworks and languages (Buckl & Schweda, 2011; Lankhorst, 2017).

In their widely cited work, Lapalme (2012) captured the progression of EA in three stages; i.e., the technical, the sociotechnical, and the ecosystem schools (Korhonen & Poutanen, 2013; Lapalme, 2012). The three schools represent the historical evolution of EA in which the technical is subsumed under the sociotechnical which, in turn, is appropriated and expanded by the ecosystemic. Table 7 presents exemplar descriptions of the three schools.

The technology-centric *Enterprise IT Architecting* school aims to meet the efficiency and profitability goals of the organisation through technology use (Lapalme, 2012; Zexian, 2007). According to this school of thought, EA is the glue that links the business with IT, implying that there is a tenuous connection between the two components of an organisation. Consistent with this belief, the school adopts a reductionist, analytic approach to system design.

Table 7
EA schools: Exemplar definitions

EA School	Exemplar Definitions
Enterprise IT architecting school	An EA "is a plan of record, a blueprint of the permitted structure, arrangement, configuration, functional groupings/partitioning, interfaces, data, protocols, logical functionality, integration, and technology of IT resources needed to support a corporate or organisational business function or mission " (Minoli, 2008, p. 35).
Enterprise integration school	EA "is a top-down, business-strategic driven process that … represents the holistic expression of the key business, information, application, and technology strategies of the enterprise and their impact on business functions and processes" (Buchanan & Soley, 2002, p. 5).
Enterprise ecological adaptation school	EA "involves understanding the current enterprise in the context of the ever-changing environment within which it operates (what is called its ecosystem), creating a holistic vision of the future, generating and evaluating alternatives, and selecting a future architecture to realise the envisioned future" (Nightingale & Rhodes, 2015, p. 11).

The *Enterprise Integration* school, on the other hand, defines EA as the link between strategy and execution, its main objective being the translation of strategy into action. Within the organisational boundary, this school posits conceptualising EA as a holistic integrative mechanism.

The *Enterprise Ecological Adaptation* school transcends the other two schools by promoting system-in-environment coevolution (Lapalme, 2012). Thus, Nightingale and Rhodes (2015) emphasised the utility of EA as the means for organisational innovation and sustainability. They stated that innovation entails being forward-looking in order to position the enterprise in the most advantageous competitive position for the future. Consequently, the ecological adaptation school encourages businesses to examine their existing and future states holistically and strategically.

3.9. Discussion

This chapter, along with the next, serves to substantiate the four propositions I forwarded in Chapter 1. By way of offering a concept analysis of EA, I have made an effort to lend credence to the assertions that I made at the beginning of the study. I have covered the first three propositions (**P1** to **P3**) in this chapter, and the fourth proposition (**P4**) will be addressed in Chapter 4.

3.9.1. Enterprise Architecture as Patterns of Sociotechnical Systems

In stating my first proposition, I characterized EAs as patterns of sociotechnical systems. EA can be understood as a purely technical discipline aimed at modelling a system architecture to serve the interests of the enterprise (read owners). In such a conception of EA design, the technical component has been stressed much more than the social (Kloeckner & Birkmeier, 2010). In

contrast, progressive views of the enterprise maintain that it is a social entity consciously constructed by humans to pursue human objectives (Hoogervorst, 2009; G. R. Jones, 2013). The social and technical elements that make up the enterprise are in continuous interaction in the performance of the enterprise's essential functions to achieve stakeholder goals (Daft, 2007). EA, as an extension to enterprise strategy, should therefore be considered as a sociotechnical architecture designed to cater for the needs of stakeholders (Kloeckner & Birkmeier, 2010; Korhonen et al., 2016).

According to Daft (2007), there is intentionality to the design of an enterprise. Methodologically, the best perspective to understanding and designing enterprises can be achieved only through holism (Bernus et al., 2016; Lapalme et al., 2016; Panetto et al., 2016). In particular, Lapalme et. al. (2016) stressed that a holistic analysis of EA which takes account of the changing economic, environmental, and human conditions is required. Several management theories have also demonstrated that organisations and their governance cannot be explained through the exclusive use of engineering-oriented theories, techniques and tools (Bolman & Deal, 2017). Thus, an exclusively technical and structural understanding of organisations is impractical. The holistic treatment of EA is possible when we conceptualize EA as a socio-technical architecture.

Indeed, there are compelling reasons to support the holistic treatment of EA. To start with, the core of EA lies in the term *enterprise*, which is nothing but a sociotechnical system that is designed to cater for the goal or goals of the enterprise (Kloeckner & Birkmeier, 2010). The goals define the reason for existence of the enterprise, but there may be multiplicity of goals that the enterprise must optimize (Meadows & Wright, 2015). The multiplicity of its stakeholders means that the enterprise is multi-minded and therefore its members may promote personal or group goals (Rebovich Jr., 2016). Enterprise management requires synchronisation of efforts and resources to attain a high level of effectiveness and holistic harmony.

In addition, technology is typically implemented in a social context (Brey & Søraker, 2009). Even when the technology is autonomously functioning like in self-driven vehicles, its use and the impacts thereof cannot escape social scrutiny. Thus, it might be instructive to understand EA as lying at the intersection of the enterprise, technology, and the enterprise ecosystem and therefore the socio-technical approach seems appropriate in the study of EA.

3.9.2. Enterprise Architecture as Promoters of Stakeholder Value

Enterprise systems are essentially complex. Architecture is imperative when the thing we are building is complex in scope, time, and cost (Kappelman, 2010). In the built environment, architecture is understood as functionality, resilience, and beauty, which could be mapped

respectively to structure, aesthetics, and ethics. One may extend Ruskin's (1849) definition of architecture as *edifices* created for "whatsoever uses" (see Table 3) to include organisational, material, or artistic creations which humans build with the express or implied objectives of raising their overall well-being. The architecture is material, functional but emphasis must be placed on the moral and spiritual instead (Baljon, 1997; Conway & Roensch, 2005).

The transformation of the enterprise from a mechanistic, to a biological and finally to a sociotechnical and socio-cultural mode entailed changes in its goals. In the mechanistic mode, enterprises are share-holder focused; in the biological mode they are survival focused; but in the sociotechnical mode they expressly work to serve all their stakeholders (Gharajedaghi, 2011). EA serves as a platform for stakeholder collaboration and communication. Its preoccupation is more with capturing and representing stakeholder expectations than with providing a detailed design manual (Chen et al., 2008).

For a long time, the way stakeholders were conceptualised and treated in EA has been in a narrow, system user sense (Niemi, 2007). Only those stakeholders who interact with the EA by either providing inputs or those who must comply with the EA specifications were taken as stakeholders (Niemi, 2007; van der Raadt et al., 2008). This narrow definition of the stakeholder in EA perceives the stakeholders as objects of interest which could be employed to achieve the goals of the enterprise. On the other hand, there is some level of recognition of stakeholders' needs, goals, and expectations in EA. For instance, the *ISO/IEC/IEEE 42010:2011* acknowledged stakeholders with their concerns and views (ISO/IEC/IEEE, 2011; Lankhorst, 2017).

Several researchers have identified heterogeneity of stakeholder interests as one of the most prominent challenges in EA (Gorkhali & Xu, 2017; Júnior et al., 2020). This variety in stakeholder values is not to be shunned, though. Rather, it is to be captured, magnified, and converted to beneficial organisational capabilities. The strategic role of EA is to serve as an instrument for creating common understanding and reference among the stakeholders of the enterprise who often times have conflicting interests and views (Zexian, 2007). In this strategic view, the stakeholder is an actor with his/her own choices and interests and the relationship should be one of mutuality. Thus, EA should expand the choices of stakeholders. In this way, we can tightly tie the interests of the shareholders, the other stakeholders, and the organisation in general. Articulating the needs, goals, and expectations of the various stakeholders and striking a balance among the competing interests of stakeholders would therefore be the task of the enterprise architect (Lankhorst, 2017; Zexian, 2007). This is what I call the conscious EA.

Haines et al. (2005) indicated that a system may seek to achieve multiple outcomes as it is composed of system components with different goals. The implication of the proposition P-1 is recognizing all stakeholders as goal-directed, and channelling EA design towards advancing the

values of the stakeholders. As allopoietic societal systems, organisations depend on external as well as internal entities, who define their purpose (Dekkers, 2017). As a result, the purpose of the organisation can only be fully investigated through stakeholder analysis and stakeholder value realization (Dekkers, 2017). Here*, values* are broadly defined and include any utility the stakeholders may draw as a matter of their engagement with the enterprise (Harrison, 2013). These values include economic (material) values such as financial remunerations earned by employees, dividends drawn by shareholders, services extended to communities, employment opportunities opened for citizens, taxes paid to government, etc. (Friedman et al., 2006; Friedman & Kahn, 2008). But, they also include human values with moral import such as welfare, privacy, bias avoidance, universal usability, trust, autonomy, creativity etc. (Friedman et al., 2006; Friedman & Kahn, 2008).

Nightingale and Rhodes (2015) suggested that the architect creates structures that further the needs, wills, and imaginations of the people who interact with them at some capacity. At the centre of any architectural design is humanity. As Dreyfuss succinctly put it, man is the measure of design (Dreyfuss, 2003; Tiley, 2002). The designer can be considered successful only if their design brings safety, comfort, efficiency, or happiness to people (Tiley, 2002). The diffusion of human values into architecture is commonplace. The habits and cultures of societies are usually represented in their architectures. In other situations, the architects may, by design, embed human values into their architecture (Schrijver, 2015).

The primary implication of the EA as a worldview perspective is that it facilitates a holistic understanding of the enterprise (Rousseau & Billingham, 2018). EA serves as the worldview of the enterprise, encapsulating its beliefs, visions, principles, and orientations with regard to the management of its own affairs. A worldview operates primarily at the conscious level, manifesting itself through enactment, articulation, memorisation, and textualization (Sienra et al., 2017; Taves, 2022). EA, as the articulation of an organisation's beliefs, visions, and strategies, is expressed in the form of principles and blueprints, and is enacted in the form of information systems and governance frameworks. As the structure of a building enables human needs such as interactions to flourish, the structural design of enterprise systems is intended to guide stakeholder behaviour toward the attainment of individual and organisational goals (D. J. Nightingale & Rhodes, 2015). Table 8 demonstrates that the architect of any artefact must strive to incorporate diverse human values into their designs.

Table 8

Architectural design values and intentions

Design Value	Intentions
Social	Social change
	Consultation and participation
	The "third-world"
	Crime Prevention
Environmental	Green and sustainability
	Re-use and modification
	Health
Traditional	Tradition
	Restoration and preservation
	vernacular
Aesthetic	Self-expression
	Spirit of the time
	Simplicity and minimalism
	Structural, functional, and material honesty
	Natural and organic
	Classical, traditional, and vernacular
	Regionalism
Other	Gender-based
	Economic
	Novel
	Mathematical and scientific

Note. Drawing on the original work of Ukabi (2015), this table presents value themes and associated intentions that may be fostered by architectural design. Adapted from "Architecture, Values and Perception: Between Rhetoric and Reality" by L. Bianco, 2015, 2018, Frontiers of Architectural Research, 7(1), p. 93 (https://doi.org/10.1016/j.foar.2017.11.003). CC BY-NC-ND 4.0.

Stakeholder values are often captured in the missions and strategies of organisations and are expected to diffuse to their structures, systems, and infrastructures. Hence, it is safe to understand EA as the pattern of enterprises and the role of the architect as a "pattern-maker and a synthesizer" who works to create a seamless alignment among aims, strategies, and systems of the business (Hewitt, 2019, p. 12). For Hewitt (2019), the enterprise architect's role go beyond that of developing software or information system to shaping the business as a whole.

3.9.3. Sustainability as an Enterprise Architecture Design Criteria

Sustainability is a practical manifestation of systems thinking. More generally, sustainability is striking a balance between the needs of current and of future generations (Dyllick & Hockerts, 2002). Enterprises are moving fast to address not only intra-generational but also inter-generational environmental and social concerns (Sutherland & Hovorka, 2014). Yet, economic sustainability still boasts an exalted position relegating social sustainability to a less important status (Visser, 2007). Further, scant attention seem to have been paid to human agency and choices in EA research and practice (Burger & Christen, 2011; Hoogervorst, 2017; Mingers & Walsham, 2010).

The inherent relationship between EA and sustainability thinking is apparent. Both are forward-looking and holistic. EA can serve as an instrument of sustainability; but sustainability is also part of the intrinsic, although not explicit, nature of EA (Pankowska, 2013).

One can take two interrelated yet distinct views of sustainability in EA. The first, which I call *EA for sustainability*, is the view that is exemplified in the work of Drews & Schirmer (2014). In this view, EA is presented as a strategy for organisational innovation and sustainability (Lapalme, 2012). This instrumentalist view suggests that EA practices, such as use of multi-vendor open technologies in an interoperable architecture leads to overall sustainability (Pankowska, 2013). Similarly, the reuse of system building components is a typical activity for the sustainable development of EA and for corporate sustainability.

The second view can be called *sustainable EA*. In this view, the very essence of EA itself is sustainability. The holism, future-orientation, and normative nature of EA are well documented. Pankowska (2013) argued that EA places normative restriction on design freedom and sustainability is one of those ethical restrictions placed on EA itself. From modelling to implementation and verification and validation, EA should embody sustainable thinking (Pankowska, 2013).

The research community has recognised the importance of sustainability consciousness in EA (Dyllick & Hockerts, 2002). Recent studies in EA have relied on the triple bottom line-sustainability model to account for economic, social, and ecological sustainability requirements (Lapalme et al., 2016). However, as far as the implementation of the triple bottom line in EA is concerned, economic sustainability is generally given precedence over the other two, particularly in the for-profit sector (Hahn et al., 2015). Climate change and the continued depletion of non-renewable resources have compelled nations to implement ecological sustainability policies and regulations, raising the status of environmental sustainability. Yet, in triple bottom line implementations, economic sustainability continues to have an exalted position, while social sustainability is demoted to the bottom (Visser, 2007).

3.10. Chapter Summary and Conclusion

In this Chapter, I have discussed the many facets of EA by employing two research techniques that are complementary to one another: analysis and synthesis.

- The definitional analysis of its constituent terms has revealed that EA promotes a holistic view of the enterprise and emphasises serving humanity as the overarching goal of both architecture and organisational management.
- A look back at EA's history has revealed that EA has gradually shifted from a technology focus to a broader ecosystemic one.

- EA is considerably more than strategy, principles, or the organisation's design, although being variously referred to as such. It is rather the motivation behind the pattern of behaviour demonstrated by organisations, which is reflected in their mission.
- The extant literature advocates for a holistic, strategic, stakeholder-focused, regulative, and ecosystemic conception of EA.

In conclusion, I assert that EA is holistic, strategic, stakeholder-focused, regulative, and ecosystemic. The ecosystemic worldview maintains that the higher purpose of the enterprise is to elevate humanity, with the conviction that its essence resides in the generational and intergenerational stakeholder values that it promotes.

This chapter supplied the context for the research. The next chapter discusses the necessary domain and method theories for describing the research data. The theories covered in the next chapter are sociotechnical systems theory, stakeholder theory, and the HCA.

4. Enterprise Architecture – Human Values and Capabilities

In Chapter 3, I made certain assertions with regard to the nature of EA based on the review of the extant literature. Particularly, I asserted that EA is holistic, strategic, stakeholder-focused, regulative, and ecosystemic. The ecosystemic worldview maintains that the higher purpose of the enterprise is to elevate humanity, with the conviction that its essence resides in the generational and intergenerational stakeholder values that it promotes.

This chapter explores theories that place human values and capabilities at the centre of technological design. What follows is a thorough analysis of sociotechnical systems theory, stakeholder theory, and the HCA, which are used to underpin the proposed human capabilities ontology.

4.1. Introduction

Humans have long recognised the importance of organised work to achieve higher levels of efficiency and effectiveness. However, as human societies progressed, the pure profit motive started to take centre stage in most organisational endeavours where humans (employees, customers, etc.) became instrumentalised to the extent that they are considered extensions of technical tools in order to achieve an economic benefit for the enterprise (Hoogervorst, 2017; Mingers & Walsham, 2010).

Instances abound of *instrumentalisation*, *dehumanisation*, and *alienation* of stakeholders (Mackey & Sisodia, 2014). *Instrumentality*, an aspect of the notion known as *objectification,* occurs when the *objectifier* uses the *objectified* human or animal as a tool for the satisfaction of the goals of the *objectifier* (Nussbaum, 1995). *Dehumanisation,* on the other hand, is the process by which a human is stripped of his innate *individualness* by the actions or behavioural manifestations of other humans, institutions, or even by self (Nussbaum, 1995; Sen, 1993). *Alienation* is the notion that a human engaged in an exploitative economic relation is estranged from work, from the fruits of his labour, and ultimately from his *species essence* (Nussbaum, 1995).

However, the unbridled pursuit of profit and cynical manipulation of society by businesses are not without consequence. Aristotle, Marx, and Sen, among other social thinkers, have warned us of the impending social strife caused by cynically exploitative economic relation (Marx & Engels, 2009; Sen, 1999). As a result, there have been calls on organisations to re-evaluate their priorities and to redefine their purpose from *shareholder profitability* to *societal prosperity*.

In Aristotle's *Metaphysics*, any physical (for example, a building), spiritual (for example, music), or social (for example, the enterprise) construction would have a material, formal,

efficient, and final cause (Aristotle, ca.350 B.C.E./ 2016; 2018; Falcon, 2019). This final cause (telos), which justifies the existence of the construction, is also its ultimate purpose. The telos is especially apparent in human-made systems, organisations for example, since humans apply consciousness, intentionality, intelligence, and deliberation in designing such systems.

Organisations are higher-order complex systems constructed from sociotechnical components that are designed purposefully by humans to realise a goal or mission (Dekkers, 2017; Giachetti, 2010; Hatch, 2011; Hoogervorst, 2009). Any typical definition of an enterprise recognises these fundamental constituents of the system, namely sociotechnical elements (material cause), an entrepreneurial agent (efficient cause), interconnections (formal cause), and a reason for existence (final cause) (Meadows & Wright, 2015). Given this recognition, the question arises as to what the overarching purpose of enterprises and, by extension, EA is or should be. To answer this question, one must look at developments in several societal endeavours.

First, organisations are moving away from exclusively technical-, material-, and owner-centred thinking towards a holistic, human-value driven, and stakeholder-centred thinking and decision-making. There is a growing understanding that enterprises, in principle, can and should be ethical, producing a win for all stakeholders – investors, employees, customers, suppliers, the natural environment, and society (Mackey & Sisodia, 2014). As a result, stakeholders are taking centre stage in many organisational decisions.

Second, we are witnessing marked progress in human consciousness (Jasanoff, 2016). Inequalities are being challenged everywhere (Jasanoff, 2016). Individuals as well as society are becoming more conscious of the impact of their actions towards other humans/societies, other species, the physical environment, and future generations.

Third, digital technologies are making us more connected, but at the same time more predictable, controllable, and homogeneous (Pastor-Escuredo, 2020; Sullivan & Reiner, 2020). Preserving individual and societal heterogeneities is something desirable unless the goal is to create a regimented, tech dystopia full of robot-like humans. Ethics is therefore becoming intrinsic to technological designs with the objective of maintaining and expanding human capabilities (Pastor-Escuredo, 2020; Sullivan & Reiner, 2020).

Bringing these strands of social development together, Enderle (2013) asserted that organisations: (a) can plan and operate within the limits of environmental constraints; (b) are *moral actors*; and (c) have the purpose of creating wealth in a comprehensive sense, i.e., physical, human, natural, and social wealth or capital. The Stiglitz-Sen-Fitoussi commission report (Stiglitz et al., 2009) concurred with the latter assertion. Solomon (2004), within the narrower context of business, described the organisation as "a human institution in service to humans and

not as a marvellous machine or in terms of the mysterious 'magic' of the market" (p. 1024). The higher purpose of enterprises, therefore, should be to serve humanity, and Enderle's principles can serve as a progressive platform to promote diversity, humanism, and ethics in designing our enterprises (Daft, 2007; Mackey & Sisodia, 2014).

EA, as a strategic tool that translates the enterprise values and strategy to information system services, naturally inherits the purposes of the enterprise (Júnior et al., 2020; Mentz et al., 2014). Enterprises should, of necessity, put in place an EA that not only accounts for economic, social, and ecological consideration but also for human choices. EA will also have to adapt to the social, psychological, and technological changes in society in order to stay relevant (Gorkhali & Xu, 2017). For instance, Gartner's *emergent architecture principles* (Avram, 2009; InformationWeek, 2009) suggested that the future is for *goal-oriented* and *rule-bound* actors. Goal-orientation means that employees may want to promote their own interests without necessarily prevailing over organisational objectives (Morgan, 2014). Rule-bound, on the other hand, implies that EAs need to avoid detailed specifications and to allow for choice within the bounds of a minimal rule set. Active ecological adaptation is therefore sought in EA to allow people to pursue well-being, human growth, and social development (Daft, 2007; Korhonen et al., 2016; Lapalme, 2012).

There is a need for change in the conceptualisation of enterprise design towards the humanisation of enterprises and the affordance of meaningful work bringing human capabilities to centre stage in EA planning and evaluation. The new EA, based on these tenets and based on Mackey & Sisodia (2014), might be referred to as conscious EA and is a logical extension of the enterprise ecological adaptation school of thought (Lapalme, 2012).

The consciousness I am referring to is a consequence of the understanding that decision-making at all levels is value laden. It calls for foregrounding moral values of human dignity and justice in designing products and processes. In subsequent sections, I will draw on systems theory, stakeholder theory, and the HCA to forward certain propositions in support of a conscious EA. In passing, I note that, while moral agency ranges from the *micro* (individual) level to the *meso* (organisational) and the *macro* (system) level, the hierarchical nature of systems allows us to safely assume that what applies to the lower-level agents equally applies to higher level agents. Thus, when I talk about organisations, I am also referring to economic (national) systems.

4.2. Theory Sampling

Organisations use EA to align their business and technology strategies (Bernus et al., 2016; Romero & Vernadat, 2016a). In this role, the efficacy of EA is contingent on the organisational

foundations, which form a tight link between the business and its technology. The concepts that describe these foundations can be found in related fields of study such as organisational theory, technology, ethics, and economics. By drawing on these fields, EA knowledge is evolving towards an increased understanding of stakeholder engagement, organisational sustainability, and ecological adaptation.

Researchers have suggested tens, if not hundreds, of theories for use in EA. For example, Kotusev & Kurnia (2020) compiled a list of 32 theories proposed or actually applied in EA. They also provided a database of 123 theories which have potential for use in EA. At the same time, there may still be theories in a variety of fields, including economics, management, philosophy, and sociology, which hold potential for EA research. Allowing for the practical limits of time and space, I have selected two theories from information systems and another from economics to argue for human capabilities conscious EA.

For this research, the selection of theories followed the procedure suggested by Weiss et al. (2012). In their method, one includes a theory *t* to the set of theories *S2* from a potential list (kernel theories) *K*, if *t* satisfies the *S1* of properties. My intention is to propose an integrative framework that could extend the ecosystem school of EA thought. As such, my *S1* is made of characteristics that a theory, method, or tool must satisfy to support the ecosystemic view (Korhonen & Poutanen, 2013; Lapalme, 2012).

I undertook a purpose sampling of the theories by reading the description of the kernel theories provided in Kotusev & Kurnia (2020). I considered systems and stakeholder theories as domain theories since they already have some application in the EA literature (Kotusev & Kurnia, 2020; Weiss et al., 2012). Sociotechnical systems and stakeholder theories are complementary in that, while the concern of the former is mainly work systems internal to the organisation, stakeholder theory magnifies the impact of such work systems on internal as well as external stakeholders.

I designed my investigation based on the prescriptions of Jaakkola (2020) and Mora et al. (2008). I deployed the HCA as a method theory to function as an integrative framework, so enhancing the research by informing the other two theories (Jaakkola, 2020). My attempt was to systematically assemble, organize, and interpret theories and concepts pertinent to human capabilities consciousness in EA to create new avenues of application in research and practice (Gilson & Goldberg, 2015; McGregor, 2018; Mora et al., 2008). Rigor is achieved through identifying the knowledge gap; justifying the selection of theories; explicating the role of the theories; and arguing via claims, grounds, and warrants (Jaakkola, 2020; Mora et al., 2008). Consult Table 9 for an evaluation of the theories based on essential characteristics of ecosystemic EA. The sources cited are only exemplars.

Table 9

Potential of selected theories to accommodate and expand ecosystemic EA

Characteristics of Ecosystemic EA (S1)	Theories (S2)		
	Sociotechnical System Theory	**Stakeholder Theory**	**HCA**
Holism (Lapalme, 2012)	+ (de Sitter et al., 1993; Dekkers, 2017; Harmon, 2005; Weiss et al., 2012)	? (Freeman et al., 2020)	+ (Oosterlaken, 2009, 2012b)
Business ecosystem (diversity of inhabitants) (Drews & Schirmer, 2014; Lapalme, 2012)	+ (Dekkers, 2017; Gharajedaghi, 2011)	+ (Freeman et al., 2004; Laplume et al., 2008)	+ (Robeyns, 2016, 2017)
Fosters organisational innovation, sustainability, and organisational coherence (Drews & Schirmer, 2014; Lapalme, 2012)	+ (Gharajedaghi, 2011; Savaget et al., 2019)	+ (Bonnafous-Boucher & Rendtorff, 2016)	+ (Cantón, 2012)
System-in-environment coevolution (Drews & Schirmer, 2014; Lapalme, 2012)	+ (Dekkers, 2017; Gharajedaghi, 2011)	+ (Kloeckner & Birkmeier, 2010)	+ (Cantón, 2012)
Emergent behaviour (Drews & Schirmer, 2014)	+ (Dekkers, 2017; Gharajedaghi, 2011)	-	?
Self-organisation (Drews & Schirmer, 2014)	+ (Dekkers, 2017; Gharajedaghi, 2011; Savage et al., 2016)	-	+ (J. B. Davis, 2009)
Decentralized governance (Drews & Schirmer, 2014)	+ (Savage et al., 2016)	-	+ (Mizohata, 2011)
Collaboration, competition and co-opetition (Drews & Schirmer, 2014)	+ (Savage et al., 2016)	+ (Westermann-Behaylo et al., 2016)	+ (Westermann-Behaylo et al., 2016)
Environment can be changed (Lapalme, 2012)	+ (Bertalanffy, 2009; Gharajedaghi, 2011; Hoyland, 2011)	? (Freeman et al., 2010)	+ (Cantón, 2012)
Joint design of all organisational dimensions (Lapalme, 2012)	+ (de Sitter et al., 1993; Gharajedaghi, 2011)	+ (Freeman, 2010; Westermann-Behaylo et al., 2016)	+ (Cantón, 2012)
Dialogue fostering (Lapalme, 2012)	+ (Clegg, 2000; de Sitter et al., 1993; W. M. Fox, 1995)	+ (Freeman, 2010; Westermann-Behaylo et al., 2016)	+ (Stillman & Denison, 2014)
Larger group facilitation (Lapalme, 2012)	+ (W. M. Fox, 1995)	+ (Westermann-Behaylo et al., 2016)	+ (Frediani et al., 2014; Oosterlaken, 2014)
Fostering sense-making (Lapalme, 2012)	+ (Gharajedaghi, 2011; Hasan & Kazlauskas, 2009)	+ (Freeman et al., 2004; Laplume et al., 2008)	+ (Cantón, 2012; Robeyns, 2016)
Value-sensitive design (Friedman et al., 2006; Friedman & Kahn, 2008)	+ (Handley, 2019; Savaget et al., 2019; Winby & Mohrman, 2018)	? (Freeman et al., 2004; Laplume et al., 2008)	+ (Cantón, 2012)

Note. Key**:** (+) Conforms; (-) Does not conform; (?) Incomplete. Adapted and expanded from "Towards a human capabilities conscious enterprise architecture" by E.A. Kassa and J.C. Mentz, 2021, Information, 12(8), p. 5 (https://doi.org/10.3390/info12080327). CC BY 4.0.

The sample literature summarised in Table 9 demonstrate that sociotechnical systems theory, stakeholder theory, and the HCA support the ecosystemic view of the enterprise. In terms of their function in this research, these three are complementary. The systems approach helps identify the enterprise's guiding principles and fosters a holistic view of the organisation in its environment. By emphasising stakeholders and their legitimate stakes, stakeholder theory helps fill in the ethical foundation that is missing from the systems approach. The HCA, on the other hand, emphasises human capabilities as the dynamic's most fundamental element.

The ecosystemic enterprise exhibits several distinguishing characteristics. The holistic sociotechnical view of the enterprise recognises the human and material components of the enterprise within its environment (Lapalme, 2012). To be relevant and effective over the long term, the enterprise adapts to and changes in tandem with the environmental dynamics (Drews & Schirmer, 2014; Lapalme, 2012). The holistic ecosystemic thinking fosters organisational innovation, sustainability, and coherence (Drews & Schirmer, 2014; Lapalme, 2012).

The ecosystemic enterprise is home to diverse inhabitants who are in continuous collaboration in pursuit of shared goals (Drews & Schirmer, 2014; Lapalme, 2012). It is possible for the stakeholders to engage in competitive and co-optative behaviours as they strive to achieve both shared and individual objectives (Drews & Schirmer, 2014). Whereas sociotechnical systems theory acknowledges the existence of the multitude of stakeholders, stakeholder theory provides an ethical foundation for engaging these stakeholders in organisational decision making.

The multiplicity of the stakeholders and their interests has several implications. To begin, embracing the values and interests of the multitude of stakeholders is formally recognized. Next, value-sensitive design of organisational dimensions is sought after to achieve joint-optimization of stakeholders' values (Friedman et al., 2006; Friedman & Kahn, 2008; Lapalme, 2012). By emphasising capability promotion as a primary criterion for the success of artefact design, the HCA brings human agency and choice into the dynamics. EA then serves as a platform to facilitate sense-making and dialogue among the numerous enterprise stakeholders aiming to promote human capabilities (Lapalme, 2012).

4.3. Domain Theories

4.3.1. Sociotechnical Systems Theory

Systems theory is an overarching analytical framework for diagnosing universal problems (Dekkers, 2017; Meadows & Wright, 2015). It does not seek to explain, but rather to magnify and expose the interactions between system components and their environment in pursuit of a desired outcome (Gharajedaghi, 2011; Meadows & Wright, 2015). In the context of

organisational management, systems theory challenges the mechanistic world view propagated by bureaucratic management and identifies organisations as organic entities composed of interacting components existing in a hierarchic structure within an environment (Bertalanffy, 2009; Morgan, 2006; Weinberg, 2001). Hence, instead of using reductionism and linear causality, systems thinking relies on holism and causal loops to expose the intricate causality relations that exist within organisations (V. Anderson & Johnson, 1997).

Haines et al. (2005) identified five salient features of *systems thinking* as:

1. a way of seeing the whole as primary, the parts as secondary;
2. a higher-level way to view, filter, and frame mentally what one sees in the world;
3. a worldview that considers the whole entity or enterprise, along with its fit and relationships to and with the environment;
4. a tool for finding patterns and relationships among subsystems and learning to reinforce or change these patterns to achieve specific outcomes; and
5. a shift from seeing elements, functions, and events to seeing processes, structures, relationships, and outcomes.

Giachetti (2010) defined an organisation as "a complex, sociotechnical system that comprises interdependent resources of people, information, and technology that must interact with each other and their environment in support of a common mission" (p. 4). Organisations are identified as societal systems at levels nine and 10 of complexity on Boulding's 11-scale hierarchy of systems (Dekkers, 2017; Hatch, 2011; Hoogervorst, 2009).

Thus, organisations are open, organic, dynamic, allopoietic, goal-directed, and meaning-driven systems, the behaviour of which is tempered by the environment (Coldicott et al., 1995; Dekkers, 2017). Complex human systems exist for a purpose, and the purpose creates a context that, in turn, gives meaning to all the activity that takes place in that context. Coldicott et al. (1995) concluded that, in the context of bigger social systems such as organisations, the overall purpose of unleashing systemic thinking is to understand the context under which people operate and how that context modifies behaviour.

If organisations are sociotechnical systems, it extends logically that EA is a result of the productive interaction between constituents of the sociotechnical organisation, its environment, and the principles of its constitution (Lapalme et al., 2016).

But what exactly are sociotechnical systems? Simply stated, sociotechnical systems are systems made up of social and technical components. However, a widely recognised management theory with the same name illuminates the nuances of the term more accurately.

The origin of sociotechnical systems theory is to be found in the works of Eric Trist and Ken Bamforth who, in 1951, published a seminal paper on the psychosocial effects of a certain mass-production coal mining process (Golden, 2013). Trist (1981), one of the key figures who completed the foundational work on sociotechnical theory at the London-based Tavistock Institute of Human Relations attributed his inspiration to Lewis Mumford who, in 1934, published a book entitled *Technics and Civilization*. However, the theory is definitely influenced by the works of several thinkers including the most significant contribution of Ludwig von Bertalanffy's *Open Systems Theory.*

Von Bertalanffy, the Austrian biologist who infused systems thinking into his writings as early as the 1920s, characterised organisms as open systems. Organisms exchange matter, energy, and information with the environment to maintain their balance (Midgley & Rajagopalan, 2021; Mobus & Kalton, 2015; E. L. Trist, 1981). Later, he labelled his theory as *General Systems Theory*, extending its applicability to encompass social, political, economic, and other spheres. Indeed, fields such as systems design and engineering, as well as the use of systems concepts in sustainability studies benefitted from general systems theory (Mobus & Kalton, 2015).

Sociotechnical systems theory spawned several complementary schools in North America, Europe, and Australia (Mohr & Dessers, 2019a; van Eijnatten et al., 2008). Each of these schools made contributions to the theory, design, or change and development concerns of sociotechnical systems theory (van Eijnatten et al., 2008).

The North American sociotechnical system school has been led, among others, by Lou Davis, Eric Trist, Tom Cummings, Bill Pasmore, and Albert Cherns. This school asserts that there is no one best way of designing work, redesign is ongoing, and designers must target the joint optimization of the social and technical subsystems. The sociotechnical system principles they formulated represent a key contribution of the North American school (Cherns, 1987). The school emphasises the empowerment of employees and improvement of their quality of work life (van Eijnatten et al., 2008).

The Australian sociotechnical system school (Participative design), spearheaded by the contributions of Fred and Merrelyn Emery, explicated two design principles that underlie modern organizations. An organization setup based on Design Principle 1 (DP1) assumes that there are more people than are required to complete a task, and as a result a supervisory or hierarchic structure is more appropriate. An organization setup based on DP2, on the other hand, asserts that there is redundancy of functions in work systems, implying that individuals have more capabilities of knowledge and skill than they need to complete a task. In such arrangements, responsibilities to coordinate and control remain with the workers themselves,

making the supervisory function redundant (M. Emery, 2000). The Australian sociotechnical system theory approach, therefore, recommends participative democratic arrangement to design work systems guided by DP2 (van Eijnatten et al., 2008). This, they claim, will help to overcome any resistance to change because of group decision making without the need for dictation from external experts (M. Emery, 2000).

The Scandinavian sociotechnical systems school gravitated towards establishing democratic dialogue as a primal design principle with active engagement of stakeholder for the design of egalitarian work systems (Mohr & Dessers, 2019a; van Eijnatten et al., 2008). The school of thinkers hold that in a change process all participants and their ideas are equal, notwithstanding their relative positions in the organizational hierarchy (van Eijnatten, 1993). Change, they claim, can only be sustainable if it is accompanied and nurtured by continuous system and human development (van Eijnatten et al., 2008).

The Dutch sociotechnical system school, also called the Lowlands sociotechnical system school, relies heavily on the works of Ulbo de Sitter and colleagues. They suggested one of the most significant amendments to the original Tavistock sociotechnical system thinking thereby introducing the *Modern Sociotechnical Theory* (de Sitter et al., 1993; van Eijnatten et al., 2008). De Sitter et al. (1993) critiqued classical sociotechnical system theory for creating an unnecessary separation between the technical and the social aspects of work. They argued that this oversight hinders the theory's ability to effectively improve stakeholders' quality of work life, as it fails to account for the dynamic organizational environment. They highlighted the logical untenability of designing a whole entity by optimizing its parts separately. Instead, they advocated for pursuing integral organizational renewal by designing interconnected components guided by a holistic vision. De Sitter et al. (1993) noted,

> *The designers' goal should be to design an architecture sustaining and reinforcing the development of interactive relationships which support and reinforce each other with respect to all functional requirements … [Sociotechnical organisation design] can only open new perspectives by fulfilling a truly comprehensive function with respect to the question of how sets of differentiated and purposive functions can be grouped and coupled into an organizational structure in such a manner that they mutually sustain and reinforce each other. (p. 6)*

The Dutch sociotechnical system school defined work organization as an interacting network of people executing tasks and roles, using technological instrumentation, tools and machines. In the Dutch version of sociotechnical systems, people are therefore the primary "elements" of the system, with materials, technology, and information as "attributes" or means used by the human actors to perform the required operations.

Despite language differences, one can observe that these schools share a fundamental conviction that the social and technical components of work systems must be aligned to achieve higher productivity at the workplace and quality of work life for the working people. They also emphasise *participative design*, which allows people to have a holistic and macro view of the design and transition from one perspective to the other to achieve multilevel optimization.

Sociotechnical theory stands in opposition to technical determinism and scientific management ideals of efficiency prioritisation, and has two major pillars: (a) that organisations are open systems that are situated in the environment; and (b) that organisational goals could be realised if organisational systems are designed with both technical and social system goals in mind (Golden, 2013; Winby & Mohrman, 2018).

Baxter & Sommerville (2011) identified five essential characteristics of sociotechnical systems, emphasising that a singular focus on either the social or the technical component will most likely lead to degraded system performance and utility.

1. Systems should have interdependent parts.
2. Systems should adapt to and pursue goals in external environments.
3. Systems have an internal environment comprising separate but interdependent technical and social subsystems.
4. Systems have equifinality. There are design choices to be made since a goal can be achieved in different ways.
5. System performance relies on the joint optimisation of the technical and social subsystems.

The ecosystems view advocated by Winby and Mohrman (2018) takes the sociotechnical systems theory from the internal organisation in which it is situated traditionally to the external environment. This is an endorsement of stakeholder views and interests in organisational design. Klein (2014), among the stalwarts of the Tavistock institute who created the sociotechnical theory, argued that the boundary of the sociotechnical system has to be moved from its original industry work teams to trans-organisational work systems (Eason, 2014; L. Klein, 2014).

Sociotechnical systems theory holds stakeholder value in high esteem. Problem understanding, solution design, and implementation in sociotechnical systems essentially mean understanding the roles, responsibilities, concerns, varying perspectives, and success criteria of the stakeholders (Baxter & Sommerville, 2011). The digital sociotechnical systems design framework of Winby and Mohrman (2018) identified stakeholder motivation as a primal factor leading to high performance in organisations. In departing from the traditional sociotechnical systems theory, the digital sociotechnical systems theory identifies the ecosystem as its focus of analysis. Table 10 presents Pasmore et al.'s (2019) vision of the transition from classical to next generation socio-technical system architecture.

Table 10

Sociotechnical systems design trends

From	To
Designing an organisation	Designing an organisation and its ecosystem
Designing a static system	Designing a system that is in a continuous state of change
Designing social systems around a fixed technical system to achieve joint optimization	Designing organisations, ecosystems, technical systems and social systems on an ongoing basis as each element changes to achieve balanced optimization
Designing an internal design team to represent the system being designed	Using design labs that bring many voices from inside and outside the system into the design process
Designing the work system	Designing the strategic, operating and work systems
Designing a system with a fixed membership for its current members	Designing a system in which many important contributions are made by people who come and go as their expertise is needed; designing for people who are not yet members of the system
Focusing exclusively on the internal workings of the system	Perfecting collaborative work among entities that compose the value chain
Design for high performance and variance control	Designing for innovation and agility
Design based on analysis of current systems	Design based on ideas about what is possible

Note. From "Reflections: Sociotechnical Systems Design and Organization Change" by W. Pasmore, S. Winby, S. A. Mohrman, and R. Vanasse, 2019, *Journal of Change Management*, *19*(2), p. 69 (https://doi.org/10.1080/14697017.2018.1553761). Copyright 2019 by Taylor & Francis. Used with permission.

As shown in Table 10, the design of sociotechnical systems has evolved from a concentration on technical and operational considerations to one that also takes into account the needs and contributions of humans. In this paradigm, we prize innovation, agility, and foresight in designs.

4.3.2. Stakeholder Theory

The predominant thinking in business has been that the interests of the owners should get primacy over all other interests (Hoogervorst, 2017). Agency theory, for instance, considers management as the agent of the shareholders on whose behalf financial investments should multiply (Harrison, 2013). The agents – management and other employees – are expected to channel their efforts to achieve organisational goals instead of their own personal objectives (Cunliffe, 2008; Hatch, 2018; Jones, 2013; Miles, 2012). In this view, economic value is the single most important bottom line that matters.

The dialectical contradictions between the interests of the owner and of the other stakeholders has been long anticipated by several economists and philosophers. In particular, Marx treated this contradiction in much more depth and suggested that the capitalist system will culminate in disintegration resulting in an egalitarian society. This notion is often criticised for

being deterministic and incapable of predicting the adaptive nature of the capitalist system. The capitalist system is adapting to the ever-growing demand for more justice, equality, and opportunities by incorporating moral thinking into business decision-making (De George, 2006).

Business ethics was developed from the pursuit of a moral argument that reconciles shareholder profit with stakeholder value. Broadly defined, business ethics is the application of ethical thought to business problems. The purpose of business ethics cannot solely be to create an ethical person. It should help to create ethical structures in organisations (De George, 2006). It thus places moral objectives on businesses and their agents, far and beyond the narrow profitability goals they are expected to pursue (Schwartz, 2008). According to Schwartz (2008), business ethics reigns over individual and organisational decision-making, the relationship between business and society, the moral evaluation of business systems, the marketplace, and specific business issues such as discrimination, compensation, etc. The King II report on corporate governance in South Africa recommended "institutionalising ethics on the strategic and system levels of the company" as a best practice for corporations (Rossouw, 2006, p.263). The significance of business ethics for policies and procedures, as well as the justification for the very existence of companies based on moral principles, is emphasised in this research.

Stakeholder theory is a theory of business ethics that stands in direct opposition to theories that promote shareholder value exclusively. Stakeholder theory attempts to expand the bottom line of the enterprise by incorporating the interests of several stakeholders in business decision-making.

Although stakeholder theory originated formally at the University of Pennsylvania through the collaborative works of, among others, R. Edward Freeman, James R. Emshoff, Russel Ackoff, and Eric Trist, its antecedents are to be found in works that date as far back as the 1930s (Laplume et al., 2008; Orts & Strudler, 2002). The publication of Freeman's book entitled *Strategic management: A stakeholder approach*, in 1984, prompted a serious discussion on the relevance of the concept (Freeman, 2010; Harrison, 2013).

Prior to diving into the theory, it is important to define the term *stakeholder*. Stakeholders are individuals or groups that may have a *stake* in the organisation. A stakeholder, a person, a group of persons, or a societal system such as an organisation, is someone with interest in the development, operations, outputs, and ecological outcomes of a system (Op 't Land et al., 2009). They impact the overall operations of the enterprise through the provision of inputs, the use of outputs, or by influencing the process of the conversion of inputs to outputs (Freeman, 2010; Harrison, 2013). Their stakes may be labelled as *economic,* as with employees, *equity,* like that of shareholders, or *influencer,* like that of the government.

Donaldson and Preston (1995) identified *descriptive*, *instrumental,* and *normative* stakeholder theories. In the descriptive paradigm, the existence of a range of stakeholders who have stakes in the organisation is acknowledged, their characteristics and relationships are identified, and their interests are promoted (Miles, 2012). The instrumentalists, on the other hand, emphasise the instrumental role of the theory to achieve better organisational performance and stakeholder value (Phillips et al., 2003). Thus, customers may be provided with superior service as long as doing so increases profitability. Similarly, employees may be attended to if doing so contributes to the bottom line of the company. Normative theorists argue that neither the descriptive nor the instrumental arguments are sufficient to sustain the theory, and that moral and ethical values must be attached to an organisation's mission, guiding its direction. In this light, many have suggested that businesses require normative justifications for their existence (T. Donaldson & Preston, 1995).

Hence, stakeholder theory, particularly the normative flavour, holds that a host of stakes should be considered when determining the purpose of the enterprise. The emphasis on the value of all stakeholders in corporate decision-making is not only sought ethically but also strategically (Harrison, 2013; Miles, 2012). In a rebuttal to the shareholder centrality arguments of Sundaram and Inkpen (2004), Freeman et al. (2004) asserted that stakeholder value promotion does not oppose shareholder values. In fact, they argued, promotion of stakeholder values would give enough incentive to managers to take appropriate risks to further the benefits of the shareholders within the bounds of morality and law.

Organisations are expected to create value for their stakeholders not only to ensure the latter's continued engagement but also in the overall interest of shareholders (Freeman et al., 2004). That is, organisations should not attempt to separate shareholder value from the values of other stakeholders (Freeman et al., 2004). For example, the employee expects to gain well-being, security, and equity; the customer looks for product or service quality, safety, and transparency; and the investor expects to get an economically sensible return on investment without jeopardising the interests of others (Harrison, 2013; Jamali, 2008).

Despite its insistence on the need to embrace and advance the needs of all stakeholders, stakeholder theory understands that some stakeholders are more important than others by virtue of their merit (Harrison, 2013; Phillips et al., 2003). An overly loose interpretation of stake in any enterprise may lead to financial ruin, shareholder disenchantment and desertion (Mitchell et al., 1997). Therefore, the term stakeholders is often restricted to people who have a significant and legitimate stake in the organisation (Harrison, 2013; Hillman & Keim, 2001; Miles, 2012).

In a 2008 essay, Freeman highlighted some important ideas that could serve to propel stakeholder theory, particularly in the private sector (Agle et al., 2008). Citing Sen (1987),

Freeman asserted that there is no practical reason or moral justification for the disentanglement of business from ethics (Agle et al., 2008). He showed his dissatisfaction with the separation between ethics and economics and the resultant forced practices such as CSR. He advocated for the integration of the moral and the economical with the central focus of promoting human values and a sense of responsibility to self and the ecosystem.

Organisations that are run on the edicts of stakeholder theory would provide much more value to their stakeholders (including shareholders) than they would otherwise achieve. Managing stakeholders coupled with adherence to other ethical principles such as justice, freedom, capability promotion, etc would lead to reciprocal trust, respect, and mutualism with stakeholders (Harrison, 2013). Flow of natural resources and information would be easier since the company would earn the trust of stakeholders. High reputations would also mean brand recognition and customer attraction. Internally, organisations that are run on ethical principles are expected to have less turmoil which, in turn, would attract more investors (Harrison, 2013).

4.4. The Human Capabilities Approach as a Method Theory

4.4.1. Sen's Human Capabilities Approach

Orts and Strudler (2002) showed that the normative base of stakeholder theory leads to the conclusion that the theory is not complete as it does not account for the non-human stakeholders of the organisation, nor does it have any bearing on its ethical responsibilities to obey the law. They concluded that company decision-making must underscore ethical values even where such values are not captured in stakeholder theory. Therefore, several ethical theories such as *common good principles*, *feminist ethics*, *Kantianism*, *Jonas' theory of responsibility*, and *Senian economics* have been used to justify and bolster stakeholder theory (Agle et al., 2008; Phillips et al., 2003; Zsolnai, 2006).

In this thesis, the HCA is proposed as a framework capable to extend the sociotechnical systems and stakeholder theories to enrich research and practice in EA. The HCA, initially proposed by Nobel laureate Amartya Sen and further elaborated upon by philosopher Martha Nussbaum and a number of other scholars in a series of publications beginning in the 1980s, has emerged as the leading alternative to standard economic frameworks for thinking about poverty, inequality, human capability, freedom, and human development generally (Gasper, 2007; Wells, 2012).

Aside from Aristotelian dynamics, Conill (2013) connected the HCA to the notions of freedom of Adam Smith, Immanuel Kant, Karl Marx, and John Rawls. Sen underlined the connections with Smith and Marx from the start, while later proponents of the theory highlighted the relationship with Rawls and others. The leanings of HCA towards objective measurement of

capabilities are borrowed from Rawls (Martins, 2011). Sen noted that Rawls's Theory of Justice (1971) and his emphasis on "self-respect" and access to primary goods "deeply influenced" the HCA (Sen, 1992, p. 8).

For a long time, two major theories of justice piqued economists' interest (Clark, 2005). One of them, *utilitarianism*, is based on an individual's subjective sense of happiness and has served as the pivot for much modern economic thought (Clark, 2005; Nussbaum, 2003). The other viewpoint, *resourcism*, has been attributed to John Rawls and Donald Dworkin and is concerned with increasing resources as part of the goal of achieving economic justice in society(Clark, 2005; Sen, 1993).

Sen criticised the utilitarian approach for its additivity, subjectivity, and rationalism. He claimed that utilitarianism trivialises the distribution of people's utilities, naively assuming that individuals maximise their personal goals with little or no regard for relationships and emotions. The rational economic model is thus insufficient to serve as a foundation for motivating the production of collective goods and for ensuring the fair treatment of people with disabilities (Enderle, 2013). The HCA is therefore, first and foremost, a paradigm in economic thinking that is posited against classical welfare economics (Clark, 2005; Gasper, 1997).

Furthermore, the HCA is a broad normative framework for the evaluation and assessment of individual well-being and social arrangements, the design of policies, and proposals about social change (Robeyns, 2005). The core claim of the HCA is that assessments of well-being or quality of life of a person, and judgements about equality or justice, or the level of development of a community or country should not focus primarily on resources, or on people's mental states, but on the effective opportunities for people to lead the lives they have reason to value (Gasper, 1997; Robeyns, 2005).

Unlike resource-based economic theories, the HCA focuses on the ends of well-being rather than on the means. Having this or that resource may not matter in the end if those resources do not expand the capability space of the owner (P. M. Alexander & Phahlamohlaka, 2006). The means are, therefore, instruments to bring humans to their higher-order goals of increased well-being, justice, and development (Robeyns, 2005). Thus, the HCA targets the promotion of human capabilities by which we mean the opportunity space available to humans to operate in (Enderle, 2013; Robeyns, 2005).

4.4.2. Nussbaum's Capability Ethics

Some aspects of the HCA can be traced back to Aristotle, among others (Sen, 1993). Nussbaum was the first to show the intimate link between Sen's HCA and the Aristotelian ethics of eudaimonia or human flourishing (Gasper, 1997; Nussbaum, 2011). Nussbaum argued that the

ultimate goal of achieved capabilities is what Aristotle called *human flourishing* (Nussbaum, 2011).

According to Aristotle, wealth is pursued not for its own sake but to fulfil a greater human goal (Solomon, 2004). That is, more wealth should lead to greater freedom or flourishing, allowing people to live the life they choose (Conill, 2013; Sen, 1999). It is neither utilities nor goods, but substantive freedoms – the capabilities to choose the life that we have reason to value that matter (Deneulin, 2002). Aristotle claimed that all work should contribute towards the all-encompassing flourishing of the human agent and their community or *polis* (Giersson & Holmgren, 2000). The logical conclusion of Aristotelian eudaemonia, according to Solomon (2004), is that the primary purpose of business is to enable humanity to reach a higher level of flourishing, both individually and as a community.

Nussbaum further expounded on Sen's sketches and made its application in wider realms possible, which was greatly acknowledged by Sen himself (Gasper, 1997). Nussbaum's approach is now widely referred to as *capability ethics* to make a nuanced distinction from the *capability approach* of Sen (Beckley, 2002; Gasper, 1997). Here, in this thesis, HCA will continue to be used as the consolidative term superseding both.

The other contribution of Nussbaum's is her designation of 10 core capabilities that all societies should cultivate (Alkire & Deneulin, 2009). This is analogous to the so-called *objective list theories of well-being*, to which Aristotle's eudaemonia also belongs. These theories put forward an objective list of goods, the full or substantial attainment of which brings well-being (Brey, 2015). The goods, which include liberty, friendship, autonomy, accomplishment, wisdom, understanding, morality, the development of one's abilities, enjoyment, and aesthetic experience, presumably contribute to a person's well-being even if the individual does not desire or derive pleasure from them.

Amartya Sen, on the other hand, refused to provide a special list of capabilities, arguing that such a list would limit the applicability of his theory (Kleine, 2010). Instead, he suggested that organisations should develop their own list through continued dialogue with their stakeholders, which is consistent with the approach followed in stakeholder theory (Enderle, 2013; Kleine, 2010). Sen, apparently, is not apathetic to the idea of developing such a list as that of Nussbaum's as long as the dynamic, iterative, and participatory nature of the process is ensured (Alkire & Deneulin, 2009).

While Sen's refusal to have a list of capabilities is acceptable at one level, it rendered the theory impractical for several purposes (Oosterlaken, 2009; Robeyns, 2005). Nussbaum critiqued Sen's refusal to provide a list of common or critical capabilities and went on to develop a core list of functionings. Sen's intentional underspecification of the HCA brings forth the risks of

omission, and a challenge of power (Alkire & Deneulin, 2009). Listing capabilities could help people to capture what is important to them (Alkire & Deneulin, 2009). On the other hand, it could also help to subvert the unwanted influence that powerful individuals or groups may have on the list-making process to dictate the capability that gets its way into the list, trampling on the rights of disadvantaged individuals or groups (Alkire & Deneulin, 2009). Listing, Nussbaum argued, would help to ensure equal an opportunity to participate in the capability setting process.

Nussbaum's (2011) central capabilities are: (1) life; (2) bodily health; (3) bodily integrity; (4) senses, imagination, and thought; (5) emotions; (6) practical reason; (7) affiliation; (8); other species; (9) play; and (10) control over one's environment (Nussbaum, 2011; Watene, 2013). These core capabilities serve as a guide for policymaking and evaluation.

Even though, it is not a critique directly aimed at the capability approach, I must touch on the confusion that arises with respect to the supposed *universalism* of human capabilities. This issue is particularly pertinent to this research because EA research and practice crosses boundaries and cultures. Some may argue that capabilities cannot be universal since human communities are diverse and people may have differing values. The reply Nussbaum put forth against this challenge is five-fold (Nussbaum, 2000). Nussbaum argued that capabilities have multiple realizability, meaning that a capability may mean one thing in one socio-cultural situation and something else in another. Secondly, she claimed that the capability approach is targeted at promoting capabilities or instead of actual functionings, leaving the choice to individuals. Thirdly, the capabilities approach emphasises human agency to decide on choices. Further, the approach established the foundation for a democratic dialogue of what is of value, despite individual differences in what matters. Finally, the approach provides for ideal principles any organisational or political entity should aspire to achieve but ultimately it is up to nation states or organisational leaderships which principles to prioritize. In conclusion, the universalism of capabilities is a crucial premise for establishing design principles that guide the development process, whether for EA or any other community governance framework.

4.4.3. Capabilities, Functionings, and Agency

The HCA is founded on three important concepts: *agency*, *capability*, and *functionings* (Alkire & Deneulin, 2009). While functionings are those things that people value in their being and doing, a capability is the set of valuable functionings that provide humans with *opportunity freedom* (Kleine, 2010). Agency, on the other hand, is the ability of an individual to pursue their own goals. Agency, often identified with the concepts of autonomy, self-determination, empowerment, voice, etc, is important to nurture the creative engagement of people in social processes for the promotion of their own aspirations (Alkire & Deneulin, 2009). Agency contrasts with instrumentalisation, oppression, and passivity (Alkire & Deneulin, 2009). In

conclusion, capabilities refers to the opportunity set and functionings are the outcomes of agency (Frediani, 2010).

According to Sen, individual humans convert goods (resources) into functionings such as working, resting, being literate, being healthy, being part of a community, being respected, and so forth. This implies that providing the same goods to different people would not produce the same results. Rather, we should determine the kinds of resources to provide based on people's abilities to convert the resources to functionings. A standard desktop computer, for example, may not mean the same thing to both abled and disabled people. As a result, when assessing human well-being, other *conversion factors* such as personal, institutional, environmental, and relational factors must be considered (Alkire & Deneulin, 2009; Enderle, 2013)

The distinction between achieved functionings and capabilities is between what is realised and what is possible effectively; in other words, between achievements on the one hand, and freedoms or valuable options from which one can choose on the other (Gasper, 2007; Robeyns, 2005).

According to Sen, the evaluation of well-being should focus on the capabilities, not on the functionings. What is ultimately important is that people have the freedoms or valuable opportunities (capabilities) to lead the kind of lives they want to lead, to do what they want to do, and to be the person they want to be. Once they effectively have these substantive opportunities, they can choose those options that they value most. For example, every person should have access to health services provided by the government. However, the HCA recognises that a person may refuse to use e-health services available to the public for some personal or religious reason. The HCA is therefore focused on choice or freedom, holding that the crucial good that societies should be promoting for their people is a set of opportunities, or substantial freedoms, which people then may or may not exercise in action: the choice is theirs. It commits to respect for people's power of self-definition.

While capability and functionings pertain to the opportunity aspect of freedom, agency is associated with the process aspect of freedom (Alkire & Deneulin, 2009; Sen, 1993). Agency has several facets (Alkire & Deneulin, 2009). To start with, agency entails effective control over oneself and one's environment. It therefore stands not only on a person's agency but also that of the collective. Thus, it may promote an individual's well-being as well as that of the collective such as of the family, village, community, ecosystem, etc. Second, agency is operational within the range of goals that a person values and has reason to value. The key is the "reasonableness" of the values. Goals that affect negatively or harm the agency, person, or goals of others cannot be said to be "reasonable" even if they are, for some reason, valued by the agent. Finally, the

agent's responsibility for creating and sustaining the situations or opportunities for achieving the valuable goals must be underscored.

One deals with human capabilities only under certain constraints. An agent operates within certain constraints when they try to expand their functionings. These constraining factors make up the basis for sustainable decision-making since the agent should recognise the impact of their decisions on current and future ecosystems (Rauschmayer & Leßmann, 2013; Schultz et al., 2013). Whether the functioning constraints are loaded automatically at the time of decision-making or are externally imposed is, however, a contested terrain (Rauschmayer & Leßmann, 2013; Schultz et al., 2013).

Before closing this section, a particular distinction needs to be made between *capability* and *choice*. Choice is not capability for the simple reason that it does not constitute the value that is at the core of capabilities (Alkire & Deneulin, 2009). Choices must be valuable in order to be called capabilities. Furthermore, the goal of the HCA is not to expand choices per se. Instead, it targets the improvement of quality of life. Hence, it does not necessarily follow that choice expansion results in capability expansion. More choices may create disillusionment and disappointment. It is also interesting to note that, in many Indigenous and some traditional societies, capabilities in some cultures are the results of community deliberations instead of individual choices.

4.4.4. Critiques

The HCA is not without its detractors, though. Two major objections of the HCA will be highlighted below, along with their respective rebuttals.

One of the criticisms directed at HCA is its supposed focus on individual well-being, with utter disregard for the well-being of groups. In a detailed response to this critique, (Robeyns, 2005) argued that the HCA embraces *ethical individualism*, as opposed to ontological[1] or methodological[2] individualism. The HCA takes a stance of ethical individualism, arguing that we should consider only individuals as the decisive units of moral concern (Alkire & Deneulin, 2009; Robeyns, 2005). That does not, however, disqualify groups from coming into play when analysing policy decisions or evaluating artefacts and structures. The HCA asserts that groups

[1] Ontological individualism asserts that "society is built up from only individuals and nothing than individuals, and hence is nothing more than the sum of individuals and their properties" (Robeyns, 2005, p. 108).
[2] Methodological individualism, also called explanatory individualism, holds that all social phenomena "can be explained in terms of individuals and their properties" (Robeyns, 2005, p. 108).

and institutions are valuable insofar as they promote individual well-being (Alkire & Deneulin, 2009). Ethical individualism, according to Robeyns, is to be sought because groups such as the family or community often hide or step aside from systemic oppressions and inequalities enshrined into their structures (Alkire, 2008).

Another criticism often aired against the HCA is that it is not a complete ethical theory (Martins, 2011). That is, HCA only caters for capability space and for nothing else. Martins (2011) suggested that the HCA "focuses on the descriptive element (the space in which to assess well-being) rather than on the prescriptive element (the criterion)" (p. 2). Another of the detractors, Séverine Deneulin (2002), criticised the HCA for its disinterest in capability expansion (prescription). She argued that, if the focus of the HCA is on the evaluation of the capabilities of the individual, there will be no place for scrutiny of collective actions, public policies, social institutions, and structures which are often instrumental in promoting individual capabilities.

The problem also has another practical element pertaining to the criteria for the selection of the information set required for capability evaluation. Deneulin questions whether the information set can be identified based on the specific need of the evaluation effort focusing on those capabilities of value, or whether the information base should have the potential for prescription (Alkire, 2008).

Robeyns (2005) pointed out that the HCA is not conceived of as a descriptive theory that aims to explain poverty, inequality, or well-being. Rather, Robeyns (2005) argued, the HCA "provides a tool and a framework within which to conceptualize and evaluate these phenomena"(p. 94).

The remedy suggested for these practical problems is to be found in acknowledging the place of groups and institutions in capability promotion (Alkire, 2008). That is, the very definition of capabilities as *beings* and *doings* should be expanded to account for group participation as an essential element for the realisation of the beings and doings. In other words, the individual cannot enjoy capabilities detached from the group (Alkire, 2008). Smith & Seward (2009) studied ways of integrating individual as well as social elements of concern in the HCA.

The ecosystem view is also advocated by Alkire (2008) and others to create the methodological support base for the use or operationalisation of the HCA in wider application domains. In this respect, scholars have shown the evaluative and prescriptive potentials of the HCA in so many domains. The following section presents some of the works concluded in four relevant domains.

4.5. Operationalisations of the Human Capabilities Approach

Gaining wider credence, the HCA has been in use in diverse domains including developmental and welfare economics, political philosophy and in ICT4D and other technology-related domains (Oosterlaken, 2012b; Robeyns, 2005). In ICT4D, several research undertakings deployed the HCA as an evaluative framework for gauging the merits of artefacts in expanding human choices (Dasuki et al., 2014; Olatokun, 2009; Tshivhase et al., 2016; Zheng & Stahl, 2011). Similarly, the HCA has applications in the broader field of technology design (Brödner, 2013; Oosterlaken, 2009; 2012b). The potential utility of the HCA is also being examined as an ethical framework to influence corporate behaviour (Bertland, 2009; Enderle, 2013).

In this section, four important HCA application domains are outlined that are believed to be relevant to the current study. The methodological reviews presented in Tables 11-14 address four aspects of the specific evaluated study: (a) the type of research (qualitative, quantitative, conceptual, etc); (b) the theme of the research, which is represented by keywords; (c) a brief summary of the work; and (d) implications for the study, which either suggest theory, research approach, method, data input, or justification. As there is neither the interest nor the space to delve deeply into each study, they are only highlighted here. The actual application of the examined materials is demonstrated in Chapters 5 and 6, where they are shown as part of the conceptual framework and the human capabilities ontology.

4.5.1. The Human Capabilities Approach in E-government and ICT4D

Even though there are many conceptual studies that justify the application of the HCA in information system research and practice, empirical evidence is required to bolster the credibility of HCA as a normative and evaluative approach.

One empirical work that sought to understand the potential of HCA for assessing the developmental outcomes of e-government projects was that by Zarei et al. (2014). E-government involves the provision of government services as well as platforms of engagement and collaboration to the public through electronic means. In a survey of Iranian government employees, Zarei et al. (2014) showed that provision of e-government services enabled the personal, professional, and environmental capabilities of employees.

ICT4D is another of the most pervasive applications of the HCA. Development is seen as a multifaceted process that addresses the economic, social, political, sustainability, and capability goals of human beings (Zheng et al., 2018). ICT4D research explores the actual and prospective applications of information technology artefacts to drive the developmental aspirations of societies through the prism of theories of change (Sein et al., 2019).

ICT4D employs the HCA both to guide and to evaluate the capability requirements of citizens in a range of technology application domains. Several empirical works have been identified that apply the HCA in the ICT4D domain. One such piece of empirical evidence may be found in the work of De La Hoz-Rosales et al. (2019) who, in a data panel study involving 145 countries, found that ICT use by individuals, businesses, and the government improves people's quality of life. Their research revealed the capability-enhancing effects of ICT use at the individual, organisational, or governmental levels. In particular, they found that the business use of ICT is impactful on the innovativeness and entrepreneurial efforts of individuals. Similarly, De (2006) concluded that the managerial project assessment methods may be augmented by the HCA to assess the impact of technology projects holistically. Principally, the well-being component of project impacts may only be taken into consideration if the HCA or comparable normative frameworks are incorporated into the evaluation procedure.

In a series of qualitative research, Hatakka and colleagues analysed the effects of ICTs on the capabilities of students at various educational levels. In a case study of the usage by students of internet resources in higher education, Hatakka & Lagsten (2012) discovered that the HCA provides a deeper understanding of what and why developmental outcomes are achieved by students who use internet resources. Hatakka et al. (2013) concluded that individual access to laptops expanded some of the students' capabilities while limiting those of others.

In a study targeting the education sector, Bass et al. (2013) proposed an approach that combines the HCA and institutional theory for the post-hoc analysis of social drivers that encourage or discourage individuals from having full participation in and getting full benefits from ICT4D projects. They took a case study of an ICT4D project from Ethiopia and concluded that promotion of the capability of individuals could strengthen and develop institutions. This framework is later used by Dahiru et al. (2014) to examine the adoption of software-as-a-service (SaaS) applications by small- and medium-sized enterprises in sub-Saharan Africa.

A recent study in Nigeria by Iliya and Ononiwu (2021) deployed the HCA as an evaluative framework to understand the driving forces and underlying mechanisms that influence mobile phone use among people with disabilities (PWD). They discovered that the use of mobile phones has increased the capabilities of PWDs, including their access to political freedom, economic and social possibilities, and sense of security. Individual and socioeconomic factors, such as literacy and access to finance and electric power are some of the factors impacting capability realisation. The authors concluded that interactive underlying technological and knowledge mechanisms moderate the process of capability realisation.

One of the most expansive programmes of study on the application of the HCA to ICT4D is by Gigler (2004; 2005; 2015). Gigler's study particularly focused on Indigenous people,

and their individual and communal capabilities. He proposed an HCA framework that captures the multifaceted capability needs of traditional societies.

Table 11 summarises the reviewed studies that applied HCA to ICT4D and digital government research.

Table 11
HCA in e-government and ICT4D

Citation **Type of Study** **Research Theme (Keywords)**	**Summary and Implications for research**
Gigler (2004) Ethnography; Participatory workshop ICT; well-being; innovation: poverty, inclusion; digital divide, ICT for development; empowerment; gender; marginalised communities; civic engagement; capability approach; human development; international development; economic development.	**Summary:** This paper investigated how ICTs help the development of Indigenous peoples in Latin America. In contrast to the digital divide narrative, the research placed human development, not technology, at the centre of ICT project evaluation. The study concluded that there is no direct causal relationship between ICTs and empowerment; rather, this relationship is the result of a dynamic, multidimensional interaction between technology and social context. **Implications:** The paper provided a capability-based evaluation framework for ICT interventions. This research was part of a body of work by Gigler that is relevant to identifying potential stakeholder capabilities. His evaluation framework introduced a novel informational capability component. The researcher suggested an alternative evaluation framework for ICT interventions based on Sen's capability approach.
Gigler (2005) Qualitative participatory fieldwork International development, economic development, well-being, human development, Indigenous people, worldview, capability approach, health, education, environment, Indigenous rights, freedom, sustainable development, livelihood approach, gender.	**Summary:** The research examined the utility of the HCA to analysis of the sustainable human development of Indigenous peoples. The author argued that Sen's refusal to compile a fixed list of core capabilities made the HCA appropriate for evaluating the capability of Indigenous peoples via a participatory approach. Through a collaborative process, the researcher gathered a list of human and social capabilities enjoyed by Indigenous people in Peru and Bolivia. Owing to their strong social identity and worldview, the researcher found that certain groups characterise their well-being in collective rather than in individual terms. **Implications:** Gigler compiled a list of human and social capabilities articulated by Indigenous Peruvian and Bolivian people. The author found that, while the HCA provides an effective framework for analysing the individual well-being of people, it has significant shortcomings in evaluating the collective well-being of groups. I could use the capabilities identified in Gigler to populate my ontology.
De' (2006) Qualitative case study; evaluation,	**Summary:** The researcher argued that in addition to traditional managerial project assessment methodologies development theory should be used to analyse project success. An e-government system in Karnataka, India, was used as

development theory; project assessment; governance reform; protective security.	a case study to assess the performance of both development and project assessment approaches, yielding disparate outcomes. **Implications:** The research can be used to justify the use of HCA as an evaluative and normative technique in enterprise projects. Furthermore, the themes generated for development evaluation through the HCA are applicable to my research.
Atoev & Duncombe (2011) Triangulation; Qualitative and quantitative; Semi-structured interviews, online survey and Secondary, review. e-Government; e-Citizenship; individual instrumental freedoms; e-Participation; capability approach.	**Summary:** This study examined e-participation in transitional economies, using Tajikistan as a case study, and concluded that access to public e-services promotes citizen engagement in policymaking and citizen empowerment through participation. The researchers employed Sen's categories of individual instrumental freedom to compare push, pull, and interactive models of e-participation. **Implications:** They have identified important capabilities and functionings, which may be used to populate my ontology.
Hatakka & Lagsten (2012) Qualitative case study; interviews and dialogue seminars. Internet resources; education; capability approach; human development.	**Summary:** The researchers sought to understand the potential of the HCA for assessing the developmental outcomes of e-government projects. In a case study of students' usage of internet resources in higher education, the researchers first developed an evaluation framework consisting of the features and practical utility of the technological artefacts used by students. According to the researchers, the HCA provides a deeper understanding of what and why developmental outcomes are achieved. In addition, they concluded that institutional support such as training and infrastructure, and personal, social, and environmental conversion factors facilitate or inhibit students' ability to realise their capabilities. **Implications:** One of the two use cases developed to demonstrate the utility of my ontology is in the higher education domain. The higher education context of Hatakka and Lagsten's (2012) study renders their capabilities, functionings, and mechanisms eligible for inclusion in my ontology.
Bass et al. (2013) Qualitative case study; interviews. Education; institutional analysis; capability approach; ICT4D; Ethiopia.	**Summary:** This study employed institutional theory and the HCA to examine ICT4D in the context of Ethiopian higher education. **Implications:** My research is aided by this study since it gave a model of the interplay between ICT, institution, and capability, as well as the exciters and inhibitors that play a role in shaping these factors.

Hatakka et al. (2013) Qualitative case study; Group interviews and questionnaires. ICT supported learning; Education; Capability approach; Learning; Information technology.	**Summary:** The goal of this qualitative study was to identify the ways in which students' access to laptops has expanded their individual capabilities. The researchers found that the initiative expanded some student opportunities while limiting others. Some of the capability benefits include a sense of equality in computer use, access to educational resources, the possibility of experimenting with learning approaches that match a student cohort, and the creation of a fun environment. On the other hand, students experienced a decline in safety and security, an increase in health-related maladies, and a rise in computer dependence and social isolation. **Implications:** The list of capabilities and agency outcomes identified are useful for populating my ontology.
Dahiru et al. (2014) Qualitative case study; interviews. Cloud computing; sub-Saharan Africa; small- and medium- sized enterprises; institutional theory; capability approach.	**Summary:** Based on the analytic framework developed by Bass et al. (2013), this research employed a sociotechnical paradigm to examine software-as-a-service (SaaS) cloud applications in sub-Saharan Africa. Using institutional theory and HCA, the study identified 15 drivers and inhibitors of cloud computing adoption in sub-Saharan Africa. It revealed why small- and medium- sized enterprises in sub-Saharan Africa do not view security, privacy, trust, or fear of data loss as key barriers to cloud adoption. The research showed how the exciters and inhibitors impact each other to determine adoption. **Implications:** This is one of the studies that showed how the institutional dynamic affects human capabilities realisation. From the narrower perspective of my research, this paper is interesting because cloud computing and SaaS are concerns of contemporary EA. The framework itself and the data gathered may be used to populate my ontology.
Zarei et al. (2014) Quantitative; questionnaire survey. E-government; capability approach; stakeholder capabilities; Stakeholder functions.	**Summary:** In this study on how e-government influences the talents and activities of government personnel, the researchers discovered that e-government services had an impact on up to thirteen employee capabilities. **Implications:** The *who* and *how* of the study are particularly relevant to my inquiry. First, their research focused on employees affected by e-government services. Employees are proximal stakeholders who have direct influence on organisational performance. Second, they used literature review to identify thirteen stakeholder capabilities and seven functionings, which comprised the assessment instrument used to determine the capability priorities of employees. Methodologically, this study validates my plan of study to compile a universal list of capabilities using literature sources.
Hatakka et al. (2014) Qualitative case study; individual and group interviews.	**Summary:** The purpose of the study was to investigate the capability outcomes enabled by access to and utilisation of ICT in education, as well as the factors that enabled or constrained the outcomes. In a study of a Kenyan study circle programme, the researchers determined that access to and utilisation of ICT creates opportunities such as increased

ICT supported education; education, study circle; capability approach; ICT4D; ICT access; ICT training.	income, learning benefits, community development, and improved literacy and self-confidence. On the other hand, limited infrastructure and IT illiteracy prevented many individuals from fully utilising ICT and its benefits. **Implications:** The list of capabilities and agency outcomes identified are useful for populating the ontology of this study.
De La Hoz-Rosales et al. (2019) Quantitative; panel data analysis. Information society; ICTs; innovative entrepreneurship; social progress; theory of human development.	**Summary:** Using the HCA as a theoretical framework, this study used data panel technique to analyse how the use and acceptance of ICT affects human development, as measured by the *social progress index* and h*uman development index*. They found that, regardless of a country's level of development, individual ICT use affects human development parameters such as having a long and healthy life, being knowledgeable, and having a decent standard of living. **Implications:** They found that ICT use in both individual and business settings can help to advance human development. This work may serve as a basis for introducing HCA as a normative instrument in EA or in general information systems practice.
Iliya & Ononiwu (2021) Qualitative; interviews and focus groups. Capability approach; critical realism; mobile phones; people with disabilities; empowerment.	**Summary:** The study was designed to understand the mechanisms, structures, and conditions that affect empowerment through the use of mobile phones by people with disabilities (PWDs) in Nigeria. The researchers discovered that the use of mobile phones by people with disabilities, moderated by personal, social and environmental factors, enhanced their economic and social prospects, as well as their political freedom, transparency guarantees, and safety. While mechanisms such as knowledge, access, and features of technological artefact impacted use, institutional factors such as provision of affordable mobile phones and services, training, and support, as well as personal innovative capacity influenced the mechanisms. **Implications:** Critical realism allowed them to delve deeper and comprehend the underlying mechanisms that influence Nigerian PWDs' use of mobile phones. They were able to describe events, identify entities and their relationships, and then provide theoretical description and retroduction by utilising critical realism.

4.5.2. The Human Capabilities Approach in Technology Design

The value-ladenness of technological design has been recognised for long. The HCA is a reaffirmation that any engineered system is value laden. It substitutes an *ethical approach* that aims to understand human motivation in developing systems for the *engineering approach*, which makes naïve assumptions about human reality and seeks to create systems that are rational and efficient (Enderle, 2013). Hence, researchers have been trying to explain the human value of technological artefacts through theories of ethics. In this approach, both the end product and the production process are objects of ethical consideration. Table 12 provides a synopsis of research that examined the applicability of the HCA to technology design.

In the ICT4D literature, the HCA has been widely used as an evaluative framework. This evaluative role is not, however, completely satisfying from a design and engineering perspective. In this respect, Dong (2008) declared the shift in focus from "procedural conditions" focusing on the evaluative aspect of design to the "constitutive and instrumental conditions" for prescription (p. 87). The shift in focus is from nominal user participation to consequential stakeholder engagement to co-create products that encapsulate the well-being concerns of humans and non-humans. Therefore, the HCA is used not only as an evaluative but, more importantly, as a prescriptive framework in design and engineering research.

Haenssgen & Ariana (2018) considered technology to be a constituent part of conversion factors and technical inputs to the capability-creation process. Their technology-augmented HCA model acknowledges the *generative* and *transformative* dimensions of technology. Technology enables capabilities, but it also moderates other inputs in the attainment of valued capabilities.

As stated in Section 4.4, two interpretations of the HCA dominate in the academic literature. According to Oosterlaken (2009), the process-oriented Senian conception of capability emphasises agency, whereas the product-oriented Nussbaumian understanding of capability is more concerned with human well-being. Cenci & Cawthorne (2020), for example, seem to embrace Sen's deliberative version of the HCA to improve the process aspect of design. Frediani & Boano (2012) criticised this process–product dichotomy and proposed the concept of *capability space* to explore the process and product components of freedom related holistically with participatory design. Oosterlaken (2014) appeared to endorse this integrative view, which opens up an avenue to create a holistic design space in EA. Blending the two interpretations is expected to produce the cohesion and comprehensiveness that EA aspires to bring to enterprise work.

Two recent applications of the HCA to technology design study are by Jacobs (2020) and Cenci & Cawthorne (2020). Cenci & Cawthorne (2020) attempted to inculcate capability-based ethics to value-sensitive design (VSD), which lacks ethical commitment. Jacobs (2020) went even further and proposed the capability-sensitive design (CSD) framework, which combines VSD

and the HCA, to account for human diversity and to assess technology design normatively for health and well-being. The author demonstrated how abstract capabilities can be translated into concrete design requirements via norms.

Table 12
HCA in technology design research

Citation Type of Study Research Theme (Keywords)	Summary and Implications for Research
Jacobs (2020) DSR with case study value-sensitive design; capability approach; capability-sensitive design; design framework; ethics by design; ethics	**Summary:** This article introduced the capability-sensitive design (CSD) framework, which combines value-sensitive design (VSD) and HCA. CSD, which aims particularly to assess technology design for health and well-being normatively, accounts for human diversity and counters systemic injustices that manifest in technology design. The framework was applied to a hypothetical design scenario involving a chatbot for mental health therapy to demonstrate a capability-centred design approach. **Implications:** The author demonstrated how abstract capabilities can be translated into concrete design requirements via norms. This capability hierarchy is important to apply capability thinking in EA practice.
Kenigsberg et al. (2019) Qualitative focus groups assistive technologies; capabilities; empowerment; ethics; human rights; psychosocial model of disability; public policies, economics.	**Summary:** The study made use of the HCA as an analytic framework to learn how dementia care might be enhanced by the use of assistive technology. **Implications:** The identified capabilities are candidates for instantiating my ontology.
O'Donovan & Smith (2020) Q-method capability approach; technology; makerspaces; innovation policy; sociotechnical configuration.	**Summary:** In this study, the authors analysed how the sociotechnical configuration of UK digital makerspaces offered users, or makers, a set of enhanced capabilities for design and fabrication. The authors observed that it was the sociotechnical configuration of makerspaces, not the technology per se, that helped to expand human capabilities. **Implications:** From this study, I have learned that the inductive approach works well for extracting a set of generic capabilities from documents or other artefacts. While their capabilities list could be used to populate my ontology, their thesis regarding sociotechnical configurations also provided conceptual support for my research.
Oosterlaken (2012a) Conceptual	

moral judgement; capability approach; disabled person; human diversity; technical artefact.	**Summary:** The author used insights from analytical philosophy of technology to argue that human capabilities are intrinsic to technical artefacts and engineering design. She argued that HCA shares commonalities with universal or inclusive design thinking. **Implications:** Studying the shared value of human diversity between inclusive design and the HCA, the author argued that statements of inappropriateness must be part of design norms of technology design. This serves as an important input to EA principles.
Oosterlaken (2014) Conceptual agency; justice; well-being; capability approach	**Summary:** In this paper, the author argued both for the narrow well-being usage of the HCA and the broad usage, which addresses a range of values including, agency and justice. Oosterlaken (2009) labelled the narrow conception as *design for capability*, claiming that it is product-oriented and focuses on individual well-being. However, the author conceded in this article that the narrow conception faces an epistemological and an aggregation challenge. Abandoning her previous conviction to look at the two conceptions separately, she proposed that the narrower conception must go hand in hand with the broader usage. She showed some similarities between the broad usage on the one hand and participatory design and universal design on the other. **Implications:** In her model (Figure 1, p. 245), three core human capability values (agency, justice, and well-being) were tied to participatory- and capability-sensitive design, anchored in a sociotechnical setting. From the perspective of my work, her model is important since it constitutes individual and group capabilities and links them to design approaches.
Cenci & Cawthorne (2020) Conceptual value-sensitive design; procedural ethics; capability approach; technological design for well-being; democracy; participatory-deliberative methods.	**Summary:** Similar to Jacobs (2020), this paper attempted to improve VSD by introducing capability-based ethics to technology design. By using a humanitarian cargo drone study as a case, this paper tackled the challenges that the lack of commitment of VSD to a specific ethical theory generates in practical applications. They argued that the process aspect of design can be improved by the participatory approach to value and welfare entailed by HCA. **Implications:** The authors advocated Sen's deliberative version of capability approach instead of Nussbaum's deontological list of central capabilities, which were embraced by Oosterlaken (2014) and others. However, findings from other works imply that it would be more productive to combine the two interpretations to address both the product and process components of design.
Harris (2015) Conceptual	

well-being; welfare; quality of life; aspirational ethics and codes.	**Summary**: The author used the HCA to propose design criteria that could enhance the capabilities of those who use technological artefacts. In what he called *aspirational ethics*, the author asserted that, when designing for societies, engineers should cultivate certain virtues in addition to obeying regulations. The author cited empathy and compassion as examples of virtues that developing societies appreciate. On the other hand, concern for the environment, sensitivity to the effects of technology, and creativity were mentioned as virtues that developed societies could value. **Implications:** The conceptual framework devised as an input to my ontology is influenced by their organisation of Nussbaum's core capabilities into four capability dimensions.
Haenssgen & Ariana (2018) Qualitative case study capability approach; technology; mobile phones; health; India; China.	**Summary:** Critiquing other conceptions of technology in HCA, the authors suggested a technology-augmented HCA in which technology is a constituent part of conversion factors and technical inputs to the capability-creation process. They acknowledge the *generative* and *transformative* dimensions of technology, which enable capabilities and, at the same time, affect other inputs in the attainment of valued capabilities. **Implications:** This paper is an important work that contextualised technology within HCA and provided justification for analysing technology using the HCA. The technology-augmented HCA can be a useful instrument for framing and developing essential research questions regarding the social implications of technology.
Zheng & Stahl (2012) Conceptual critical theory; capability approach; human diversity; ambient intelligence; affective computing.	**Summary:** Drawing on the HCA and critical social theory in information systems, the authors proposed the *critical capability approach of technology*, which they applied to explore the implications of three examples of emerging ICTs: affective computing, ambient intelligence, and neuro-electronics. The authors shared the belief of Frediani & Boano (2012) that the HCA is "short in providing normative directions that could safeguard the project of participatory design from the threats of co-option, localism and conformity" (p. 220). Therefore, they complemented the HCA with concepts from critical theory to frame their approach. **Implications:** The four principles of the critical capability approach of technology are essential inputs to EA principles. Capabilities associated with emerging technology cases can be used to instantiate my ontology.
Nichols & Dong (2012) Conceptual capability approach; public infrastructure; normative framework; clean drinking water; central capability.	**Summary:** In this study, the authors sought to identify capabilities that align with people's conception of good design. Using the HCA as a theoretical lens, the authors argued that design is a central capability, that capabilities are multidimensional, and that there are instrumental and intrinsic freedoms of design. **Implications:** Despite the significance of the authors' other two claims, the multidimensionality of capabilities argument is particularly pertinent to my ontology as a theoretical foundation. Any practitioner or researcher cannot predict which capabilities are vital for an individual or group. As a result, it is critical to develop a dynamic knowledge base of capabilities that may be validated and expanded over time.

Frediani & Boano (2012) Conceptual capability approach; participatory design; deliberative democracy; normative principle; Global South.	**Summary:** In this work the authors proposed the concept of *capability space* to explore the process and product components of freedom associated with participatory design. Then they elaborated on a series of normative values based on concepts from radical democracy and social production of space literature. They concluded that design is embedded in the processes of deepening democratic practices by revealing power relations and navigating through dissensus. **Implications:** This paper, coupled with that of Oosterlaken (2014), may be used to create a holistic design space that can be deployed in EA. The planning–design–implementation trichotomy must be obscured in an HCA-tamed participatory product development.

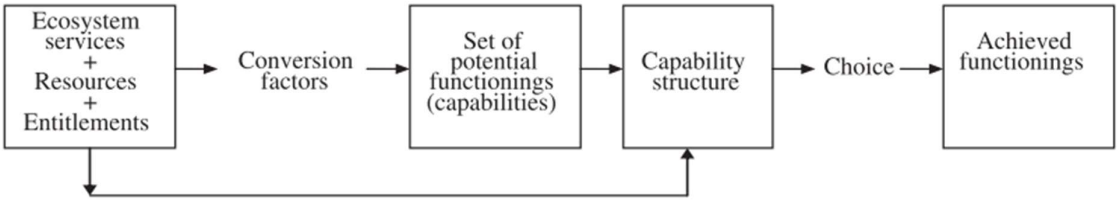
4.5.3. The Human Capabilities Approach in Sustainability Research

Sustainability is the profitable use of resources without endangering the environment or the welfare of present or future generations. The HCA offers a compelling and comprehensive vision of sustainability that takes into account its economic, social, and environmental facets. Sen (2013) argued that the HCA should be used as the foundation for ethically elevating sustainable thinking. He urged a change from a sustainability perspective that prioritises resources to one that prioritises freedom. He contended that this change accords equal weight to the ability to establish and pursue one's own goals, aspirations, and commitments in any manner one sees appropriate and the satisfaction of human needs.

One way of relating sustainability to human capabilities is the concept of ecosystem services (ESS) (Ballet et al., 2011; Polishchuk & Rauschmayer, 2011, 2012). In this framework, ecosystem services are the benefits that humans receive from the ecosystem; thus, they are equivalent to other resources that create opportunity freedom.

The model in Figure 7, while not a complete account of the relationship between human functionings and the ecosystem, demonstrates the need for consideration of sustainability issues in organisational decision-making.

Figure 7
A representation of the link between human capability and sustainability thinking



Note. From "A note on sustainability economics and the capability approach" by J. Ballet, D. Bazin, J. Dubois, and F. Mahieu, 2011, *Ecological Economics*, *70*(11), p. 1833 (http://dx.doi.org/10.1016/j.ecolecon.2011.05.009). Copyright 2011 by Elsevier Ltd. Reprinted with permission.

Probably since the publication of the Brundtland Commission (1987) report, sustainability has become a critical concern for organisations. Inherent to the concept of sustainability is the idea that the present consumption of resources would not only harm the current generation, but also the future generation in a more dire manner. In this respect, Burger & Christen (2011) underscored that future orientation is a primal principle of sustainability thinking. Consequently, strategic outlook is essential at various levels of decision-making in terms of sustainability considerations. Sustainability strategies are now part of the strategic planning of organisations.

Burger & Christen (2011) emphasised the need for "high level strategic actions decided by structural agents" to realise sustainability (p. 788). Similarly, Grasso & Giulio (2003) held that sustainable development is dependent primarily on the effectiveness of institutional arrangements and their relationships with instrumental freedoms. As a result, institutional structures, strategies, infrastructures, work systems, and so on must be geared towards bringing sustainability to the organisation and beyond. As instruments of strategy, information systems must be concerned about the environmental, social, and economic sustainability of the organisation and the society in which they operate. Thus, information systems research, planning, design, and evaluation are aimed at promoting sustainability (Piotrowicz & Cuthbertson, 2009).

Grasso & Giulio (2003) adopted a broader notion of institutions to mean both formal and informal social arrangements. Informal institutions are social capitals that include creed, values, or trust shared by the society. Formal arrangements are those institutions created at global, international, national, local, or organisational levels. These formal arrangements have immense power to envision and realise a sustainable future for present and future generations. Between the formal and informal extremes lie *structures* that include informal rules and traditions as well as formal regulations, laws, and constitutions. These are actually mechanisms through which the informal and formal institutions exert their influence.

In EA research and practice, we must address four sustainability questions (Dobson, 1996).

(i) What to sustain? In answering this question, the EA practitioner needs to get access to the sustainability information base.
(ii) Why to sustain? The HCA provides one of the most comprehensive normative justifications for sustainability thinking upholding human well-being as well as generational and intergenerational justice.
(iii) What are the objects of concern? These objects of concern may be current and future generation human needs and wants as well as present and future generation non-human needs. Stakeholder analysis could provide a detailed tally of the parties that may have concern with enterprise operations. The HCA also fills in where accounting for the concerns of non-human stakeholders is concerned.
(iv) What is the level of substitutability between human-made and natural capital? The answer to this question is left for sustainability science distributed in several fields of study. EA must again get access to the state of the art in sustainability science to determine what to substitute and under which circumstances.

In Table 13, I have summarised objectives, methods, findings, and implications of a selection of studies that employed the HCA in sustainability research.

Table 13
HCA in sustainability

Citation	Summary and Implications for Research
Type of Study	
Research Theme (Keywords)	
Grasso & Giulio (2003)	**Summary:** Among the earliest applications of the HCA to analyse sustainability, this p
Conceptual; case study.	13) of the capability approach to enable detailed investigation of the environmental, ec
capabilities; institutions; instrumental freedoms; sustainable development.	sustainable development. By taking real-world cases, the authors demonstrated how in influence sustainable human development. They concluded that sustainable developm "institutional efficiency and effectiveness and their relationships with instrumental free
	Implications: Their analysis framework, the capability map, and the cases can be used
Grunfeld et al., (2011)	**Summary:** This paper examined the capability, sustainability, and empowerment impa
Qualitative; focus group study.	ICT4D initiative. Participants in the study highlighted the multidimensional capability
capability approach; empowerment; ICT4D; iREACH; participatory evaluation; sustainability.	Additionally, they valued the affiliation benefits of the project, which enabled them to the global community.
	Implications: While the sources of capability, sustainability, and empowerment identi instantiate my ontology, the micro-, meso-, macro-layer schematic of institutional dyn conceptual model.
Burger & Christen (2011)	**Summary:** The researchers began by identifying six adequacy conditions for the conce
Conceptual	proceeded to develop a sustainability framework based on these conditions. These ade
theory of sustainability; capability approach; normativity; systems.	orientation, normative power, inter- and intra-generational justice, universality, recogn resources, and the presence of structural and political elements.
	Implications: The paper is useful to the extent that it justifies the use of the HCA as a sustainability issues.
(Polishchuk & Rauschmayer, 2012)	
Conceptual	

ecosystem services; human well-being; capability approach.	**Summary:** The ecosystems services (ESS) view accounts for the *benefits* that humans draw from ecosystems. The authors applied the HCA to show the effects of the ESS on human well-being, far beyond the mono-dimensional utilitarian view that had been dominating the literature. Integrating the ESS concept to the HCA, according to the authors, allows explicit incorporation of environmental aspects of well-being to the HCA. In addition, they developed a research outlook that takes into consideration human diversity and individual well-being by explicating the cultural dimensions of ESS. **Implications:** One way in which the sustainability aspect of EA is addressed is through the valuation of environmental services that improve people's quality of life. My conceptual framework and human capabilities ontology can build off the ideas presented in this study.
Sen (2013) Conceptual Capabilities, environment; Sustainability; Freedoms; Sustainable consumption; Agency; Participation; Development.	**Summary:** In this philosophical essay, Sen argued that the HCA provides a moral foundation for sustainability studies. He proposed shifting from a focus on resources to one of individual liberty in the pursuit of sustainability. Sen maintained that this shift gives equal weight to the satisfaction of basic human needs and the independence to set and pursue one's own priorities. **Implications:** With Sen's *rational man* argument in mind, it is feasible to reimagine sustainability in a way that prioritises protecting people's freedom to live as they see fit. This argument, from the originator of the HCA himself, lends credibility to employing the HCA as a framework to frame sustainability thinking within EA.
Leßmann & Rauschmayer (2013) Conceptual capability approach; sustainable development; systemic level; collective institutions; dynamics	**Summary:** This paper argued for a reconceptualization of sustainable development based on the HCA. Developing a four-step model, the authors showed that a CA-based implementation of sustainable development requires knowledge with regard to: (1) how resources and conversion factors contribute to individual capability sets; (2) how achieved functionings affect the ecological, economic and social systems; (3) how the systems will change over time; and, finally, (4) how these changes impact on the capability set of future generations. They advocated combining the individual and systemic levels when addressing sustainability issues. **Implications:** The integration of individual levels of sustainability to the system level informs my conception of sustainability in EA.
Smyth & Vanclay (2017) Conceptual; qualitative workshops	

social impact assessment; project-induced displacement and resettlement; social impact management plans; sustainable livelihoods approach; impoverishment risks and reconstruction model; sustainable development goal	**Summary:** The authors developed the *social framework* for analysing, planning, managing, and assessing social issues pertinent to bigger projects with the objective of enhancing positive impacts and reducing negative impacts. The framework was developed iteratively by assessing existing models, such as the UN sustainability goals, the UK government's *sustainable livelihoods approach*, the HCA, and interactions with stakeholders. **Implications:** The social framework for projects constitutes eight key social and environmental categories which address the issues that contribute to people's well-being and the social sustainability of projects, namely: people's capacities, capabilities, and freedoms to achieve their goals; community/social supports and political context; livelihood assets and activities; culture and religion; infrastructure and services; housing and business structures; land and natural resources; and the living environment. These themes may help enrich my conceptual framework.
Hillerbrand et al. (2021) Qualitative case study energy justice; normativity; capability approach; central capabilities; smart grids; automated driving.	**Summary:** The authors bemoaned the technocentric discussions in the energy literature and proposed the social and ethical approach to the subject. Using two cases of energy digitalisation (smart grids for the power sector and autonomous cars for the transportation sector), they investigated whether and how the HCA could support the notion of energy justice. They concluded that the HCA, which is based on the rational man, is an appropriate normative measure for conceptualising energy justice. **Implications:** This research demonstrated the practical application of Nussbaum's central capabilities. This research has the potential to expand my ontology's definitions.

4.5.4. The Human Capabilities Approach in Corporate Ethics

Business ethicists debate the relationship between moral behaviour and people's happiness, success, and well-being in the workplace (Bertland, 2009; Sison, 2013; Solomon, 2004). The HCA is a normative approach with potential to elevate the place of human well-being and dignity in corporate ethics. In this regard, Enderle (2013) challenged resource-based and utilitarian approaches to corporate ethics, as well as lingering *value-free* conceptions of economics, to advocate for capabilitarianism and justice orientation in economic thought. In a similar vein, González-Cantón et al. (2019), following the lead of Enderle (2013), outlined the human rights obligations of businesses within the framework of the HCA. They showed the link between corporate responsibility, human rights, and the HCA.

Accordingly, the HCA has been tried in several contexts of business ethics. For example, using the HCA, Westermann-Behaylo et al. (2016) introduced the notion of human dignity to business decision-making. They proposed what they called the *stakeholder capability enhancement model*, which promises cooperative advantage for businesses and their stakeholders as well as advances in social well-being and dignity.

The International Journal of Manpower devoted an entire issue to the discussion of capabilities concerns in human resource management in the private, public, services, industry, and associative sectors (Subramanian et al., 2013). One of the papers in this issue was by López-Andreu & Verd (2013), who showed the effects of company policies and strategies on employee career development decisions from a human capabilities perspective. Bonvin et al. (2013), in the same issue, reported the case of French and Swiss companies which implemented a capabilities-oriented approach to restructuring organisational processes.

More recent research by Sferrazzo & Ruffini (2021) showed how the so-called *liberated* companies – companies that allow full freedom to employees to make decisions relevant to their work and career – are actually realising the full potential of the HCA. They listed competence, responsibility, time autonomy, equality, inclusivity, self-motivation, and human flourishing as primal capabilities relevant to organisational management. The idea of liberated companies can be traced to the self-managing teams chronicled by Emery & Trist (1965) and others of the sociotechnical movement. This demonstrated the capability implications of sociotechnical thinking and the primacy of stakeholders in organisational decision-making.

Despite Sen's conviction to the contrary, listings of valuable capabilities comparable to those of Sferrazzo & Ruffini (2021) are common. It is possible that the resistance to explicit prescription of the Senian capability approach has contributed to the ubiquity of such specifications (Alkire & Deneulin, 2009). However, Enderle (2013) suggested using international standards and norms such as the *Global Reporting Initiative*, *ISO 26000*, and the *UN Framework for*

Business and Human Rights to build a normative set of capabilities for use by organisations. Such organisation of human capabilities in businesses would not only guide planning and evaluation, but it may also encourage continued debate on the importance of human dignity in economics and business.

Table 14 summarises six studies with significance to the HCA in corporate ethics.

Table 14
HCA in corporate ethics

Citation Type of Study Research Theme (Keywords)	Summary and Implications for Research
Sferrazzo & Ruffini (2021) Conceptual Capability approach; freedom; happiness; liberated companies; organisational ethics.	**Summary:** This paper added to the scant literature on the application of the HCA in a business setting by demonstrating the HCA's potential for management and organisational ethics. Using the example of so-called liberated firms, which give employees a wide range of decision-making flexibility along with matching responsibilities, the authors argued that human resource management should move its attention from the needs of the organisation to the needs of the individual. **Implications:** This study is found relevant to my research in three ways: (1) it lends a conceptual and empirical backing; (2) it validates the literature-based capabilities elicitation method; and (3) their inventory of capabilities can be used to populate my ontology. In particular, they suggested a novel list of capabilities valued by employees, including, competence, responsibility, time autonomy, equality, inclusivity, self-motivation, and human flourishing.
Bertland (2009) Conceptual Virtue ethics, capabilities approach, business ethics.	**Summary:** In this paper, a philosophical argument combining the HCA and virtue ethics led to the conclusion that a manager or the organisation as a whole must nurture an environment that encourages the unrestricted development of stakeholder competencies. The argument assumed that humans are born free and possess a sense of human dignity, which must take precedence over other values. **Implications:** This paper is relevant to justify the potentials of the HCA as a normative framework in enterprise management in general and EA in particular.
Leßmann & Bonvin (2011) Conceptual Job satisfaction; valuable work; capability approach; subjective well-being; participation	**Summary:** The authors argued in favour of the HCA's expansive interpretation of job satisfaction. Their holistic view of work acknowledged the multidimensionality of work and job satisfaction, emphasised the human value of agency, choice, and capabilities, and complemented the informational dimension of job satisfaction with the capabilitarian concept of *valuable work*. The authors advocated for participation and process freedom as prerequisite for valuable work. **Implications:** This research is significant to the extent that it acknowledges the HCA as a beneficial normative framework for incorporating human capabilities and dignity into the managerial conception of job satisfaction. Therefore, it may be regarded as one of the reasons for introducing the HCA into EA.

Westermann-Behaylo et al. (2016) Conceptual Human dignity; HCA; cooperative advantage; stakeholder management; stakeholder reciprocity.	**Summary:** The authors employed the HCA in the context of business enterprises to introduce the concept of human dignity to business decision-making. By blending stakeholder theory with the HCA, the article offered the stakeholder capability enhancement model as a vehicle for introducing the concept of *human dignity* to business. They suggested that enhancing stakeholder capabilities as a business strategy provides businesses and their stakeholders with a cooperative advantage as well as with improvements in social well-being and dignity. **Implications:** This research not only provided a rationale for my study, but it also showed how to integrate the HCA with stakeholder theory. The identified stakeholders and their capabilities may be used in my ontology.
González-Cantón et al. (2019) Conceptual HCA; human rights; dignity; corporate responsibility; UN guiding principles.	**Summary:** The article provided a broad sketch of the human rights obligations of a business within the framework of the HCA. The article established a link between corporate responsibility, human rights, and the HCA, providing a set of conceptual and practical implications for a human rights perspective on corporate responsibility. **Implications:** It is possible that this additional piece of evidence, which recasts the HCA inside an organisational framework, can help bolster the case for my research.
Enderle (2013) Conceptual Business ethics; capabilities; human development; human rights; informational basis; rationality; wealth creation.	**Summary**: Another conceptual paper justifying the centrality of human capabilities and human dignity to business decision-making. The article criticised the concept of value-free economics and advocated for business decisions to be sensitive to issues of poverty and justice. **Implications:** The article provided more support for my research demonstrating the function of the HCA in business ethics.

4.6. Discussion

In this Chapter, I have touched on two aspects of the research. I have addressed the methodological aim of the study by detailing the reasoning behind my decision to use the particular theories and approach that I did. Second, this Chapter weaves together the first three propositions (**P1**, **P2**, and **P3**) with sociotechnical and stakeholder theories and the HCA to provide evidence for the fourth premise (**P4**) that increasing human capabilities is an aim EA should promote. I have argued that the synergy of sociotechnical systems theory, stakeholder theory, and the HCA provides the strongest backing for an ecosystemic view of EA.

The propositions **P1**, **P2**, and **P3** together encapsulate the holistic, strategic, and sustainable dimensions of EA. In **P1**, I have asserted that EA represents a pattern of sociotechnical systems, whereas in **P2** I argued that EA prioritises stakeholder interests. **P3** positions EA as an enterprise strategy that incorporates the economic, social, and environmental sustainability objectives of the enterprise. These propositions are in sync with the ecological adaptation school, which encourages enterprises to examine their current and future states holistically and strategically (Lapalme, 2012; D. J. Nightingale & Rhodes, 2015).

The theoretical basis for understanding EA as sociotechnical architecture, and for my purpose, human-centric architecture is to be found in theories of management and architecture. More relevant to EAs are organisational theories which elevate the place of the human element in the organisation. Sociotechnical systems theory, for instance, captures the human as well as the technical components of the system with all the intricate relationships within and outside the bounds of the organisation (Haines et al., 2005; Ropohl, 1999). This holistic view forms the theoretical backdrop even for such ideals as stakeholder focus and sustainability thinking.

All the principles of sociotechnical design that are fundamental to sociotechnical systems are inherited by EA, as evidenced by the literature excerpts presented in Table 15. EA as a strategic and macro-level design platform enshrines the holistic view of the enterprise. As such it is not only affected by business interests but by is tempered by human values and aspirations. Enterprises are socio-technical systems insofar as they consist of human and technical elements, and they have values to uphold (Hatch, 2011). Daft (2007) noted that enterprises are social entities expressly designed to achieve stakeholder goals.

Table 15
EA as sociotechnical architecture

Sociotechnical system meta-principles for design	Characterization of EA
Design is systemic, emergent and context-sensitive	"[t]he fundamental organization of a system embodied in its components, their relationships to each other, and to the environment" (IEEE, 2000, p. 3). "… enterprise architecture is …a high level, comprehensive representation of the enterprise which has universal appeal and applicability—an effective entry point for the future evolution of enterprise modeling" (Harmon, 2005, p. 85).
Values, organisational culture and mindsets are central to design	"… the principles guiding its design and evolution" (IEEE, 2000, p. 3). "… all relations describing [enterprise architecture principles] EAP mechanisms and their effects are significantly moderated by organizational culture"(Aier, 2014, p. 26).
Design involves making choices and trade-offs	"Normative principles limit design freedom. They are, however, not the only statements which limit design freedom. Requirements also limit design freedom" (Proper & Greefhorst, 2010, p. 64).
Design should be business and user-centred	The why and the who of EA describe the stakeholder and the business purpose as crucial components (Syynimaa, 2010; Zachman, 1997).
Design is an extended social, contingent process which is socially shaped	"… the lack of focus on the 'people' aspects of EA could be the reason why many organisations still struggle with EA implementation" (Nuryatno & Dobson, 2015, p. 1).

Note. The meta-principles drawn from Clegg (2000) and Waterson & Eason (2019).

According to systems theory, the evolution of hierarchic systems is from the lower to higher which implies that the purpose of the supersystem is to serve the purposes of the subsystems (Meadows & Wright, 2015). The modern stakeholder is someone who not only works to achieve corporate objectives but own objectives as well (FirstPost, 2009; J. Morgan, 2014). Thus, the purpose of the EA is expressed in the multiplicity of stakeholder goals. Solomon (2004) endorsed this view that business should be designed and run with the purpose of serving humanity above all other considerations.

The conscious EA notion aligns with stakeholder theory, which stipulates that enterprises must be managed in their stakeholders' best interests. This notion endorses ethical and just organisational leadership principles that could garner mutual trust and benefits for all stakeholders (Harrison, 2013). The sustainability of the enterprise is also dependent on such transparent and fair arrangements of enterprise management. The conscious EA is representative of the essential evolution of the organisation towards higher levels of integration and differentiation all at the same time (Gharajedaghi, 2011). Through this transformative process the organisation works to "serve both its members and its environment"(Gharajedaghi, 2011, p. 92).

I argue for the deployment of the HCA in EA in the order to account for and promote stakeholder values and sustainability (Gasper, 1997; Sen, 1999). The HCA promotes the expansion of human choices (Robeyns, 2017) thereby removing unfreedoms which limit humans from living the life they choose (Zheng & Stahl, 2011). The HCA suggests that a process, system, or technology to be deployed in a social context shall extend the capabilities of humans (Oosterlaken, 2012b).

The HCA makes a clear distinction between the characteristics of goods and the functionings that a person achieves because of the use of the goods. The focus of the HCA is on the functionings (Enderle, 2013). For instance, if we take a higher education institution (HEI), the technical side of EA may dictate the acquisition of hardware and software that meet certain functional and non-functional quality specifications. On the other hand, the HCA informs EA to favour hardware and software that could expand the capabilities of the students, teachers, alumni, etc by way of expanding their opportunity to flourish. This could be in the form of opportunities of research funds, networking, educational opportunities, research collaboration, etc

Consistent with stakeholder theory, the HCA recognizes the plurality of the values individuals want to achieve both in quality and quantity (Enderle, 2013). Therefore, an EA that attempts to cater for only a single value of the human stakeholder is ineffectual. Taking the previous example, a HEI may, for several reasons, take the wrong assumption that serving the *academic needs* of the student would suffice. However, *academic needs* may mean several things to a student or group of students. Additionally, the student may have psychological, philosophical, religious, etc values to promote, which may not be covered by the academic goals. Therefore, the institution needs to look at human flourishing needs instead, to stay relevant in the long run.

To gain an understanding of how stakeholder capability co-creation is possible in EA via the HCA, one may refer to Table 16 for a mapping of stakeholder values to the core human capabilities. I employed the three classes of EA stakeholder roles (*producers*, *facilitators*, and *users*) provided in (Niemi, 2007). Producers are those involved with EA planning and development. Facilitators, on the other hand, are those who plan, manage, maintain, or sponsor EA work. Users are those who provide input, requirements to EA and receive products and services. I added a fourth class for the *community* the enterprise operates in. Note that the classes are not mutually exclusive, and the role of a stakeholder may vary from organisation to organisation.

Table 16

Mapping the co-creation of EA stakeholder capabilities

Human Capability	Stakeholder Roles and Interests			
	Producers	**Facilitators**	**Users**	**Community members**
Life	Work safety	Preservation of investment	System product/service safety; protection from premature death	Production safety (Ecological)
Bodily Health	Operations safety	Preservation of investment	Ensure bodily health; provisioning of good health, nourishment, and shelter	Ecological
Bodily Integrity	Freedom of movement; security against any form of violence including harassment	Preservation of investment	Freedom of movement; security against any form of violence including for example digital bullying	Open access to facilities and resources (within limit)
Sense, imagination, thought	Education and training provision	Supporting innovation and sustainability	Self-actualization; self-expression opportunities	Supporting local education
Emotions	Motivation and job satisfaction	Social investing; corporate social responsibility	Safe emotional engagement with others	Supporting community development
Practical Reasons	Input to quality management system; stakeholder engagement	Meaningful sponsor participation	Informed choice; freedom of conscience	Community planning
Affiliation	Meaningful social interaction; ensuring freedom of assembly	Joining a community of sponsors or facilitators	Meaningful user interaction; dignity	Meaningful community-producer interaction
Relation to nature (Other species)	Green information system	Sustainability investment	Green products and services	Green campus
Play	Work-life balance	Supporting innovation	Capacity to play	Green space development
Control over environment	Being able to work as a human being; equal employment opportunity; capacity to exercise practical reason	Property right protections	Free participation in the political and economic life of the society	Transparent local political participation

Note. The interests of a subset of EA stakeholders are mapped to Nussbaum's basic capabilities.

As is evident from Table 16, each stakeholder category may have a capability requirement that EA is expected to meet. These capability concerns cut across all capability themes. Hence, technology choices, work configurations, application designs, or business decisions must be governed by these capability concerns.

EA is not only concerned about current users or current generations. As a strategy, it is also concerned about future stakeholders. The ultimate purpose EA should therefore be to preserve and expand human capabilities of current and future generations. In this relation, sustainability is coming up as a progressive research agenda in the EA literature (Pankowska, 2013; Perdana et al., 2020; Sutherland & Hovorka, 2014). In parallel, the HCA, with a substantial contribution to sustainability thinking, is being promoted as a valuable theoretical framework in ICT4D and technological design fields (Ballet et al., 2011; Burger & Christen, 2011; Rauschmayer & Leßmann, 2013).

To reiterate, while organisations could play the negative role of alienation, repression, and domination in many societies because of the often divergent interests of the owner, manager, and employees, the HCA can be considered as a theoretical counterweight to instrumentality and the associated dehumanization and alienation (Chooback, 2010; Farazmand, 2002). Considering this to be a worthy agenda, I proposed the HCA as a conceptual link to promote stakeholder value and sustainability in EA theory and practice. Considering the core issues that EA is meant to address, the HCA may be utilised in:

1. establishing the information base necessary to perform the mission of the enterprise;
2. setting up the structures requisite to implement the enterprise mission;
3. determining the kinds of principles that place design limit on EA;
4. determining the technologies necessary to perform the mission of the enterprise;
5. determining the techniques and tools used in EA planning and implementation; and
6. evaluating or comparing EA efforts from human function achievement perspective.

Adopting the HCA as a guiding framework would mean, anchoring EA design on the principles of equity, justice, well-being, and human agency. EA Principles that reflect the capability promotion ideals of the HCA would guide the design of technologies and structures. The techniques and tools of EA development would become capability sensitive, inclusive, and participatory. The overall goal should however be embedding human capability consciousness in EA (Oosterlaken, 2014).

I completed a thorough literature review to better understand how the HCA has been used in practice in digital government, ICT4D, technology design, sustainability research, and corporate ethics. The review's primary concern was with the various approaches, methods, data sources, and justifications that have emerged from the extant body of research. In Chapters 5 and 6, some of the reviewed materials are integrated into the conceptual framework and the human capabilities ontology, providing concrete examples of their practical use.

Studies on e-government and ICT4D have utilised the HCA more than any other information system field. The bulk of research examined were qualitative in nature. The

reviewed works have contributed in two ways to my research. At least two of them have made methodological contributions to my research. Gigler (2015), for example, created the Alternative Evaluation Framework (AEF), which would add to my conceptual framework. The research of Iliya & Ononiwu (2021) demonstrated, on the other hand, the utility of critical realism in revealing the mechanisms that drive technology use. The second contribution of the reviewed works is their potential to contribute to the ontology I have suggested. The capabilities, functionings, and mechanisms identified in studies such as Hatakka and Lagsten's (2012) and Dahiru et al. (2014) were deemed suitable for incorporation into my ontology.

Contrary to the digital government domain, corporate projects seem to have found limited application for the HCA. This is evidenced by the fact that the literature search returned few results, the majority of which were of conceptual and justificatory nature. Nonetheless, the justificatory contribution is still substantial, as the significance of the HCA to EA must be demonstrated in both corporate and government sectors.

Some notable applications of the HCA in the technology design domain have been reported through conceptual, qualitative, or design research. Oosterlaken was the most prominent researcher in this category, demonstrating the efficacy of the HCA to infuse human values into design in multiple related studies. One of the dilemmas in applying the HCA is how to identify capabilities. In this respect, Cenci & Cawthorne (2020) advocated for Sen's deliberative vision of the HCA. To offset the cost of extensive community deliberations and to address both the product and process aspects of design, it is equally important to leverage the knowledge of researchers and experts (see the work of O'Donovan & Smith (2020), for example). From my perspective, Harris's (2015) reconfiguration of Nussbaum's central capabilities was another influential study. As can be seen in Chapter 5, the four capability dimensions Harris's (2015) suggested have informed my conceptual framework.

4.7. Chapter Summary and Conclusion

This Chapter has first brought to the centre the ethical dimension of enterprise decision-making and how EA, as the instrument that translates enterprise values and strategy into information system services, must align with such organisational orientation. In order to provide the suggested artifact a solid foundation, sociotechnical systems theory, stakeholder theory, and the HCA were investigated. Accordingly, the following conclusions are formed about the nature and prospect of enterprises and their architectures.

- As sociotechnical systems, enterprises must implement an EA that takes into account not only economic, social, and ecological considerations, but also human choices.
- As a matter of ethics and sound business strategy, stakeholder theory emphasises the value of all stakeholders in corporate decision-making.

- Stakeholder value is fundamental to both sociotechnical systems theory and stakeholder theory, such that problem comprehension, solution design, and implementation all require an awareness of the roles, responsibilities, concerns, viewpoints, and success criteria of the stakeholders.
- The conscious EA is one in which enterprise design is reoriented towards humanisation of the enterprise, sustainability thinking, and the affordance of meaningful work, thereby placing human capabilities at the centre.
- Amartya Sen's HCA, which has been operationalised in e-government, ICT4D, technology design, sustainability, and corporate ethics research, can be used to augment the two domain theories in order to enrich EA research and practice by focusing on the expansion of the opportunity space available to individual persons.

In conclusion, the HCA, in conjunction with sociotechnical systems theory and stakeholder theory, could facilitate the development of an EA that is holistic, strategic, and stakeholder-centric. It has also been determined that the operationalizations of the HCA that have been examined will have justificatory, methodological, and data source significance for this study.

In this chapter and the previous one, I offered the study's backdrop, delved into the problem domain, and introduced relevant concepts and theories that contribute to the design of proposed solution artefacts. In Chapter 5, I will introduce the first of the envisaged research artefacts: a framework that synthesises human capability concepts pertinent to the EA domain.

5. EA Design for Human Capabilities: Synthesis Framework

In Chapters 3 and 4, I argued that the HCA, in conjunction with sociotechnical systems theory and stakeholder theory, could facilitate the development of a holistic, strategic, and stakeholder-centric EA. Additionally, I emphasised the importance of exploring how the HCA is put into practice, which would have justificatory, methodological, and data source significance for this study.

This chapter introduces a framework of human capability concepts that are applicable to EA practice. Taking EA as a backdrop and drawing on operationalizations of the kernel theories, I present a synthesis framework of human capabilities, outlining key themes and concepts relevant to the EA field.

5.1. Introduction

In this chapter, I present the integrative conceptual framework for human capabilities conscious EA. The framework brings together concepts from EA, the HCA, sociotechnical systems theory, stakeholder theory, and sustainability thinking. I will begin by outlining the worldview essential for the ecosystemic EA. Next, I will use structuration theory to explicate the institutional and agency dualism observable in EA practice. I will conclude by presenting the framework, which is the result of a synthesis of the concepts, theories, and approaches I employed.

EA is the description of the enterprise, its current state, and future prospect. EA captures the enterprise's constituents, their interrelationships, and the principles governing the enterprise's design and evolution. EA is therefore tied to the very nature of the organisation and dynamics. In previous chapters, I made a priori assertions and then used the literature to show that in fact

P-1. EAs are patterns of sociotechnical systems.

P-2. EAs have the objective of promoting the values of all stakeholders.

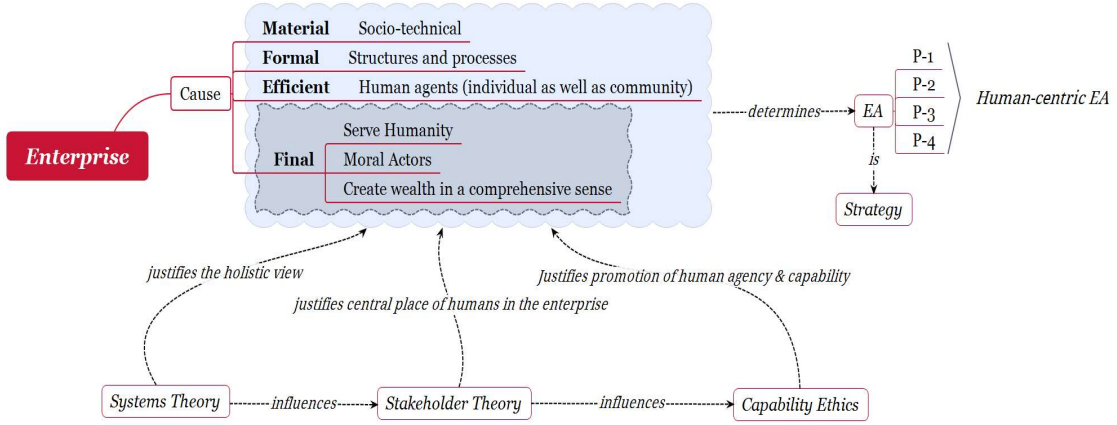
P-3. Sustainability is a critical criterion in EA design.

P-4. Promoting human capabilities is an ideal EA should promote.

As depicted in Figure 8, these propositions constitute the culmination of the chain of logical reasoning beginning with the justification for the existence of the enterprise. The propositions are the pillars on which the human capabilities conscious EA is founded.

Figure 8

Description of the enterprise "being" via Aristotelian causation



Note. P-1 to P-4 signify the four propositions.

Aristotle's (2018) theory of causality is helpful for understanding the enterprise's purpose and the role of the enterprise architect. Aristotle's teleology is significant for two reasons. First, it centralizes the final cause (telos) and creates a link with his human flourishing ethic. Second, the efficiency cause exposes the role of the architect in bringing together the various variables of productive work together to create an artefact.

The *material* cause of the sociotechnical enterprise is not confined to humans, but also includes objects and contexts (Love, 2002; Pikas et al., 2022). The *who*, *where*, and *when* of EA represent the human, logistical, and temporal dimensions of architecting (Bross, 2022; Pikas et al., 2022). On the other hand, the *how* represents the process aspect of architecting. It is captured in the tasks, procedures, strategies of the design process (Pikas et al., 2022). In the Aristotelian theory of causality these constitute the *formal* cause of the enterprise.

Goals can be understood as *final* cause towards the achievement of which all other resources and efforts are directed. I take goals to mean, not only the limited organisational goals promoted by the owners and their agents, the managers, but also the multitude of personal goals pushed by people in the organisation or outside of it. The organisation is the social instrument that integrates the disparate goals of all stakeholders to bring about value beneficial to current and future generations. If the primary goal of the enterprise is to create wealth in the comprehensive sense of the term, then EA, which is the extension to the raison d'être of the enterprise, aims to promote human capabilities. The architect and the other EA roles collaborate to articulate the motivations or the *why* of EA (Pikas et al., 2022).

While embracing the material, formal, and final causes, Heidegger (1993) interpreted the *efficiency* cause differently than is typically articulated elsewhere. Heidegger argued, with reference to the original Greek sources, that Aristotle had no efficiency cause in which an artisan coaxes a material into a certain form. Rather, he maintained that the artisan's task is to reveal

(*apophainesthai*) the true essence of the artefact by combining, through their artisanry, the potentials of the material, its form or the *abstraction of beingness*, and its ultimate purpose. In EA, the architect and the other roles enter into a productive process of revealing the latent nature of the enterprise, which is to create wealth and flourishing to all. Thus, the architect imbues EA with individual and collective knowledge, skills, infrastructures, technologies, processes, cultures, time, and values of ethics and aesthetics (Bross, 2022).

In passing, I will make two important observations. First, despite the significance of Aristotle's theory of causality as an analytical tool, it is essential to recognise that causes often overlap, particularly in modern modes of production. In software design, for instance, the software engineer might be considered both the efficient and material cause. Secondly, the product-process duality is intrinsic to Aristotelian causality. To expose the true potential of the material cause, one must target both the product and the process aspect of artefact design (Frediani & Boano, 2012; Oosterlaken, 2014). While it is possible to embed human capabilities into products and services, the process aspect of capabilities can however be brought about through sustained dialogue. In conjunction with stakeholder theory and the HCA, the ecosystemic EA school has the potential to foster dialogue and sense-making through group facilitation (Lapalme, 2012; Mohr & Dessers, 2019a). Practice of democratic dialogue addresses the process aspect of Senian capability.

5.2. The Human Capabilities Conscious Enterprise Worldview

By integrating several perspectives into one coherent strategy, EA permits a more comprehensive examination of the enterprise. EA's holistic *weltanschauung* necessitates a deep dive into the organisation's textual artefacts, cultures, spoken communications, and practices in order to describe the organisation's core tenets (W. Donaldson, 2017; Jackson, 2019). In suggesting a human capabilities conscious worldview (EA), I am outlining the requisite *microsociology* or philosophy that would create an organisational climate supportive of the diffusion of this way of thinking into EA practice (W. Donaldson, 2017).

A coherent worldview that supports human capabilities is essential to bracket the human capabilities conscious EA framework. Even while the enterprise's worldview is to be deduced from the enacted, articulated, memorized, or textualized expressions, Taves (2022) argued that textualization offers greater "systemization, rationalization, and commentary" (p. 10). It is also important to realise that in an enterprise setting, system worldviews (paradigms) impinge on individual worldviews. W. Donaldson (2017) wrote, "the system imposes a microontology of its own on the participant by virtue the system's language, images, and actions becoming catalogued in a system ontology, a way representing the system" (p. 9). Influencing the system is therefore preferable to controlling it at lower levels of abstraction (Pennock & Rouse, 2016).

A comprehensive specification of the necessary worldview is possible by analysing what W. Donaldson (2017) called the "ologies." He suggested twelve non-mutually exclusive "ologies" including psychology, ontology, epistemology, axiology, and methodology. These "ologies" jointly form an enterprise philosophy, which would influence the goals and actions of the system.

Despite the fact that all "ologies" are pertinent, I restrict myself to ontology, axiology, praxeology, and epistemology. Vidal (2012, p. 308) identified the first three as "first-order" questions, which ponder about the world we live in. Epistemology, on the other hand, is a "second-order" question for it provides us with the instruments to accumulate the knowledge necessary to answers the first three questions. Brief descriptions of each of these "ologies" follow.

Ontology may mean the kinds of things philosophers take to exist. In the specific context of a theory, ontology refers to "the things that would have to exist for that theory to be true" (Craig, 2005, p. 756).

Axiology is concerned with the nature of value and the kinds of things that have value. Taking a broader view, axiology explores what things are valuable including the values of ethics, aesthetics, and epistemology. In contrast, axiology may take a more nuanced approach and focus on morally acceptable and ultimately valuable human actions (Lemos, 2015).

Praxeology, Rigg (2014) claimed**,** originated in ancient Greek philosophy of action for human flourishing. It is driven by the notion that knowledge is beneficial as far as it serves practice. Setting aside concerns of being and the ways of knowing, praxeology is preoccupied with the methods of translating knowledge into action and how that action leads to knowledge.

Epistemology is the study of knowledge concerned with three related, yet distinct, questions (Moser, 2015): (a) What are the characteristic features of knowledge and justification to knowledge? (b) What are the sources of knowledge? (c) What are the limits of knowledge and justification?

Convinced that the HCA, stakeholder theory, and sociotechnical systems represent distinct system worldviews, I utilised the extant literatures to generate an integrative human capability conscious enterprise worldview (presented in Table 17). It is not my goal to provide a complete representation of the worldviews encapsulated in each of the three theories/approaches. The relevant literature is sampled opportunistically to capture the partial but prevailing philosophy of each, as portrayed in the authoritative sources.

Table 17
The human capability-conscious enterprise worldview

Worldview Perspectives	**Sociotechnical Systems Theory**	**Stakeholder Theory**	**HCA**
Ontology (Metaphysics) *What kinds of substances exist most fundamentally? What grounds the existence of reality?*	Ropohl (1999) claimed, "in reality there do exist objective entities to which the models correspond. A system is a cognitive map of reality and, therefore, cannot depict everything at a time; the depicted landscape, however, really exists in all its complexity" (p. 190).	Stakeholder theorists admit to the reality of the world, but asserts that it is impossible to provide a singular objective description of this reality (Godfrey & Lewis, 2019; Wicks & Freeman, 1998)	The HCA is only conceivable if we are able to recognise a real-world circumstance, such as poverty or deprivation. Therefore, ontological realism is inherent in the HCA (Martins, 2007a, 2007b).
Epistemology *What/how can we (not) know?*	According to Ropohl (1999), sociotechnical systems theory is a synthesis of competing epistemological ideas: "the synthesis of unity and diversity, —the synthesis of holism and atomism, —the synthesis of idealism and materialism" (p. 190). It transcends all these competing notions through a pragmatic application of knowledge. Systems are abstractions of entities existent in the real world (Ropohl, 1999).	According to Godfrey & Lewis (2019), stakeholder theory embraces multiplicity of stakeholders and heterogeneity of their desire. Two of the most prominent proponents of stakeholder theory, Wicks and Freeman (1998), presented pragmatism as a philosophy commensurate with the conceptions and convictions of the theory. The epistemology of pragmatism has four facets (Freeman et al., 2010; Wicks & Freeman, 1998): (a) the world is real but epistemologically relative to experience; (b) facts are but expressed through language, culture, and artefact; (c) all scientific inquiries are interpretive and narrative; and (d) science is a game played within the language constructs or conventions of the paradigm and field of study.	Martins (2007a) held that capabilities are real, but epistemologically relativistic. Notwithstanding the efforts to list basic universal capabilities by some, the general conviction is that human capabilities are contextual and hence must be harvested through a continuous process of engagement (Comim, 2008; Robeyns, 2006, 2016). Multidisciplinary inquiries are encouraged (Alkire, 2003). Methodologically, it has been determined that both qualitative and quantitative research methods are beneficial (Zimmermann, 2006).
Axiology	Values are intrinsic to enterprise design. Design of sociotechnical systems should not	Stakeholder theory agrees with pragmatism in its moral imperative of satisfying the desires of	The HCA is essentially normative. Deneulin & McGregor (2010) wrote, "[a]

What is important and why? What makes something "good'?	entirely obsess with economic questions of productivity. Job satisfaction, motivation, and quality of total work life are central ideals enterprise design must target. Design should move to achieve higher levels of physical as well psychological well-being to workers (Appelbaum, 1997; Clegg, 2000; Fayoumi & Williams, 2021; Waterson & Eason, 2019).	as many stakeholders as necessary (Freeman et al., 2010). Godfrey & Lewis (2019) characterize stakeholder theory as "organization-level moral pragmatism," creating eudaemonia of the plurality of stakeholders (p. 30).	key normative argument of the capability approach is that social arrangements should aim to expand people's capabilities, that is, their freedom to undertake or achieve valuable doings and beings, and in doing so those arrangements should respect people's agency" (p. 3).
Praxeology *How should we live? What gives meaning to our actions? How can we achieve meaningful actions?*	Sociotechnical systems design should be grounded in the needs of the business, its users, and their managers. Design of work systems should be worker centred (Clegg, 2000; Winby & Mohrman, 2018). P. Jones (2021) claimed that systemic design is grounded overwhelmingly on "an overarching scientific philosophy of pragmatism, embracing multiple perspectives to describe a system and its problems and structures" (p. 788). Systems engineering, information science, operations research, organisational studies, etc. contribute to the study and practice of systems design (Ropohl, 1999).	The most prominent of the stakeholder theorists embraced pragmatism as a philosophy most appropriate for understanding and acting on the varied stakeholder desires and interests (Freeman et al., 2020; Godfrey & Lewis, 2019). Pragmatism is concerned with enactment than theory construction and knowledge accumulation. Managers should engage as many stakeholders and as many views as necessary in each issue that touches the stakeholder interests (Freeman, 1994; Freeman et al., 2010). Freeman and others (2007) even argued that the interests of each individual, not stakeholder groups, should be considered. Such a pragmatic philosophy, Valentinov & Chia (2022) argued, "draws attention to how the key processes of moral living can practically facilitate the attainment of human flourishing" (p. 2). Social interactions build on common values to create structures for peaceable action and co-existence. Social actors and institutions create	The HCA, according to Robeyns (2006) is not a theory for explaining poverty, but a practical framework to "conceptualize and evaluate these phenomena" (p. 353). By focusing on human ends of well-being and flourishing, the HCA shares with critical theory the goal of changing the world. It recognises human diversity and thus the multidimensionality of capabilities (Alkire, 2003). Multiple methodologies of assessment have been implemented. There are also recent attempts to introduce capabilities into design (Oosterlaken, 2012a, 2012b).

	protected space for divergent values to co-exist and flourish. Actors recognize limits of their own vision/values and accept the validity of other views. Social actors and institutions facilitate open dialogue between diverse groups.

I begin the discussion of the constituent worldviews with a quick summary of the essential general cosmology. Naturalism is the supreme cosmology in all scientific disciplines. A supernatural being is deemed unnecessary, nay irrelevant, to explain world order (Sire, 2015). The integrative view does not exclude any cosmology be it naturalism, theism, deism, or pantheism. "Methodological naturalism" is a sufficient condition for the integrative human capabilities conscious enterprise view (Sire, 2015, p. 180). Naturalism holds that all things, including our thoughts, are made of matter. The world begins and ends in matter. The problem however is materialism tells us how matter behaves not how it ought to behave from a moralistic perspective (J. N. Anderson, 2014). Nonetheless, the assumption is that the other -ologies will provide the moral component.

My integrative view accepts ontological reality. However, reality is hidden behind a veil of fog. What we perceive is, at best, a skewed representation of reality due to the inherent limits of our senses. Therefore, my objective could only be to investigate the EA factors such mechanisms, structures, powers, languages, etc. that contribute to the realization of human capabilities (Lewis, 1996). Moreover, I regard holism as the essence of being; hence, models of nature must strive to imitate it.

The appropriate epistemology is one cognizant of the diversity of stakeholders and their equally diverse needs and desires. Pragmatic application of multidisciplinary and multimethod approaches is encouraged to apprehend the true nature of the practical, functional, and applicable knowledge we seek.

The integrative axiology derived from the synthesis of stakeholder-centric and capabilities-promoting sociotechnical systems approaches is a synergistic holism that prioritises the well-being of humans in their relationship to the ecosystem. Social systems are designed for the service of humans in harmony with the natural ecosystem. Morality is universal but local culture and context must be accommodated for practical purposes (Robeyns, 2003).

Several researchers argued for pragmatism in design research (Melles, 2008; Pikas et al., 2022). Propounded by Charles Sanders Peirce and William James in the 1870s, pragmatism is a method of inquiry concerned with finding practical solutions to real world problems (Tonetto, 2020). Pragmatism's utility to human flourishing is emphasised from the perspective of the Aristotelian idea of praxeology and contemporary theories of design thinking, which emphasise the ability of designers to attune processes and products to human needs (Tonetto, 2020).

To sum up, the integrative capabilities conscious worldview is one which is holistic, critical realist, multistakeholder, and multimethod. In this thesis, this integrative worldview is reflected in the research paradigms and triangulation of authority (scientific, philosophical, as well as subjective) and mixed methods deployed.

5.3. Characterising the Ecosystemic Enterprise

In Lapalme's (2012) account of the EA trajectory, the future-looking ecological adaptation school of the enterprise, which subsumes and extends the technical and integration schools, "fosters system-in-environment coevolution and enterprise coherency" (p. 39). The ecosystemic view is a holistic view that accounts for the technical, the social, the environmental, and all other relevant aspects of the enterprise.

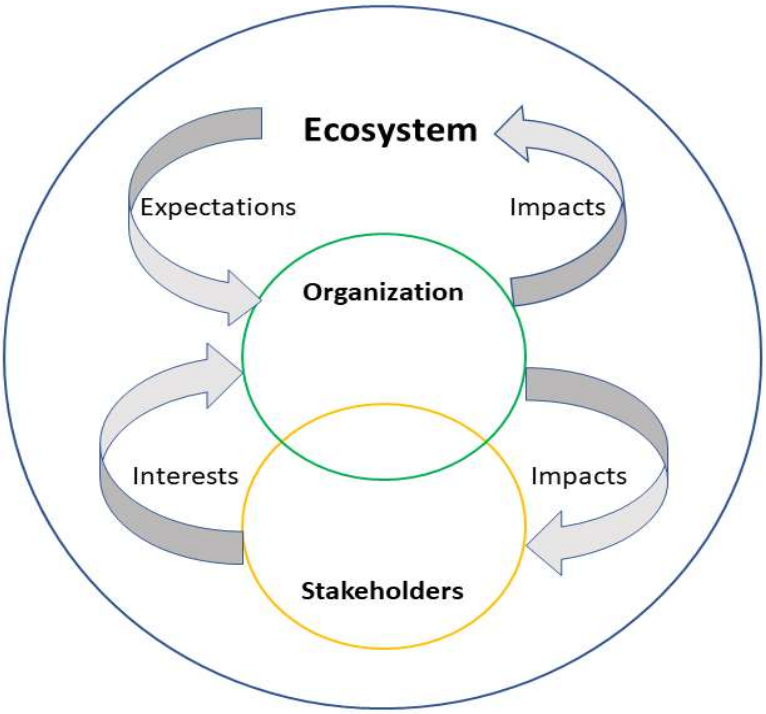
The organisation is in a dynamic relationship with its internal and external stakeholders and the wider ecosystem. These relationships determine how organisational decisions and actions impact individuals, groups, the physical environment, and intergenerational interests. As exhibited in Figure 9, both humans and the physical environment are worthy stakeholders of the organisation in whose interest organisational decisions must be made.

Individual interests may conflict with the interests of society, the environment, and future generations. Consequently, ecosystemic design calls for balancing the interests of the diverse stakeholders. Ecosystemic design suggests that higher levels of work performance can be achieved if the designer (a) understands that humans are agents with their own goals and interests, and (b) targets achievement of a high quality of work life for those humans agents (Appelbaum, 1997; Cherns, 1976). It is for this reason that Drews & Schirmer (2014) advocated for ways of analysing and designing for the "lifeworld" of the diverse group of "ecosystem's 'inhabitants'" with distinct needs (p. 21).

While the *ISO 26000:2010* model depicted in Figure 9 is important for highlighting the interactions between the organisation, its stakeholders, and the socio-environment, it falls short of explaining the internal organisational structures that would determine the nature of these relationships.

Figure 9

The stakeholder-organisation-ecosystem dynamic

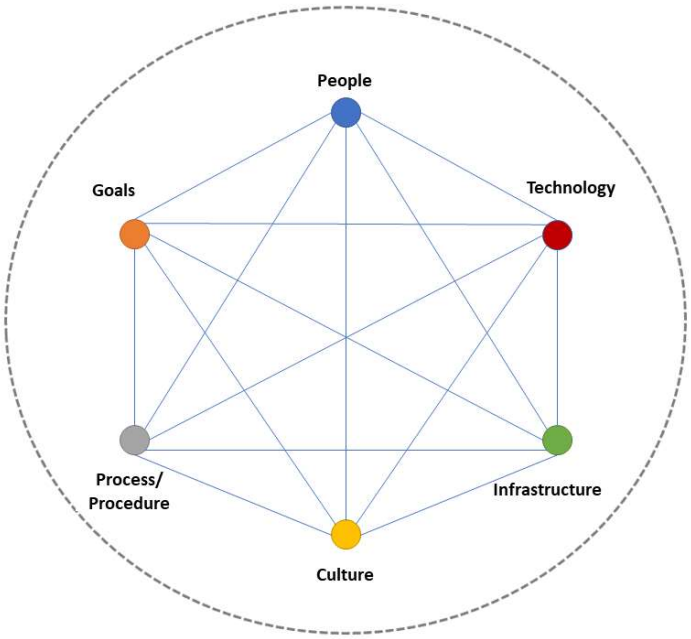


Note. The graphic shows the relationship among the organisation its stakeholders and ecosystem. Adapted from *ISO 26000:2010 Guidance on Social Responsibility* (p. 15), by International Standards Organization, 2010. Copyright 2010 by International Standards Organization.

A better view of the internal organisational structure is provided by M. C. Davis et al. (2014) who expanded on an earlier model by Leavitt (1965). In my rendering of the model (Figure 10), the dotted (permeable) barrier between the organisation and the environment signifies the open system notion at play. Two more elements are not shown but assumed in the model. The first one is the environment in which the system resides. The second one is "information" which pervades the organisation. While information is a source of power, environment imposes constraints on the organisation and its stakeholders.

Figure 10

Ecosystemic enterprise configuration



Note. Adapted from "Advancing socio-technical systems thinking: A call for bravery", by M C. Davis, R. Challenger, D. N.W. Jayewardene, C.W. Clegg, 2014, *Applied Ergonomics*, *45*(2), p. 173 (https://doi.org/10.1016/j.apergo.2013.02.009). Copyright 2014 by Elsevier Ltd. Used with permission.

In this model, organisations are made of six interconnected variables: goals, people, processes, culture, infrastructure, and technology. The goal of the organisation, as defined by The Open Group (2022), is "a high-level statement of intent, direction, or desired end state for an organization and its stakeholders" (p. 43). People encompasses all internal human stakeholders concerned with task-related and human capabilities issues. The organisation deploys physical infrastructures and technologies (the two often conflated in EA) to implement work processes within an organisational cultural setting (M. C. Davis et al., 2014). Outside the organisation's permeable boundary are external stakeholders, such as governments, customers, society, and the environment, which both impact and are impacted by the organisation.

The sociotechnical organisation's narrower goal might be the production of a good or a service. Nevertheless, the interactions between the sociotechnical components have "social and psychological consequences" (Cummings & Worley, 2009, p. 387). Consequently, joint optimization, and by implication, joint design of all organisational dimensions and stakes are sought (Cummings & Worley, 2015; Lapalme, 2012; Winby & Mohrman, 2018).

While every interaction between constituents, and between a constituent and the dynamic ecosystem is significant, my focus is on the "people" aspect of the dynamic. As has been established, the principle that the design of ecosystems must be value-sensitive is the primary argument for placing human interests at the centre (Friedman et al., 2006; Friedman &

Kahn, 2008). To restate what I have already indicated in previous chapters, human capability promotion is the final goal of the enterprise.

Human capabilities in EA are created and sustained as a result of the bidirectional relation between (a) people and people, (b) people and organisational goals, (c) people and organisational processes, (d) people and technology, (e) people and infrastructure, (f) people and culture, and (g) people and environment. It is these interactions that make up the input for capability formation. The task would thus be to elicit the capabilities enabled by these interactions from both process and product perspectives. Table 18 presents sample EA artefacts produced as a result of the interactions between people and the other enterprise elements, as well as the guiding perspectives for these interactions.

Table 18
Snapshot of human-structure interactions in EA

Interaction	Ecosystem Perspective	EA Artefacts (a subset)
People and people	Who are the EA stakeholders?	Business architecture Project Management Stakeholder analysis
People and organisational goals	What are the organisational goals?	Strategy Goals Principles Requirements Constraints
People and organisational processes	What are the organisational processes?	Business architecture
People and technology	What are the technologies?	Technology architecture Application architecture
People and infrastructure	What are the infrastructures?	Physical architecture
People and culture	What are the cultures?	Organisational practices Human resource management
People and physical environment	What are the environmental factors?	Strategy CSR Principles
People and information	What are the informational factors?	Goals Strategies Principles

5.4. Human Capabilities Conscious EA through a Structuration Lens

Using Kleine's (2010) choice framework as a scaffolding, I built a framework of human capabilities within the context of EA. While Kleine (2010) presented the choice framework as "holistic and systemic" operationalization of the HCA with the potential to analyse diverse macro- and meso-level development initiatives, here I will primarily focus on the institution-agency dynamic to help cascade capabilities (p. 683). To set the stage for my discussion of the

choice framework, I will quickly explore structuration theory, from which it drew inspiration (Kleine, 2011).

5.4.1. Structuration Theory

In information systems research, there have been several attempts to explain the relationship between agency and structure through institutional, social network, critical, and other social theories (J. M. Bass et al., 2013; Sawyer & Jarrahi, 2014). Structuration theory (Giddens, 1984) and its extensions have also been found to be instrumental in exposing the tight relationship between human agency and structure (M. Jones et al., 2004; Orlikowski, 2000; Porwol et al., 2013). Structuration is the term Giddens used to describe the interface point where agency meets structure (Gibbs, 2017).

Structuration theory aims to synthesise the dichotomy between agency and structure observed in agency and structural theories before it (Gibbs, 2017). Giddens posited that (a) a structure, however real, has no material existence; (b) human action patterns, not intentions, establish agency; and (c) time and space play a vital role in social reproduction (Orlikowski, 2000; Pozzebon, 2013). The agents produce structures in social settings of time and space through their routine acts.

This conception of the relationship between structure and agency has multiple implications (Gibbs, 2017). First, agents operate within the context provided by structures. Second, human actions that are observant to established rules and norms reinforce existing structures. Yet, structures are not inherently stable and have no permanency outside of the reinforcing characteristics of human action. Further, structures enable as well as constrain human action. Finally, humans through their aberrative actions may destabilize these structures. The recursive nature of the relationship between action-outcome-structure is emphasised (Miles, 2012).

Stones (2005), who is said to have resuscitated structuration theory by giving it a narrower, yet vigorous interpretation, claimed that structure exists in both "memory traces" of agents and in "the material or physical conditions or levers … required as 'capability' preconditions for that action … or interaction" (p. 22). Thus, structures are both internal and external to the agent, having both "phenomenological and material dimensions" (Stones, 2005, p. 18).

The possibility that structures may exist within the agent necessitates the reflexivity of agents. Not only do humans exhibit unique identity in the social structure but they are also reflexive of their situation. The capability to reflect, called "knowledgeability" by Giddens, entails the motive to change the status quo (Pozzebon, 2013). More practically, each person has

the power to intervene and maintain, reinforce, or transform the existing structure (Stones, 2005).

On the other hand, external structures, which include material, social, and structural constraints in the agent's real universe, may put "independent causal power over situated agents" (Stones, 2005, p. 10). This view is consistent with the critical realist view adopted in this research since the emphasis, according to Greenhalgh & Stones (2010), is on "the causal properties of social structures external to agents and highlight an analytical distinction between structure and agency" (p. 1287).

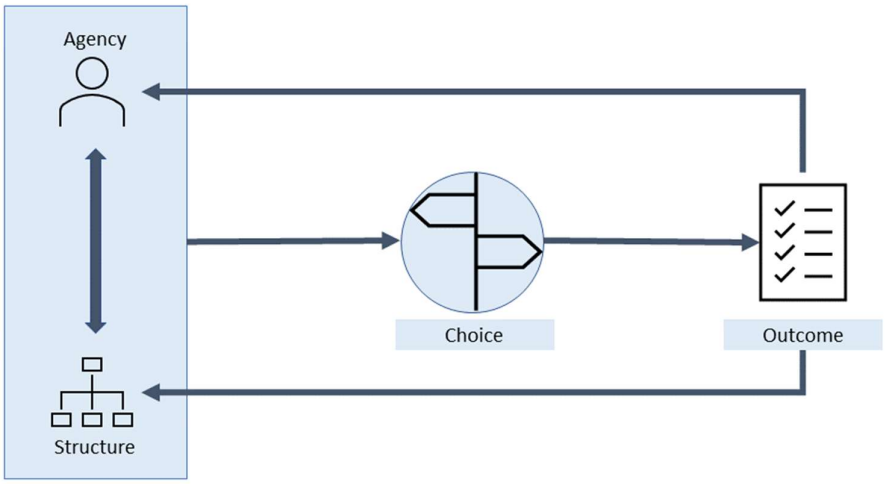
Structuration theory forms the foundation for the choice framework, which I shall discuss in the next section. The choice framework recognises structural constraints on par with individual agency in realizing the full capabilities of the individual (Kleine, 2010). An important feature of the choice framework is visualization of the development process linking the interactions of structure and human agency with development outcomes via empowerment actualized by choice (Tshivhase et al., 2016).

5.4.2. Choice Framework

Based on the theory of structuration, Kleine's choice framework, depicted in Figure 11, has two interacting components that determine the degree of empowerment of a citizen (Kleine, 2010). The first one is the structural or institutional arrangement which sets the stage for whole-rounded development. However, the availability of an infrastructure or a functioning bureaucracy are not enough for benefits realization. The second component, human agency, constitutes the individual citizen's capacity and readiness to interact with the structural components to yield the *resource portfolio*. The resource portfolio consists, for example, financial resources and health resources. To take the example of Kleine (2010), the interactions between credit rules of banks and the ability of the citizen to present a collateral to secure loans forms financial resources (Kleine, 2010, 2011).

Kleine (2010) acknowledged the institutional, political, and normative frame within which ICTs operate, and argued that ICT initiatives need to be analysed within the context of the societies they are built in to. It is thus the interaction between the individual agency-based ("resources") and the structure-based capability inputs that creates human capabilities (Kleine, 2010, 2011).

Figure 11
Simplified rendering of the choice framework



Note. Adapted from "ICT4WHAT?-Using the choice framework to operationalise the capability approach to development", by D. Kleine, 2010, *Journal of International Development*, *22*(5), p. 680 (https://onlinelibrary.wiley.com/doi/10.1002/jid.1719). Copyright 2010 by John Wiley & Sons. Used with permission.

The dynamic between the institutional and agency dimensions of structure creates *choice* (Kleine, 2010). Choice constitutes two related aspects of empowerment—the existence of valuable choice and agency. Only when human agents possess agency resources, such as access, knowledge, and psychological readiness, can available resources be utilised to create capabilities. From both the HCA and the structuration perspectives, human agency is an important aspect of valuable social systems. Humans must be the free active agents and determiners of their own fate. And humans can only enact a social interaction when the "memory traces" they hold allow the interaction. Agency power is thus a critical aspect of human capability formation (Alkire & Deneulin, 2009).

While the choice framework is a powerful instrument to situate human capabilities in ICT4D projects, insights from Orlikowski (2000) may enhance its applicability in an organisational setting. According to Orlikowski, structures are instantiations of practice which are not fixed and objective. It is not intentions but enactments that either reinforce or transform existing structures. Different configurations of technology use in a continued and situated manner, i.e., the way technology is used in different personal, organisational, spatial, or temporal settings create different structural arrangements in the social organisation.

The technology-in-practice view of Orlikowski (2000) suggested that architectures of the organisation start to emerge when the agent starts to enact technology. When the agent (the efficiency cause) begins to engage productively with the organisation's resources (the material cause), the true nature of those resources becomes apparent.

Even though Orlikowski initially held Gidden's view of structures merely as memory traces, she has recently been promoting the concept of "sociomateriality" which asserts that social structures can be embedded into technology (Greenhalgh & Stones, 2010; Orlikowski, 2009). Traces of this conviction are also available in Orlikowski (2000) where she claimed designer values and signatures of experience are melted into the material element. Technology users then draw on the structure laden technology, their own internal resources, social and cultural mores, and meanings attached to technology use in their organisational routines. This spiral of enactment continues to create structures of technology use which inform and influence future agency.

In summary, the choice framework can be used in tandem with structuration theory to understand the relationship between structures and agency in an organisation environment. Within the restrictions placed by factors inside and outside the organisation, human agents use technology as they fit to create instantiations of structures. The enactments influence future agencies giving a bridge between current and future states in the system. Design of products and processes demands the full engagement of both the designers and the users all sharing each other's space.

5.5. Inputs from Stakeholder-centric View

5.5.1. Who are Enterprise Architecture Stakeholders?

Wieringa (2014) defined a stakeholder as a person, group, or institution affected by a problem and the solution to it. In the narrower EA literature, stakeholders are those individuals, groups, or organisations with a bestowed interest in EA planning, development, and use (Garlan et al., 2010; van der Raadt et al., 2008).

The architecture's goals and constraints originate from stakeholders (Wieringa, 2014). Garlan et al. (2010) noted that stakeholders shape an architecture's conception and direction to fulfil their articulated or implied needs. One can conclude that EA exists to create stakeholder value by providing some utility (Harrison, 2013). For example, through EA, organisations may create utility to their customers by providing valuable online services. They may also provide online learning opportunities to employees. And organisations' green technology strategies would create value to the environment as well as future generations.

Freeman (in Agle et al., 2008) advocated for the integration of business and ethics around human values. These values, according to Freeman, are fundamental human capabilities—what a human being is and can be. Freeman argued that to achieve integration of business ethics, an enterprise decision maker, before making important decisions, may ask three questions: (1)

whose values does the decision impact? (2) Whose rights does the decision enable or disable? (3) What will be my moral stature if I make the decision the particular way?

Wieringa (2014) made a distinction between stakeholder desires and stakeholder goals. For him, goals are those desires for which the stakeholder allocated resources. Only some of the desires are promoted to the level of goals because all stakeholders have resource limitation. "Stakeholder desire" is similar to what in the stakeholder theory is known as "stakeholder value."

Theoretically speaking, anything can be an object of desire and therefore stakeholder goal. Stakeholder desires may also conflict with each other. The enterprise therefore must prioritize the desires to upgrade to the level of goal based on availability of resources, stakeholder salience, or important organisational principles.

Wieringa (2014) urged artefact creators and researchers to account for all stakeholder desires, within the restriction of resources. Stakeholders invest their resources on artefacts only because they want to achieve certain goals. Within the frame of Freeman's "integration thesis," organisations may undertake value analysis to understand the alignment between organisational goals and stakeholder desires (Key, 1999). That is there must be a utilitarian trade-off between organisational goals and stakeholder desires (Key, 1999). This is consistent with the idea of "stakeholder salience."

Value creation necessitates a utilitarian trade-off, but not one based on competition, but rather on collaboration among stakeholders. Stakeholders can achieve a win-win situation for all if they understand that the realization of their own goals is possible only when the goals of other stakeholders is achieved (Pankowska, 2015). The insinuation is that continuous negotiation and collaboration is possible among stakeholders and that stakeholders could coalesce around a common purpose (Nakakawa et al., 2010). In this regard, Pankowska (2015, p. 73) asserted that the emphasis should be on "stakeholder relationships and on the jointers of stakeholder interests rather than solely on the trade-off that sometimes has to be made."

Going beyond definition, however, it is necessary to identify the stakeholders of EA practice. A number of stakeholders and stakeholder typologies have been proposed (Laplume et al., 2008). Harrison (2013, p. 763) distinguished between primary stakeholders who are integral to the operations of the enterprise and secondary stakeholders who "typically are not part of the firm's operating core." Primary stakeholders give input, engage in the transformation of the input, use output, or more generally affect or be affected by the operations of the enterprise directly (Hillman & Keim, 2001; Mitchell et al., 1997). Such stakeholders include shareholders, financiers, suppliers, employees, customers, and even local communities whose living environment, for instance, may be affected by the enterprise. Secondary stakeholders are those

who work to influence the enterprise's behaviour in order to attain specific aims. For instance, governments push legislations to rein on wild ambitions of corporations. Similarly, interest groups limit the activities of the corporation through application of ethical principles such as environmental sustainability, consumer protection, and social inclusion.

Another classification attributed to Sirgy (2002) distinguished among internal, external, and distal stakeholders. The distinction between external and distal is one of distance though how far is not clear. Internal stakeholders are those that strictly operate within the spatial boundaries of the enterprise including employees, management, or organisational units. Stockholders, customers, suppliers, financiers, and local community are identified as external stakeholders while competitors, interest groups and the government are labelled as distal stakeholders. Sirgy's (2002) classification, though comprehensive masks individualness.

A third typology by Phillips, Freeman and Wicks (2003) differentiated between "normative" and "derivative" stakeholders, the former being those for whom the organisation has a moral and legal obligation to prioritise. This categorization, however, presents practical difficulties since moral responsibilities are a spectrum rather than a binary.

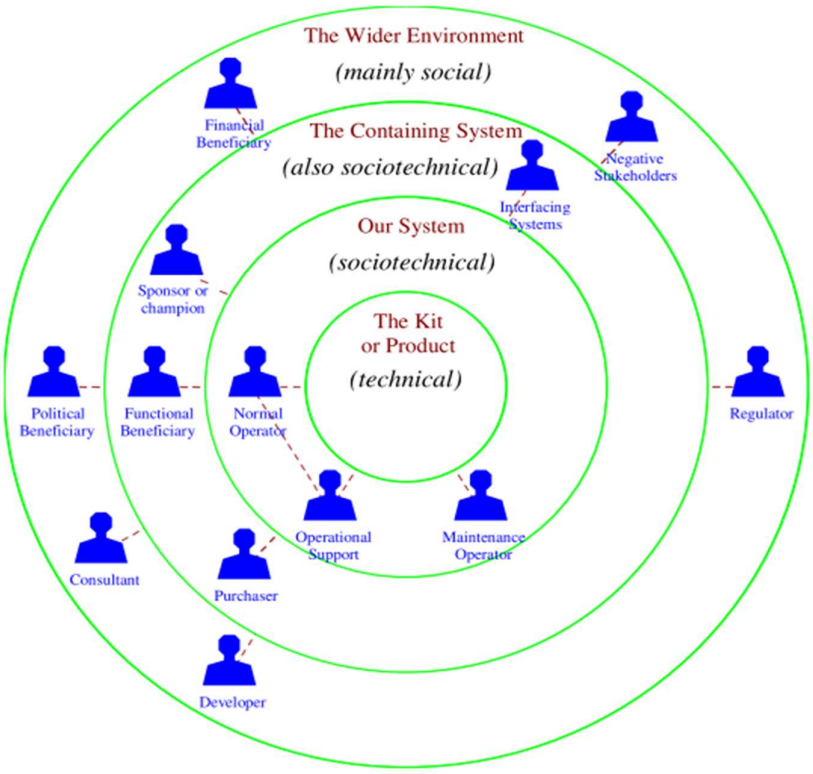
Niemi (2007) characterised EA stakeholders as *producers*, *facilitators*, and *users* based on their concerns. Producers are responsible for EA planning and development, whereas facilitators are responsible for EA governance, management, and maintenance, and users employ procedures, data, applications, and infrastructure to complete a task. While Niemi's list of stakeholders is extensive, the categorization of the more than two dozen stakeholders into three categories is debatable. For example, "owners" might as well be considered as "users." More disconcerting is the absence of the "public" from any of the stakeholder groups on the grounds that it has nothing to do with EA or EA activity.

Van der Raadt et al. (2008), on their part, recognised four groups of stakeholders based on the organisational level with which the stakeholder is associated. Accordingly, they identified enterprise, domain, project, and operational stakeholder types. Theirs is only a subset of what Sirgy (2002) referred to as internal stakeholders. While van der Raadt et al. (2008) were able to identify very specialized roles of stakeholders than Niemi (2007), the bulk of stakeholders are already in the latter's list. Further, they disregarded such important external stakeholders such as customers and the public.

The project-focused model suggested by I. F. Alexander (2005) and displayed in Figure 12 divided stakeholders into four concentric circles. At the core lies the artefact of interest with which human operators (second circle) interact with. Those can be considered as primary stakeholders of the sociotechnical information system. The third circle contains human beneficiaries of the system who may not be involved in operating the systems. These stakeholders

include purchasers (customers), sponsors, etc. Distal stakeholders such as government regulators or consultants are contained in the outer circle. That could be considered as the organisational ecosystem mainly of social interest. Each of the stakeholders and their named or surrogacy roles are defined according to project requirements and may differ from project to project.

Figure 12
An onion model taxonomy of system stakeholders



Note. From "A Taxonomy of Stakeholders: Human roles in system development," by I. F. Alexander, 2005, *International Journal of Technology and Human Interaction*, *1*(1), p. 36. (https://doi.org/10.4018/jthi.2005010102). Copyright 2005 by IGI Global.

Regardless of the typology followed, and despite the number of entities with valid stake, organisations can only dedicate enough attention to a small number of stakeholders due to resource limitations. Zsolnai (2006) held that stakeholders are morally considerable and only those who are so should be attributed as stakeholders. As a result, ranking stakeholders and their respective holdings is a widespread practice.

In stakeholder theory literature, salience refers to the degree to which managers prioritise the claims or interests of one stakeholder over those of another (Mitchell et al., 1997). Mitchell et al. (1997) emphasised power, legitimacy, and urgency as the most important factors affecting salience (refer to Table 19 for definitions and sample stakeholders). Harrison (2013) invoked what he termed the "principle of fairness" to identify which stakeholders should be prioritised,

whereas Laplume et al. (2008) proposed stakeholder culture, stage of organisational growth, and political frame as factors influencing salience.

Table 19
Stakeholder salience factors

Salience Factor	Definition	Exemplars
Legitimacy	The degree to which one believes that a stakeholder's claim to a stake is valid or appropriate.	Proximate stakeholders having de facto and de jure interests in the business, such as owners and employees, may be more salient than remote stakeholders like the general public.
Power	One's ability or authority to control and influence the behaviour and action of others.	Stakeholders such as owners who have more power to effect change than those with little or no power to produce such an effect have higher degree of salience.
Urgency	The extent to which an instant call to action elicits a response from the organisation.	Stakes that need urgent attention from the enterprise are more salient than less urgent ones. Typically, financial stakes elicit immediate action. Calls for environmental action, on the other hand, elicit a sluggish response.

Note. This table is compiled based on information from: (a) "Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts", by R. Mitchell, B. Agle and D. Wood, 1997, *The Academy of Management Review*, *22*(4), p. 869 (https://doi.org/10.2307/259247). Copyright 1997 by Academy of Management. (b) "Stakeholder oriented enterprise architecture modelling", by M. Pankowska, 2015, *Proceedings of the 12th International Conference on e-Business (ICE-B-2015)*, p. 73 (https://doi.org/10.5220/0005544700720079). Copyright 2015 by SCITEPRESS (Science and Technology Publications, Lda.).

In the section that follows, I will demonstrate how stakeholder typologies, salience factors, and human capability thinking are used in this research to construct an EA stakeholder map.

5.5.2. Sustainability as Stakeholder Value

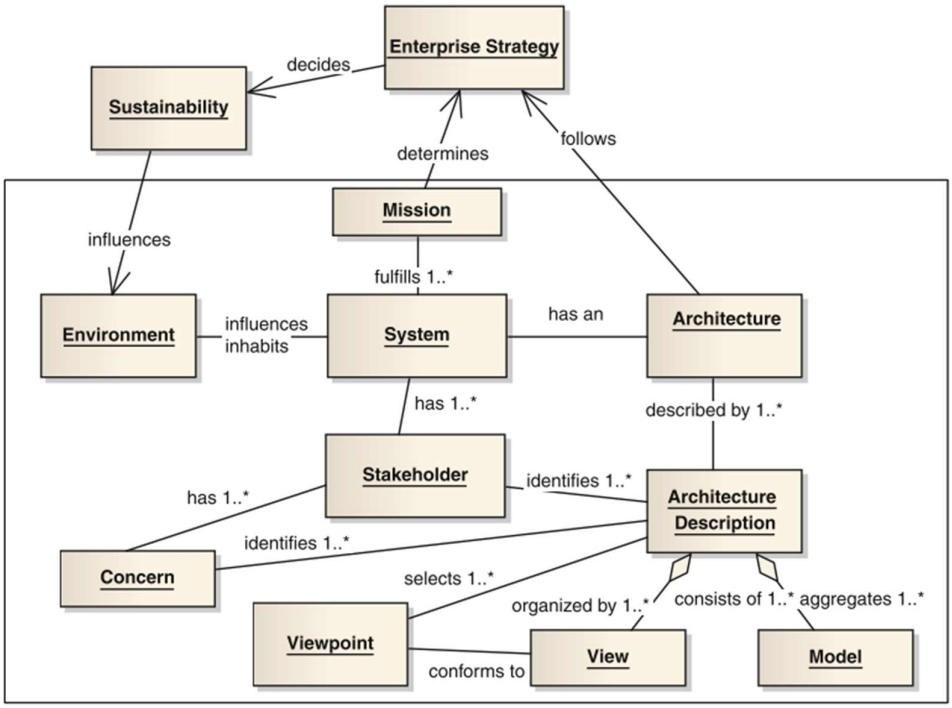
Stakeholder theory accounts for the social, economic, and environmental aspects of societal development. Economic sustainability entails the efficient utilisation of available resources to support long-term growth and the fulfilment of all financial obligations. The community's long-term social, cultural, and environmental concerns must not be compromised by economic growth.

Alternatively, sustainability can be regarded as a stakeholder value that must be promoted to advance the capabilities of current and future generations as well as organisational goals (Demals & Hyard, 2014). In this respect, Zsolnai (2006) recommended that organisations

need to contribute to the conservation and restoration of the natural world, to the development of human capabilities, and to the enhancement of the freedom of future generations.

As part of an effort to integrate sustainability into enterprise strategy, Pankowska (2013) modified the software-intensive systems architecture proposed by *IEEE 1471*. By depicting the interplay between stakeholders and the ecosystem, Pankowska's model, shown in Figure 13, illustrates the importance of incorporating social, economic, and environmental factors into strategic planning. The model was constructed under an instrumentalist paradigm, wherein organisations (system) were conceived as the sole stewards of the ecosystem and stakeholders as passive or instrumental agents. Hence, the model must be extended to account for stakeholders as both causes and consequences environmental concerns. In addition, generational sustainability concerns may be better understood if sustainability is elaborated via the prism of human capability.

Figure 13
Sustainability EA model



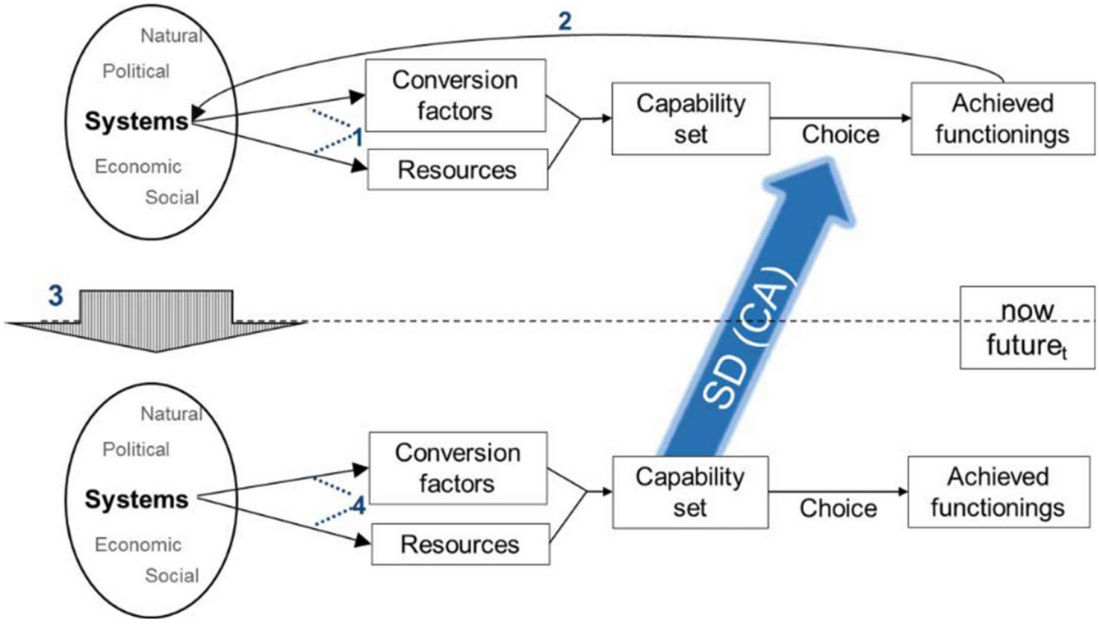
Note. From "Enterprise Architecture Modelling for Corporate Sustainability," by M. Pankowska, 2013, in Building Sustainable Information Systems: Proceedings of the 2012 International Conference on Information Systems Development, H. Linger et. al. (eds), p. 369 (https://doi.org/10.1007/978-1-4614-7540-8_28) . Copyright 2013 by Springer Science+Business Media. Reprinted with permission.

Leßmann & Rauschmayer (2013), in accord with structuration theory, reasoned that introducing space-time into the generic human capability framework would allow the latter to account for sustainability. Figure 14 depicts a model in which an agent converts internal and external structures, resources, and conversion factors into a capability set, and then into

functionings. The functionings (outcomes) in turn affect structure and agency via a continuous process of (re)enactment (Orlikowski, 2000). Consequently, the evolution of the structure over time influences the capability set of future generations.

Figure 14

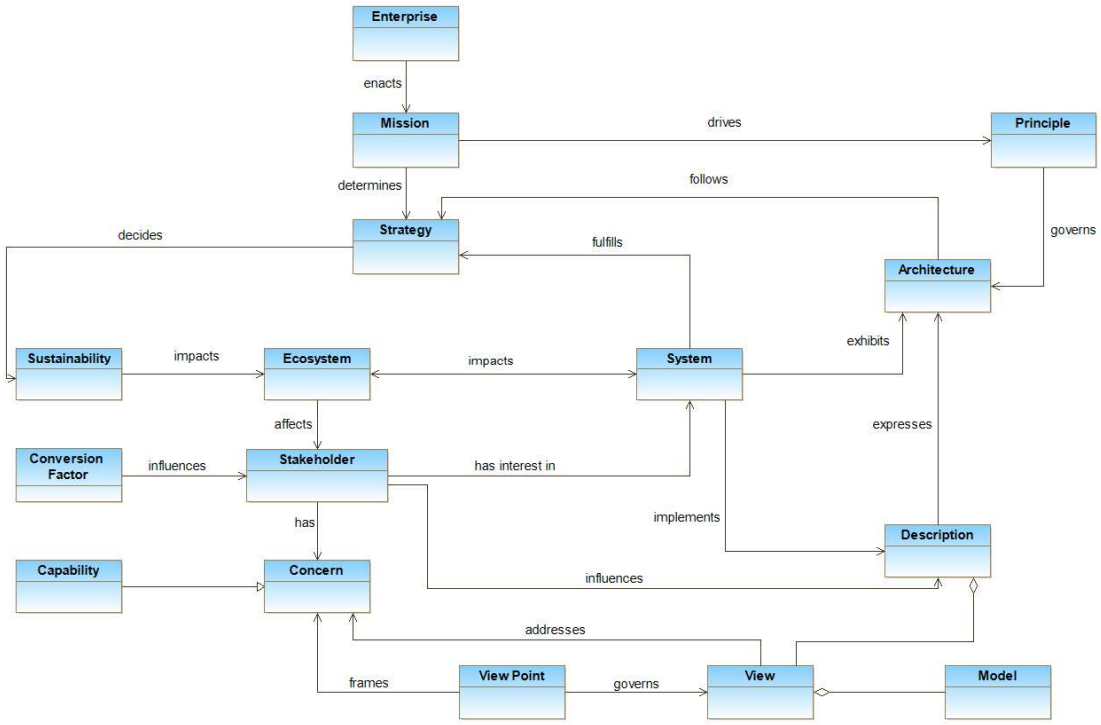
The CA-based four-step model of sustainable development



Note. "Re-conceptualizing Sustainable Development on the Basis of the Capability Approach: A Model and Its Difficulties", by O. Lessmann & F. Rauschmayer, 2013, *Journal of Human Development and Capabilities*, *14*(1), p. 99 (https://doi.org/10.1080/19452829.2012.747487). Copyright 2013 by Taylor & Francis. Reprinted with permission.

After demonstrating that sustainability is a stakeholder concern and that the HCA is robust enough to account for sustainability concerns, I adapted Pankowska's (2013) model to incorporate stakeholders and their capability concerns. In the revised model, shown in Figure 15, social, environmental, and economic factors influence human capabilities that are shaped by a process of structuration. The capabilities do also influence these factors for current and future generations.

Figure 15
A human capabilities-conscious EA architecture



Note. This class diagram presents a revised model of EA that accounts for human capability concerns. Based on "Enterprise Architecture Modelling for Corporate Sustainability," by M. Pankowska, 2013, in *Building Sustainable Information Systems: Proceedings of the 2012 International Conference on Information Systems Development*, H. Linger et. al. (eds), p. 369 (https://doi.org/10.1007/978-1-4614-7540-8_28) . Copyright 2013 by Springer Science+Business Media. Used with permission.

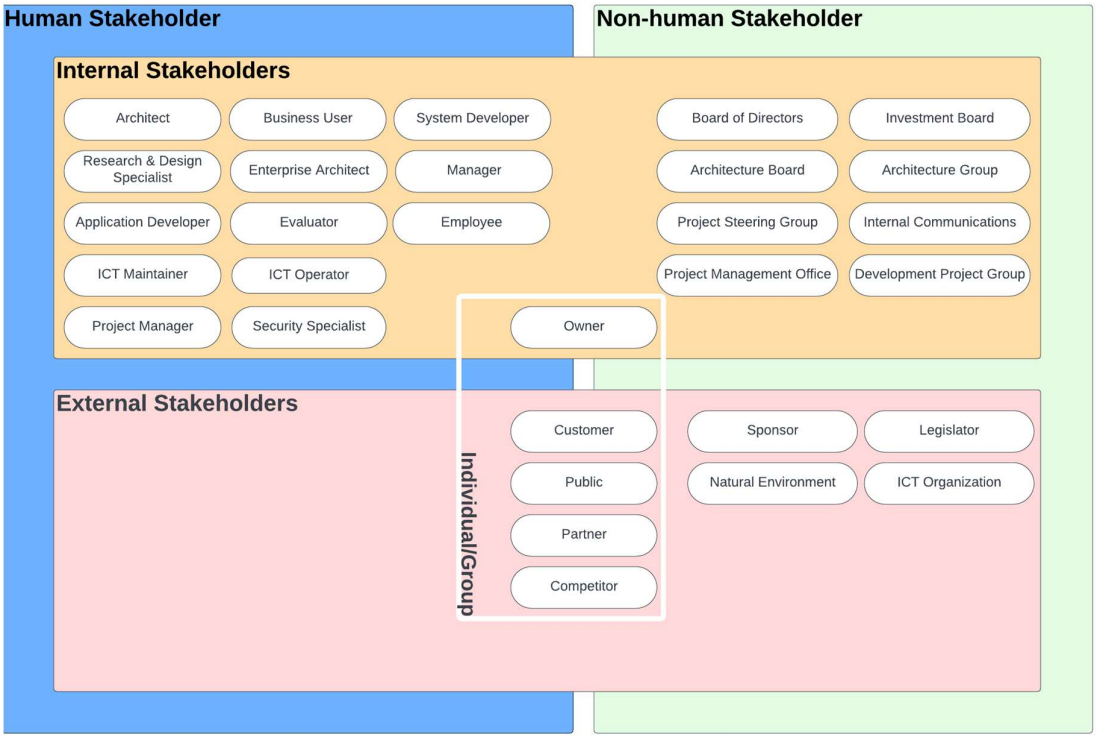
In Figure 16, I have presented a detailed, albeit not exhaustive, list of EA stakeholders. The figure illustrates the categorization of EA stakeholders as internal, external, human, and non-human. While internal and external indicate the proximity of each stakeholder to the enterprise, human and non-human refer to whether or not individual (humans) assume the specific stakeholder role.

Human stakeholders consist of individual roles having a stake in the system's design or output. These stakeholders include enterprise architects, application developers, and users who may be directly engaged in architecting the organisation. The so called non-human stakeholders are composed of groups exhibiting non-human (non-individual) behaviour and facade. They include roles assumed by communities of individuals such as organisations and organisational units, the public, and government organs such as legislators. Humans in structured organisations have shared concerns, which can only be understood via a process of interpretation and a mutually accepted interface.

Also added to the non-human category is the natural environment, which is composed of non-human entities who cannot articulate their concerns. Nevertheless, we seek to account for their stakes through humans capability concerns.

Figure 16

EA stakeholder map



Note. The figure displays the classification of EA stakeholders into internal, external, human, and non-human stakeholder kinds. Those designated as human stakeholders are roles that can be assumed by individuals, whereas non-human stakeholders are groupings of humans, such as organisations or units of organisations, and the natural environment. However, depending on the circumstances, roles such as "owner" and "customer" might be taken on by either individuals or groups of people.

In closing, I must emphasise that the cardinality of the stake relationships is contingent on a number of factors. For instance, the in a share company there are multiple owners, whereas in a sole proprietorship there is only one owner. Similarly, depending on the business environment, a competitor may be an individual or a giant corporation. Such stakes that may be assumed by individuals or groups, as the case may be, include owner, competitor, and customer.

5.6. Human Capability Themes

Senian HCA is known for its theoretical underspecification (Robeyns, 2006). Sen refused to provide a definitive list of human capabilities and argued that doing so would limit the scope and democratic process of identifying, weighing, and prioritising human capabilities (Dang, 2014; Grasso, 2006; Sen, 1999). Sen endorsed a process of extended democratic social engagement to

arrive at such a list for a particular project, which is consistent with the approach followed in "Stakeholder theory" (Dang, 2014; Enderle, 2013; Kleine, 2010).

Although having some theoretical appeal, Sen's approach has practical limits. Empirical evaluation of policy or practice is not possible without some a priori list of capabilities. Sen does not object to such an objective list so long as one single list is not taken as definitive(Alkire & Deneulin, 2009). Sen himself resorted to using such a list in his empirical works (Robeyns, 2006). In addition, proponents of a priori lists do not claim that theirs' is the only definitive arrangement of human capabilities. Nussbaum (2000, p. 77), for instance, noted that central capabilities have the feature of *multiple realisability*, suggesting that local historical and socio-economic situation should shape a priori listings. Hence, operationalizing the HCA is a necessary first step to launch any kind of evaluation (Gigler, 2015).

Several operationalizations of the HCA were attempted based on purpose, context, and theory. For example, studies by Comim (2001), Grasso & Giulio (2003), Canova et al. (2005), Ferrero y de Loma-Osorio & Zepeda (2006), Yanke (2016), Byskov (2017), Robeyns & Byskov (2020) are some operationalizations reported in the HCA literature.

To facilitate my analysis in this thesis, I reviewed three of the operationalizations, i.e., Nussbaum's *central capabilities* (2011), Gigler's AEF (2004, 2015), and Harris's aspirational ethics (Harris, 2015). The review of the three frameworks yielded a synthesis framework, which formed the basis for cascading the capabilities in the EA domain.

5.6.1. Nussbaum's Central Capabilities

According to Nussbaum (2011), to realise a holistic development of society, human endeavours should aspire to meet a minimum of ten central capabilities. These are: (1) life; (2) health; (3) bodily integrity; (4) senses, imagination, and thought, (5) emotions; (6) practical reason; (7) affiliation; (8) other species; (9) play; and (10) control over one's environment (political and material). Brief description of each is provided in Table 20.

According to Nussbaum, these central capabilities mark the minimal threshold necessary for a life of basic human dignity. The central capabilities are irreducibly heterogeneous, meaning that no one capability can be substituted, subsumed, or compensated by another capability (Nussbaum, 2011). Nussbaum asserted that "respect for human dignity requires that citizens be placed above an ample (specified) threshold of capability, in all ten of those areas" (Nussbaum, 2011, p. 36).

The ten central capabilities can be considered as kernel capabilities, but are too abstract for any application (Robeyns, 2006). Typically, researchers and practitioners elaborate these central capabilities taking into considerations the context of the domain of. It is also up to the

planners and designers to set the threshold at a level that is high enough to challenge the stakeholders to perform better, but not too ideal so that the latter do not withdraw even from attempting (Nussbaum, 2011).

Table 20
Nussbaum's central capabilities

Capability	Description
Life	Being able to live to the end of a human life of normal length; not dying prematurely, or before one's life is so reduced as to be not worth living.
Health	Being able to have good health, including reproductive health; to be adequately nourished; to have adequate shelter.
Bodily integrity	Being able to move freely from place to place; having one's bodily boundaries treated as sovereign, i.e., being able to be secure against assault … having opportunities for sexual satisfaction.
Senses, imagination, and thought	Being able to use the senses, to imagine, think, and reason – and to do these things in a truly human way, a way informed and cultivated by an adequate education, … protected by guarantees of freedom of expression … and freedom of religious exercise. Being able to search for the ultimate meaning of life in one's own way. Being able to have pleasurable experiences, and to avoid non-necessary pain.
Emotions	Being able to have attachments to things and people outside ourselves; … in general, to love, to grieve, to experience longing, gratitude, and justified anger. Not having one's emotional development blighted by overwhelming fear and anxiety, or by traumatic events of abuse or neglect.
Practical reason	Being able to form a conception of the good and to engage in critical reflection about the planning of one's life. (This entails protection for the liberty of conscience.)
Affiliation	A. Being able to live with and toward others, to recognize and show concern for other human beings, to engage in various forms of social interaction; to be able to imagine the situation of another and to have compassion for that situation; to have the capability for both justice and friendship.
	B. Having the social bases of self-respect and non-humiliation; being able to be treated as a dignified being whose worth is equal to that of others. This entails, at a minimum, protections against discrimination on the basis of race, sex, sexual orientation, religion, caste, ethnicity, or national origin. In work, being able to work as a human being, exercising practical reason and entering into meaningful relationships of mutual recognition with other workers.
Other species	Being able to live with concern for and in relation to animals, plants, and the world of nature.
Play	Being able to laugh, to play, to enjoy recreational activities.
Control over one's environment (political and material).	A. Political. Being able to participate effectively in political choices that govern one's life; having the right of political participation, protections of free speech and association.
	B. Material. Being able to hold property (both land and movable goods), not just formally but in terms of real opportunity; and having property rights on an equal basis with others; having the right to seek employment on an equal basis with others; having the freedom from unwarranted search and seizure.

Note. From *Women and Human Development: The Capability Approach* (pp. 78-80), by M. Nussbaum, 2000, Cambridge University Press. Copyright 2000 by Martha C. Nussbaum. Used with permission.

As a final note, I like to highlight Nussbaum's (2000) claim that the central capabilities are universal. Universality is an essential element of the approach in that comparative assessment

is possible only if humans subscribe to commonly shared normative principles (Walker, 2012). The UN's *human development index*, and the *sustainable development goals* (SDGs) are built on the universal principle of well-being (Alkire et al., 2008; Yanke, 2016).

5.6.2. Gigler's Alternative Evaluation Framework (AEF)

Gigler (2015) embraced the centrality of capabilities in evaluating the human value of ICTs. Instead of focusing on mere access, Gigler argued that evaluations of policies and projects need to focus on freedom and the ability people must transform such access to functionings.

Gigler created the AEF to assess the effects of ICT initiatives on human development, a move motivated by his belief that communities play a crucial part in any effective development programme. Gigler (2004) , based on the HCA and the evaluative works of Garnham (1997), Madon (2004), Mansell (2001), and Zheng (2009), identified six dimensions of human capabilities which operate both at the individual and collective levels (see Figure 17). These dimensions, abbreviated for brevity, are: (1) informational (InD); (2) psychological (PsD); (3) social (SoD); (4) economic (EcD); (5) political (PoD); and (6) cultural (CuD).

Figure 17
AEF dimensions

Dimension	Objective	Outcome indicators
Informational	To improve the access to information and informational capabilities	• Improved capacity to use different forms of ICTs • Enhanced information literacy • Enhanced capacity to produce and publish local content • Improved ability to communicate with family members and friends abroad
Psychological	To support a process of self-reflection (critical conscientization) and problem-solving capacity	• Stronger self-esteem • Improved ability to analyze one's own situation and solve problems • Stronger ability to influence strategic life choices • Sense of inclusion in the "modern" world
Social (human capital)	To strengthen people's human capital (skills, knowledge, ability to work, and good health)	• Enhanced ICT literacy and technology skills (for example, computer repair) • Enhanced leadership skills • Improved program management skills
Economic	To enhance people's capacity to interact with the market	• Improved access to markets • Alternative sources of income • Stronger productive assets • Improved employment opportunities • Improved income through (a) lower transaction costs (fewer time constraints), (b) reduced transport needs, (c) increased timeliness of sales, and (d) increased remittances from family members living abroad
Political	To improve people's participation in decision-making processes at the community level and the political system	• Improved access to government information and services (e-government) • Improved awareness about political issues • Improved capabilities to interact with local governments
Cultural	To strengthen people's cultural identity	• Use of ICTs as a form of cultural expression (design of computer graphics, websites) • Increased awareness of one's own cultural identity

Note. From *Development as freedom in a digital age : Experiences from the rural poor in Bolivia (*p. 39*),* by B. Gigler, 2015, The World Bank Group. Copyright 2015 by International Bank for Reconstruction and Development / The World Bank. https://doi.org/10.1596/978-1-4648-0420-5. CC BY 3.0 IGO.

5.6.3. Harris's Aspirational Ethics

Harris (2015) asserted that the most important consideration in evaluating a certain technology is whether it helps enhance or diminish the capabilities of human users. Harris proposed what he termed aspirational ethics, in which creators of artefacts must cultivate virtues appropriate to the society they serve. He posits, capabilities have congruence with the socio-economic status of the particular society. Consequently, in developing countries compassion and empathy are virtues that designers must behold, while in developed communities, environment, creativity, and sensitivity to effects of community on human relations are emphasised.

Harris rearranged Nussbaum's capabilities into four groups of capabilities he deemed relevant to engineering design.

Group 1: Physical capabilities (**PhC**)

- Living a normal length of life.
- Having clean water, food, and shelter.
- Engaging in recreational activity.

Group 2: Human relations capabilities (**HRC**)

- Having love and attachments to things and other people.
- Being treated with respect and dignity.

Group 3: Social/Political capabilities (**SPC**)

- Moving about freely and safely.
- Using one's senses and imagination and having free expression.
- Being able to participate in the political process, preserve material goods, and hold property.

Group 4: Self-transcendence and meaning capabilities (**StC**)

- Being able to form a conception of the good life and to plan one's life.
- Living with concern for and in relation to nature.

5.7. Human Capabilities: A Synthesis Framework

Nussbaum's central capabilities, which emanated from the notion of human dignity, centres on the individual. Nussbaum compiled her central capabilities on the basis of theoretical reflection as opposed to empirical data. In contrast, Gigler's framework was developed through a democratic process of community participation, with a focus on groups instead of individuals in isolation. As a result, Gigler's framework revealed how a particular group of people rank their capability concerns.

Considering Nussbaum's liberal dispositions, the central capabilities were critiqued for liberal elitism (Vasbist, 2010). Nonetheless, many concur that the defining characteristic of the core capabilities is universalism, not elitism (Walker, 2012). If we agree on the universality principles of equality, human dignity, and well-being then it would only be appropriate to order the capabilities according to the wishes of the people concerned. Secondly, we need a set of human capabilities that accommodate the poor as well as the well-off. It is also shown by Gigler and others that personal freedom operates only within the limits of societal and legal limits. Sustainable survival can only be ensured if individual rights are checked and harmonised with societal consensus.

While Nussbaum and Gigler addressed the HCA's theoretical and methodological considerations, Harris's aspirational ethics focused on its practical concerns. In two respects,

aspirational ethics is relevant to my research. First, it showed the utility of human capabilities in the design of technological artefacts. Secondly, it rearranged Nussbaum's core capabilities into four manageable themes.

Considering the complementarity of Nusbaum's, Harris's, and Giger's frameworks, I suggest that blending them would result in a robust framework that would serve as the basis for my ontology. Following the approach followed by J. Simon et al. (2013), I mapped the capabilities in the AEF and the central capabilities of Nussbaum to Harris's aspirational ethics. Table 21 captures the capability mapping exercise.

As can be seen from Table 21, the capability themes do not neatly map from one framework to the other. Nussbaum's central capabilities were condensed into four themes by Harris's aspirational ethics. Gigler, on the other hand, provided a distinct list that corresponded more closely with the Indigenous development practice they studied.

Table 21

Mapping of capability themes from the three frameworks

Nussbaum's Central Capabilities	Gigler's Alternative Evaluation Framework	Harris's Aspirational Ethics
Life		**PhC** Living a normal length of life. **PhC** Having clean water, food, and shelter.
Health	**SoD** Access to health	
Bodily integrity		**SPC** Moving about freely and safely.
Senses, imagination, and thought	**InD** ICT skills **InD** Information Literacy (access, evaluate, and process information) **InD** Content Capabilities (produce and disseminate content) **SoD** Communication Capabilities (with friends and family) **SoD** Access to education	**SPC** Using one's senses and imagination and having free expression.
Emotions	**SoD** Communication Capabilities (with friends and family)	**HRC** Having love and attachments to things and other people.
Practical reason	**PsD** Self-esteem **PsD** Self-reflection **PsD** Problem solving capabilities **PsD** Sense of inclusion in the modern world	**SPC** Being able to participate in the political process, preserve material goods, and hold property.
Affiliation	**SoD** Information Capabilities (vertical and horizontal information flows) **SoD** Organisational Capabilities (communities and networks)	**HRC** Being treated with respect and dignity.
Other species		**StC** Living with concern for and in relation to nature.
Play		**PhC** Engaging in recreational activity.
Control over one's environment (political and material)	**PoD** Decision-making power **PoD** Political Participation **PoD** Transparency **CuD** Cultural identity **EcD** Equal Property rights **EcD** Equal Employment rights	**StC** Being able to form a conception of the good life and to plan one's life

Nussbaum's Central Capabilities	Gigler's Alternative Evaluation Framework	Harris's Aspirational Ethics
	EcD Knowledge based productivity enhancement	
	EcD Transparency Markets through information asymmetries	
	EcD Trade opportunities	
	EcD Resource Mobilization opportunities	

Creating a novel structure of the capability themes necessitates a larger database and a philosophical foundation than can be provided by this research. Instead, I devised a heuristic to synthesise the three frameworks into one using descriptive data from the literature. I used Nussbaum's list as a starting point since it draws from a frequently cited philosophical work. Then, I mapped the other two frameworks to Nussbaum's based on conceptual similarities, eventually arriving at the thematic map shown in Table 22.

Table 22
Synthesis capability themes

Themes	Description	Capability exemplars
Physical well-being	Good quality of life, indicative of good physical and mental health, low levels of stress, and freedom from intrusion.	Life; health; rest, leisure, and recreation; bodily integrity including freedom of movement, safety, and protection from crime
Social	To have a social living in harmony with oneself and with others.	Harmonious, mutually respectful social relationships; emotions of affection, anger, longing, and gratitude; happiness; emotional well-being; belonging to a culture
Sense, imagination, thought, and practical reason	To be able to use the faculties of sense and reason not only to experience the world but also to guide action.	Sense, imagination, thought; practical reason; aesthetic experience;
Ecological sustainability (Natural environment)	Living in, yet sustaining, a natural environment conducive for other species, other societies, and coming generations.	Connection with the physical environment; Caring for other species; Caring for other societies and generations
Politico-economic	To be able to freely engage in productive political and economic activities for personal and societal flourishing.	Planning one's life; control over one's political and economic environment; work-life

When developing the new framework, I either *preserved, merged*, or *split* the capability themes from the three frameworks. Two of Nussbaum's capability themes, i.e., *control over one's environment*, and *other species* were preserved. I renamed the first capability theme to *politico-economic* to effect semantic clarity. The *other species* capability theme was redefined to encompass generational and intergenerational sustainability concerns and is dubbed *ecological sustainability* capabilities.

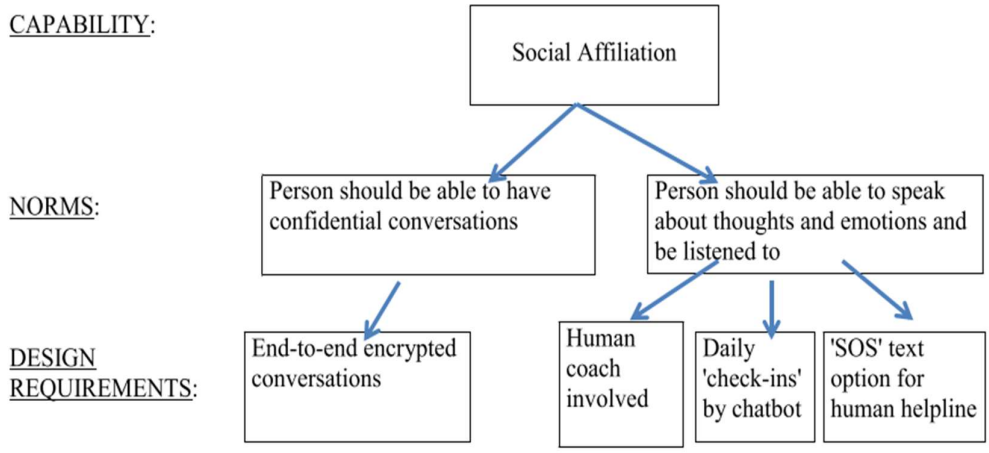
Physical well-being is a theme created from the merger of three of Nussbaum's capabilities (life, health, and play). These capabilities were jointly identified as *Physical Capabilities* in Harris's aspirational ethics. I added a fourth theme, *bodily integrity*, and named the new meta-theme physical well-being capabilities. The close connection between bodily integrity and physical well-being is illustrated by Wimberly & Sadler (2021). The new *social* capabilities meta-theme is also a blend of Nussbaum's emotions and affiliation capabilities. Another merger is between the capabilities of *sense, imagination, thought* and *practical reason*. Charles Sanders Peirce, the founder

of Pragmatism, was of the belief that we grasp the world through the nexus of sense, imagination, memory, and reason (Barrena, 2013). From a Pragmatist viewpoint action, particularly ethical action, is guided by imagination and reason (Barrena, 2013).

Gigler's framework introduced two novel capability themes: *cultural* and *informational*. I sense that he wanted to highlight the particular relevance of these two themes in the development of Indigenous people. Despite the intrinsic merits these capabilities may have on their own, from a pragmatic angle their worth is rather in their enabling role. One may have knowledge and skills of ICT just out of curiosity or vanity. But in EA, the interest is in what the person can achieve through the practice of that knowledge and skill. Similarly, maintaining one's culture is crucial so long as it facilitates one's interaction with the community to which one belongs. To cite Wilson et al. (1990), "culture represents the means, however imperfect, at the disposal of the individual for handling his relationships. On it he depends for making his way among, and with, other members and groups belonging to his society" (p. 90). Hence, I mapped Gigler's cultural capabilities to the social capability themes. The informational capabilities were split into two and mapped into social capabilities and sense, imagination, thought, and practical reason capabilities.

In the closing stages of this chapter, it is appropriate to reflect on how the capability themes can be mapped into design requirements. In this regard, the capability hierarchy proposed by Jacobs (2020), depicted in Figure 18, is a useful instrument for mapping capabilities or human values to design requirements. In the human capabilities in enterprise architecture ontology (HuCEAOn), the capability themes created in the previous section are used as high-level concepts. I equate what Pankowska (2015) called the "interests, concerns, and perceptions of rights, expectations, or even ownership" of stakeholders with human capabilities (p. 73). In this model, capabilities or human values are first mapped to one or more norms or lower-level capability concepts (sub-classes). Norms (or sub-class capability concepts) are inductively gathered from organisational documents and the HCA literature. The EA practitioner is responsible for the third-tier, context-sensitive activity of translating norms to design requirements.

Figure 18
Capability hierarchy



Note. From "Capability Sensitive Design for Health and Wellbeing Technologies", by N. Jacobs, 2020, *Science and Engineering Ethics*, *26*(6), p. 3382 (https://doi.org/10.1007/s11948-020-00275-5). Copyright 2020 by Springer. CC BY 4.0.

5.8. Chapter Summary and Conclusion

In this Chapter, I initially laid the foundational context for a worldview aligned with capability consciousness in EA. Subsequently, drawing inspiration from the works of human capability researchers, I crafted a synthesis framework specifically tailored to the domain of interest. In conclusion,

- The integrative worldview appropriate for human capabilities conscious EA is holistic, critical realist, multistakeholder, and multimethod.
- In this research, this worldview is reflected in the research paradigms and triangulation of authority (scientific, philosophical, as well as subjective) and use of mixed methods.
- The choice framework invigorated by structuration theory can be used to understand the relationship between structures and agency in an organisation environment.
- Within the restrictions placed by factors inside and outside the organisation, human agents use technology as necessary to create instantiations of structures.
- Design of products and processes demands the full engagement of both designers and users, who share each other's spaces.
- Based on a synthesis of the frameworks of Nussbaum, Gigler, and Harris, five capability themes are identified. These themes are physical well-being; social; sense, imagination, thought, and practical reason; sustainable ecological (Natural environment); and politico-economic.

While this chapter introduced the first of the proposed artefacts—a synthesis human capability framework for the EA domain—the pivotal research artefact, the human capability

ontology, will take centre stage in Chapter 6. I will detail the ontology's development process, explore the underlying concepts and relationships, and discuss the evaluation that accompany the construction of this computational ontology.

6. The Human Capabilities for Enterprise Architecture Ontology (HuCEAOn)

In Chapter 5, a human capabilities framework for the EA domain was described. Based on a synthesis of the frameworks of Nussbaum, Gigler, and Harris, I identified five capability themes: physical well-being; social; sense, imagination, thought, and practical reason; sustainable ecological (Natural environment); and politico-economic.

In this chapter, I present details the process of development, the concepts and relationships, and the evaluation that accompanied the construction of the proposed human capabilities ontology. Continuing from the discussion in Section 1.4, I first provide a brief background on the nature of computational ontologies and their significance in knowledge sharing. That will be followed by a discussion of the major concerns of ontology engineering which are foundational to the design decisions I made in developing the HuCEAOn. Additionally, insights from the relevant literature discussed in Section 6.3 influenced the design decisions. In later sections, I will delve deep into the actual design of the HuCEAOn, exposing its architecture, coding, population, evaluation, and assessment.

6.1. Introduction

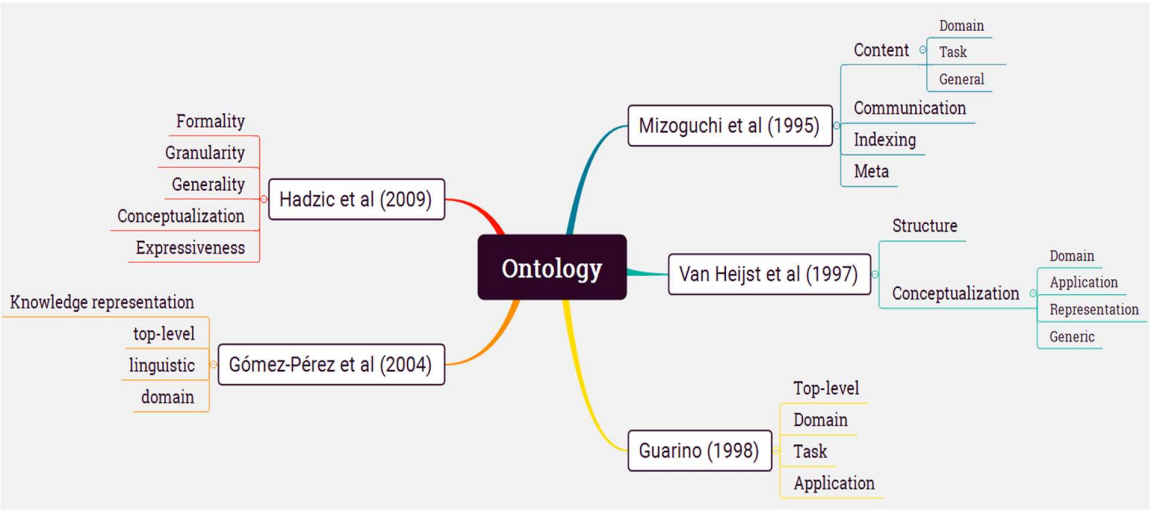
Long before the term "ontology" became a byword in computer and information science, Greek philosophers of old used it to refer to the *theory of existence* dealing with what is real and the relationships among real objects (Arp et al., 2015; Guarino et al., 2009). Beginning the 1980s, people in artificial intelligence and knowledge management started using the term to refer to cross-domain knowledge, such as a taxonomy. Information science students extended the definition to refer to the hierarchical structuring of abstracted domain knowledge (Gruber, 2009). Since the 1990s, ontologies are usually associated with semantic web technologies and representation languages such as web ontology language (OWL) and resource description framework schema (RDFS) (Milton, 2008). Ontologies have become an inevitable outcome of the flood of information caused by Internet services and the desire to manage this enormous wealth of information (Milton, 2008).

According to Milton (2008), an ontology can be a specification of a knowledge model or a technological artefact which is used by systems to enrich their processes. Hence, ontologies may mean glossaries, taxonomies, database schemas, data models, data dictionaries, or axiomatized representations of knowledge (Lehmann & Voelker, 2014; Raad & Cruz, 2015). Regardless of the detailedness or formalism introduced, ontologies are constructed using standard representational language based on consensus among domain experts on the aims and level of conceptual representation required.

As I stated in Chapter 1, ontologies serve a variety of purposes. To reiterate, ontologies help us in negotiating the complexities of information analysis, knowledge representation, system integration, and application of principles, rules, and regulations (Leenheer, 2009; Milton, 2008; Tudorache, 2020). Furthermore, they enhance the use, reuse, and maintainability of knowledge across domain experts and software applications (Arp et al., 2015; Kumazawa et al., 2009).

Taking into account the extensive range of applications for ontologies, they can be tailored to serve distinct functions and manifest in diverse configurations. Guarino (1997) distinguished among top-level, domain, task, and application ontologies. Similarly, Gómez-Pérez et al. (2004) make a distinction among knowledge representation, top-level, linguistic, and domain ontologies. Hadzic *et al.* (2009) created a comprehensive typology of ontologies by classifying them based on their degree of formality, granularity, generality, expressiveness, and amount, type, and subject of conceptualization. Other typologies include Mizoguchi et al. (1995) and van Heijst et al. (1997). Figure 19 depicts five of the ontology typologies widely cited in the literature.

Figure 19
Ontology typologies



The typologies determine the amount of effort that goes into ontology construction and consequently the time and cost associated with it. They also limit the audience of the ontology and the application domain.

6.2. Ontology Engineering

Benefits notwithstanding, ontologies come with multiple challenges for developers and users. To start with, development of real-world domain ontologies with thousands of concepts and

relationships is a demanding task to be undertaken by a team of experts over a longer period of time (Raad & Cruz, 2015). Smaller, prototype ontologies may be developed at lower cost, but their use is mostly limited to academic uses or as industrial prototypes. Consequently, ontology development is an expensive venture especially if it requires hand-crafting (Lehmann & Voelker, 2014). The alternative machine learning approaches could significantly reduce cost, but the quality may suffer. The steep learning curve associated with understanding and using the formal logical languages used to represent ontologies also have to do with the high cost of development of ontologies (Milton, 2008). Larger ontologies come also with scalability and reasoning complexity issues (Raad & Cruz, 2015). In short, several design decisions must be made before embarking on the ontology crafting process.

Gómez-Pérez et al. (2004, p.5) defined *ontology engineering* as "the set of activities that concern the ontology development process, the ontology life cycle, and the methodologies, tools and languages for building ontologies". It is explained in terms of the aspects that the ontologist deals with while making choices that assure conceptual distinctions and term clarity (Guarino et al., 2009). These elements of the craft, which I deal with in the subsequent subsections, include the purposes, philosophies, principles, process models, formalisms, languages, tools, and techniques to be used in constructing the ontology (Gal, 2009). The general review provided in this section, combined with the review of the relevant works presented in Section 6.3, serves as the foundation for the practical ontology construction decisions discussed in Sections 6.4 to 6.7.

6.2.1. Purpose and Scope

The purposes for which the ontology is to be developed determines much of the elements of ontology engineering. Motivating scenarios and informal competency questions (CQs) form the basis for defining the purpose and scope of an ontology development project (Grüninger & Fox, 1995; Hetmank, 2014).

Aside from the purpose the ontology, other considerations that would affect the development methodology include the extent to which the domain of interests is previously documented or remains tacit, as well as the number and availability of domain experts who could contribute to the formation of a shared perspective (Milton, 2008). The answers to these questions help determine whether to handcraft the ontology from scratch, use ontological learning techniques, or extend existing ontologies.

A mechanism by which we scope an ontology development project is by establishing a list of CQs that a knowledge base using the ontology under development must answer (Grüninger & Fox, 1995; Noy & McGuinness, 2001). The CQs usually serve as test cases for ontology evaluation.

6.2.2. Design Principles

The process of ontology development must follow a set of coherent principles that place objective limitations on its design (Gharib et al., 2021). In this thesis, the term *criteria* is sometimes used to refer to these ontology principles.

Table 23 presents principles compiled from four academic works. While many of the principles are shared by the materials that are referenced, ontologies may not follow all of them in the same way. Some of the principles, such as minimal ontological commitment and completeness, may even be in contradiction (Vrandečić, 2009). I am not inclined to examine all of the principles in detail; nonetheless, Section 6.4.1 outlines those that I felt were pertinent to my work.

Table 23
Principles of ontology construction and evaluation

Code #	Gruber (1995)	Gómez-Pérez (2004)	Obrst *et al.* (2007)	Vrandečić (2009)
1	clarity		intelligibility	clarity
2	coherence	consistency	consistency	consistency
2	encoding agnosticism			
3	extendibility	expandability	adaptability and reusability	adaptability
3		sensitiveness		
4	minimum ontological commitment	conciseness		conciseness
5		completeness	coverage	completeness
5			soundness and completeness	
6			accuracy	accuracy
7			computational efficiency	computational efficiency
8			mappability	
9				organisational fitness

Note: In this diagram, nine of principle clusters have been represented. Clusters are identified by colour codes and numbers.

6.2.3. Otology Elicitation Methods

Ontology elicitation is a methodology for the acquisition of knowledge from expert sources, documents, or other tools for use in ontology construction (Leenheer, 2009). Broadly speaking, there are deductive and inductive elicitation methods (Leenheer, 2009). The deductive methods involve top-down gathering of knowledge from experts, documents, or other knowledge sources. The inductive approach on the other hand employs machine learning techniques to automatically infer knowledge from structured, semi-structured, or unstructured data (Drumond & Girardi, 2008).

6.2.4. Process Models

Regarding methodology and process models, there is a widespread lack of clarity. In reality, process models are what numerous publications refer to as methodology. I understand methodology to be a broader term than process models, encompassing philosophy, methods, tools, and processes. In this context, I define a process model as that part of ontology engineering that outlines the actions to be taken while creating an ontology.

While many of the classical ontology process models are reviewed by Dahlem & Hahn (2009), recent agile ontology development processes such as DILIGENT, Modular Ontology Modeling (MOM), and Simplified Agile Methodology for Ontology Development (SAMOD) are covered in Hogan et al. (2021). I will refrain from discussing all those process models here, opting instead to concentrate on a select few that I believe would help me in designing a process model suitable for my requirements.

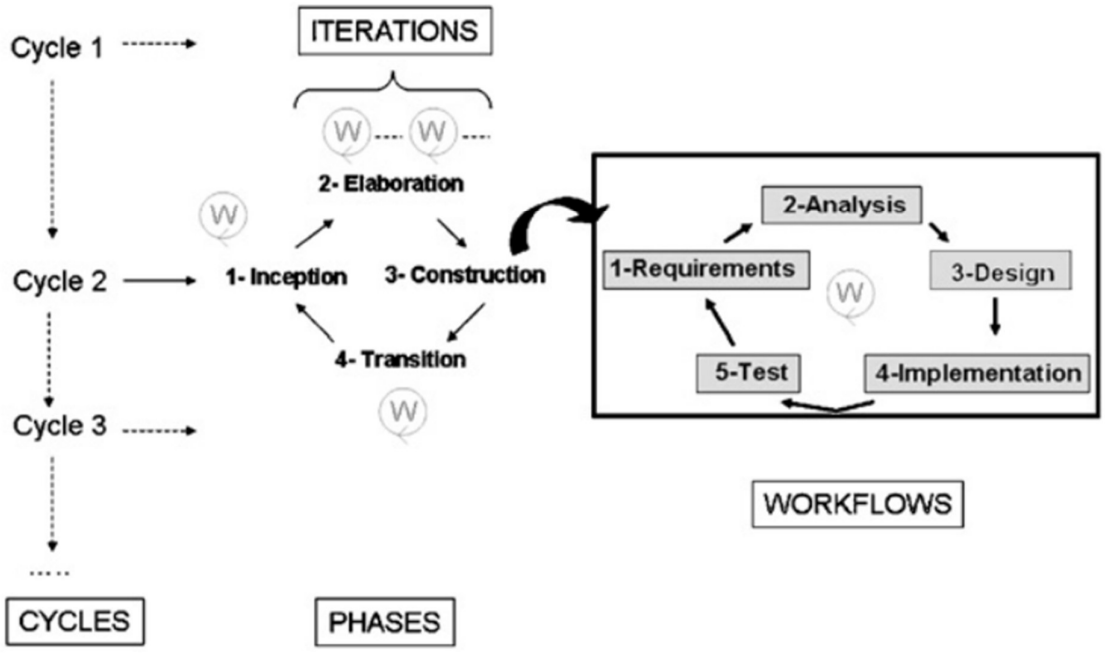
Uschold & King (1995) is among the first and most widely adopted ontology development process models. Their method involves four steps. First, the ontologist must first identify their purpose, which involves explicating the ontology's intended application. Next is the “building” stage during which the ontology designer identifies domain concepts and relationships and formalises their coding. The third crucial phase of the development process involves evaluation of the artefact against purpose statements, CQs, representational efficacy, or other technical criteria. In the fourth and final phase, documentation that is crucial for comprehending, preserving, and expanding the ontology must be compiled and availed. According to Hetmank (2014), this process model is simple, efficient, and could be used to develop “lightweight” ontologies.

Noy and McGuinness (2001) suggested a generic process model which is targeted at novices. The steps involved are: (1) Determine the domain and scope of the ontology; (2) Consider reuse of existing ontologies; (3) Enumerate important terms relevant to the domain; (4) Define the classes and the class hierarchy (taxonomy); (5) Define the properties of classes or

attributes; (6) Define restrictions on each attribute); (7) Create instances. The authors of this process model are associated with Protégé, the widely popular ontology development tool. This process model is distinguished by its simplicity and explicit formality (Dahlem & Hahn, 2009).

The Unified Process for Ontology Building (UPON) is a software engineering approach proposed by De Nicola et al. (2009) for large-scale ontology development. Its process model, presented in Figure 20, is based on the iterative unified process. The "construction" phase constitutes five stages: requirements gathering, analysis, design, implementation, and testing. The identification of use cases is an important element from this methodology. At the conclusion of the use case identification stage, CQs, use case models, and the application lexicon would be defined. The application lexicon constitutes the terms that makeup the domain of interest. The iterative-ness embedded into this process model ensures alignment with purpose (Milton, 2008).

Figure 20
The UPON process



Note. From "A software engineering approach to ontology building", *by* A. De Nicola, M. Missikoff, and R. Navigli, 2009*, Information Systems*, *34*(2), p. 259 (https://doi.org/10.1016/j.is.2008.07.002) . Copyright 2009 by Elsevier Ltd. Reprinted with permission.

6.2.5. Ontology Formalisms and Languages

Ontology formalisms describe the structure of the ontology. Ontology formalisms are essentially of two types: frames-based and logic-based (Milton, 2008). Other formalisms include Open biomedical ontology (OBO), semantic networks, and conceptual graphs (Slimani, 2015).

Frames are knowledge representation data structures similar to object-oriented formalism. In a frames-based formalism, object attributes, values, and relationships are described in a table format. A class has attribute elements called slots. Those slots will have values and data types.

The frames-based formalism has been implemented in several ontology editors including Apollo, OntoEdit, and Protégé, though the recent version of Protégé has abandoned frames. Languages that are based on frames include Ontolingua, OIL (which combines descriptive logic), and Frame Logic (Slimani, 2015). The frames-based formalism is said to be useful when the closed-world assumption and constraints on slots values are required.

Many ontologies are coded using logical expressions such as propositional logic, predicate logic, or descriptive logic (Kalibatiene & Vasilecas, 2011). Logic-based formalisms introduced formal semantics, which is lacking with frames.

While, for example KIF and CycL are based on predicate logic, the most famous of the logic-based languages, OWL DL, is based on descriptive logic. OWL embraces the open-world assumption, which assumes anything unknown as undefined and not as false (which is the case with the frames formalism). Logic-based languages are now considered as the industry standard because of their expressive power.

6.2.6. Ontology Editors

The choice of tool goes hand-in-hand with the choice of language since certain tools can deal with one or two languages and not others. Moreover, some of the tools may only be available for a fee which limit their accessibility.

Ontology editors come in different flavours. Slimani (2015) identified several tools used for different aspects of ontology development.

- Tools for constructing and editing ontologies, such as Protégé, OntoEdit, WebOnto, OilEd and ODE.
- Tools for reusing and merging ontologies such as SEN-SUS, Chimera, PROMPT, OntoMorph, and OntoView.
- Tools for reasoning with ontologies, such as OntoBroker, SWI Prolog, CLIPS, Flora, and FaCT.

- Tools for using ontologies to annotate the contents of an information resource.
- Tools for using ontologies to access and navigate an information resource, such as Ontobroker, On2broker and On-To-Knowledge.

On the other hand, ontology evaluation tools reviewed by Aruna et al. (2011) include OntoAnalyser, OntoGenerator, ONE-T, and S-OntoEval.

Tools for the automatic acquisition of ontology knowledge include Text2Onto, GALEON, ASIUM, Caméléon, LTG Text Processing Workbench, OntoLearn Tool, Prométhée, TextStorm and Clouds, and OntoGain, (Barforush & Rahnama, 2012; Konys, 2019).

Some of the most popular and freely available editors include Ontorion Fluent Editor, Apollo, Protégé, Swoop, and NeOn Toolkit. Commercial editors with free limited time or limited feature availability include OntoStudio and TopBraid Composer. Certainly, there are fully commercial ontology editors that I have not considered.

6.3. Related Works

The popularity of the semantic web has led to the development of ontologies in almost every area of human interest, including language, law, health, and science, where there are already noteworthy ontologies.

In this section, I have summarised a selection of relevant ontologies that have been reported in the scholarly literature. The review of related works described in this section, together with the general review presented in Section 6.2, informed the selection of the ontology language, tool, formalism, principle, and procedure used to construct the HuCEAOn, as detailed in Sections 6.4 through 6.7. Table 24 presents a summary of the ontologies that have been reviewed.

Not intended in this review is a detailed description of each of the ontologies under consideration. Rather, a tabular summary of the ontologies is provided, accompanied by a brief overview of a few. The review discusses the breadth and guiding concepts of each ontology, as well as its development methodologies, languages, and tools.

Table 24

Review summary of ontologies

Work reported	Domain	Process Model (PM) and Criteria	Techniques	Languages	Tools
Uschold et al. (1998)	Enterprise	• Uschold & King (1995) • Criteria: integration, communication, flexibility, support	Handcrafting	• Ontolingua (based on KIF)	• Ontolingua (Ontology Server)
Leppänen (2007)	Enterprise	• METHONTOLOGY (Lopez et al., 1999) • Uschold et al. (1998)	Handcrafting	• Informally using natural language • UML-based language	-
Hetmank (2014)	Enterprise crowdsourcing	Uschold & King (1995)	Handcrafting	• UML • OWL	• Protégé
De Nicola et al. (2009)	eBusiness (eProcurement)	Unified Process for ONtology (UPON)	Handcrafting	• UML • OWL-DL	-
Thuan et al. (2015)	Enterprise Business process crowdsourcing	• DSR • Uschold & King (1995)	Handcrafting and automated versions (for evaluation)	No formal language used	• OntoGen • Text2Onto
Porwol et al. (2016)	e-government	DSR	Handcrafting	• RDF • OWL	• Protégé • NEOLOGISM
Goudos et al. (2006)	Enterprise architecture	Prototyping	Handcrafting	• OWL DL	• Protégé
Griffo et al. (2021)	Enterprise Architecture	Guizzardi (2013)	Handcrafting and merging	• Archimate	-
Kang et al. (2010)	Enterprise architecture	Not explicitly stated	Handcrafting	• SBVR (XML) • Structured English	• WordNet
Sunkle et al. (2013)	Enterprise architecture	Not explicitly stated	Handcrafting	• OWL • SPARQL	• Protégé • Apache Jena • Pellet API

Work reported	Domain	Process Model (PM) and Criteria	Techniques	Languages	Tools
Gharib et al. (2021)	Privacy	**PM:** Uschold & King (1995) and Fernández-López et al. (1997) **Criteria:** (e.g., clarity, coherence, extendibility, minimal encoding bias, and minimal ontological commitment).	Handcrafting	• OWL • SPARQL • UML	• Protégé
Edum-fotwe & Price (2009)	Social Sustainability	Not explicitly stated	Handcrafting	• Informal using mind maps	• Axon Idea Processor
Kuster et al. (2020)	Sustainability	**PM:** NeOn (Suárez-Figueroa et al., 2015) **Criteria:** reusability, versatility, reproducibility, extensibility, availability, and interpretability	Handcrafting and merging	• SPARQL	• Protégé
Kumazawa et al. (2009)	Sustainability	**Criteria**: readability, reusability, and interoperability	Handcrafting	• XML-based frame language that can be exported to OWL and RDFS	• Hozo
Konys (2018)	Sustainability	Noy & McGuinness (2001)	Handcrafting	• OWL	• Protégé
Giovannini et al. (2012)	Manufacturing sustainability	Not explicitly stated	• Handcrafting • Alignment with other ontologies	• OWL • SQWRL	• Protégé
Deliyska et al. (2020)	Sustainable development	Own process	Mixed method – Handcrafting and Ontology learning (Text mining)	• OWL/RDF • SQWRL	• GATE • OWL • Protégé
Ivanova et al. (2021)	Social sustainable development	Own process model	Ontology Learning	• OWL • SQWRL	• GATE • OWL • Protégé

Work reported	Domain	Process Model (PM) and Criteria	Techniques	Languages	Tools
Esfijani et al. (2012, 2013)	Social responsibility	Own process model	Mixed method – Handcrafting and Ontology learning	• Informally using network diagram	• NVivo • Leximancer • WordNet
Massaro et al. (2020)	Sustainability (Urban)	Not explicitly stated	Handcrafting	• OWL	• Protégé
Hoekstra et al. (2009)	Legal	An adaptation of Uschold & Gruninger (1996) and other works	Handcrafting	• OWL DL	• TopBraid Composer • Protégé
Wyner (2008)	Legal	Not explicitly noted	Handcrafting	• OWL	• Protégé • Pellet-1.3
Järvenpää et al. (2019)	Manufacturing	Sure et al. (2009) and Noy & McGuinness (2001)	Handcrafting	• OWL • SPARQL/SPIN	• Protégé
Ahmad et al. (2018)	Waste management	DSR	Handcrafting	• OntoUML	Not formalized into an editor

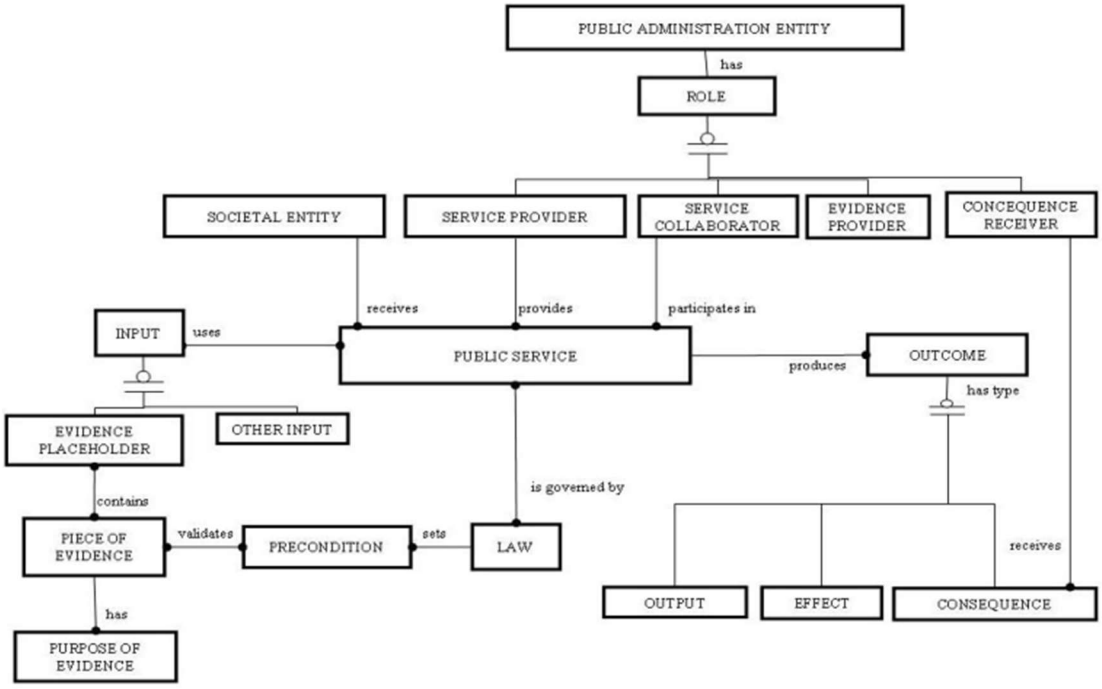
Ontology-based solutions, such as TOVE, CEO, and the Edinburgh Enterprise Ontology (EO), have been used extensively to support enterprise work (Bertolazzi et al., 2001; M. S. Fox et al., 1993; Uschold et al., 1998). A product of the Edinburgh project, EO is a flexible meta-ontology designed for representing, integrating, and communicating the various aspects of an enterprise (Uschold et al., 1998). EO represented enterprise concepts both informally as themes rendered in natural language and semi-formally utilising Ontolingua systems.

Thuan et al. (2015) developed an ontology for the enterprise crowdsourcing domain that can be considered as a continuation of the works of Hetmank (2014) and others. They gathered scholarly articles from known databases and extracted concepts, attributes, and relationships based on frequency of occurrence. They later replicated the process using automated concept extraction tools on the same set of scientific articles. The ontology developed automatically was used for evaluating the handcrafted ontology. Their process model was a blend of Küçük & Arslan (2014) and Uschold & King (1995), following a DSR framework.

The work of Porwol et al. (2016) is highly relevant to my own for a number of reasons. First, the ontology domain was e-participation, which has direct bearing on the enhancement of human capabilities. Second, in keeping with the ontology's research focus, the researchers implemented it within a DSR framework. Finally, concepts and relationships were extracted using CQs drawn from a conceptual model. It appears that they relied on textual documents and their own expertise to elicit ontology knowledge.

The citizen profile to public administration service mapping ontology prototyped by Goudos et al. (2006), depicted in Figure 21, starts by providing a service model based on the government enterprise architecture (GEA) framework. It then allows the citizen to interactively select a profile or profiles that best describe their role and allow the reasoner to generate services that fit the profile. Even though the ontology reported is only a prototype, the problem domain covered, and the concept generation process followed are relevant from to this thesis.

Figure 21
GEA public administration service model



Note. From "The GEA: Governance Enterprise Architecture - Framework and Models", V. Peristeras and K. Tarabanis 2008, in *Advances in Government Enterprise Architecture*, Pallab Saha (ed), p. 254 (https://doi.org/10.4018/978-1-60566-068-4.ch011). Copyright 2009 by IGI Global.

Gharib et al. (2021) constructed a "comprehensive" privacy ontology (COPri V.2) in Protégé based on priorly completed literature survey (Gharib et al., 2017), which is aimed at supporting enterprises that seek to meet privacy requirements imposed on customer service operations. I considered Gharib et al.'s (2021) study particularly relevant to my research because the problem they sought to tackle was comparable to mine. They lamented the fact that system requirements are often insufficiently handled in requirements gathering and later in systems development. This, they argued, is because practitioners are insufficiently versed with privacy requirements and do not discern the distinctions between privacy and other requirements. The situation with human capabilities in EA is similar, but worse. The idea itself is new to the EA literature and therefore few practitioners adopted it. They demonstrated the coverage and utility of the ontology via a use case and evaluated their ontology using the ontology pitfall scanner (OOPs!) and domain experts. They also validated their ontology using CQs.

Ahmad et al. (2018) proposed the OntoWM, targeted at the waste management domain. They adopted a process model which was based on the DSR paradigm and the works of Badr & Ahmad (2013) and Badr et al. (2013). Its utility was demonstrated using a bins collections process of a municipal council in Malaysia. They deployed a software-based verification process as well as a validation process that involved experts and researcher observation.

Several ontologies have been built to support the sustainability domain, which could be instructional to my research, either from a domain relevance or from a development process standpoint. Among these was one constructed by Konys (2018) to support in sustainability assessment. Formalized using OWL language in the Protégé environment, this ontology was constructed based on findings from a literature survey.

Edum-fotwe & Price (2009) presented an ontology that can be employed to provide a systematic articulation to the issues that impinge on the social dimension of sustainability appraisals in the construction sector. The development of the social ontology was a consequence of a research project that explored the tools, metrics, and models (SUE-Mot) employed in the evaluation of sustainability within the urban built environment. The development was achieved by the method of focus group interaction.

Massaro et al. (2020) developed an urban development domain ontology consisting of 334 sustainability indicators, gathered from the five sustainability frameworks. The ontology was created to help develop and compare sustainability assessment frameworks and indicator sets. They reported that comparing the sustainability performance of urban settlements was possible thanks to a variety of frameworks and indicators, and that each of the frameworks asserted a distinctive normative stance.

6.4. The HuCEAOn Architecture

6.4.1. Purpose, Scope, Guiding Principles, and Requirements of the HuCEAOn

In order to make informed technical decisions, the researcher/designer must initially describe the proposed ontology's rationale, scope, and target audience (Gharib et al., 2021; Uschold & King, 1995). This stage can be partially mapped to the investigative or empirical

cycle of DSR, in which the knowledge required to create the ontology is elicited and gathered (Gharib et al., 2021; Wieringa, 2014).

The purpose of the HuCEAOn has been extensively discussed in Chapter 1. As the idea of HCA is new to EA, the business as well as ethical case for human capabilities promotion in EA design and evaluation is evidenced. Further, there is no documented human capability ontology that could assist enterprise architects address human capability concerns during planning, design, and implementation.

The suggested ontology facilitates a clear, shared understanding of human capabilities conception in EA, as well as the reuse and extension of the same knowledge in EA-related domains. The purpose is thus, to assist planners, designers, and implementers build human capability conscious EA by providing a generic and expressive set of key human capability concepts and relationships.

EA planners, designers, and other stakeholders may use the ontology when evaluating or designing an EA project. The ontology could provide a prism through which academics and practitioners home in on stakeholder requirements and aspirations than existing frameworks allow.

The formulation of functional requirements, scenarios, and CQs assists in defining the ontology's purpose and scope (Hetmank, 2014). There are two major functional requirements or tasks the ontology is expected to handle. The first one is the assessment of EA practices. In that context, one may use the ontology as tool to assess the extent organisational practices meet human capability promotion goals. The second major task where the ontology may be deployed is in design of EA artefacts. That is, the planners of the architects may use the ontology to elicit requirements which needs to be met by business, application, and technology architectures.

In Section 6.6., two scenarios, one from higher education and the other from finance, are shown to demonstrate the potentials of the ontology. The following CQs (only a subset) are formulated based on the conceptual framework presented in Chapter 5, and the anticipated use cases of the ontology (Corcho et al., 2003; Grüninger & Fox, 1995).

- CQ1. Who are the stakeholders of EA?
- CQ2. What are the key dimensions of human capabilities conceptions in EA?

- CQ3. Which human capabilities align with environmental, social, and economic sustainability goals?
- CQ4. Which capabilities must be considered to assure participation in EA projects?
- CQ5. Which capabilities must be embedded to EA artefacts?
- CQ6. Which EA principles align with which human capabilities?

The purpose and scope of the ontology impinges on the principles to be adhered to. Several ontological principles have been presented in Section 6.2.2. It is difficult for an ontology of scholarly interest to adhere to all of those principles within the constraints of available time and money. As Vrandečić (2009) stated, these principles are signposts that guide the construction and evaluation of a "good" ontology. Rarely, if ever, are they measured directly, and the developed ontology can only speak to whether or not the principles are usually adhered to rather than to what degree. Instead of relying on the design principles, Vrandečić (2009) suggested, it is preferable to adopt evaluation criteria that can be reasonably examined. Hence, I identified the following as the most relevant and realisable criteria to guide the development of the HuCEAOn.

Clarity: effective, formal, and objective definition of terms is sought after in ontology construction. Wherever possible, complete definitions stating sufficient and necessary conditions for the predicate's satisfaction must be provided (Gruber, 1995).

Coherence: inferences should be consistent with definitions. This criterion dictates that inferences from axioms should be consistent with definitions provided both formally and informally in the form of documentation (Gruber, 1995; Vrandečić, 2009).

Extendibility: the ontology must be able to anticipate possible future uses. The ontology should lend itself to easy extension of its definitions and specialized uses (Gruber, 1995; Vrandečić, 2009).

Conciseness: only required domain concepts and nothing else must be captured by the ontology. This criterion states that an ontology must specify a minimal ontological commitment in which the claims about the world being modelled are set to a minimum, allowing for future extension and specialization (Vrandečić, 2009).

Completeness: also called *comprehensiveness*, this criterion requires the ontology to provide sufficient coverage of the domain to satisfactorily answer CQs (Vrandečić, 2009).

Accuracy: the ontology's axioms and inferences must be able to describe the real domain world precisely (Vrandečić, 2009).

These criteria served as the foundation for the HuCEAOn evaluation, which is described in Section 6.7.1.

6.4.2. HuCEAOn Process Model

Dahlem & Hahn (2009) offer a comprehensive list of around thirteen criteria for evaluating ontology development methodologies. However, it is seldom possible to make head-to-head comparisons between ontology development methodologies because many of the so-called "methodologies" are merely process models. Methodology, on the other hand, is only complete when it is backed by a philosophy, tools, and techniques on top of process models.

Instead of making academic comparisons among the process models, I chose to create a blend based on a set of criteria. Hence, the HuCEAOn process model shall be

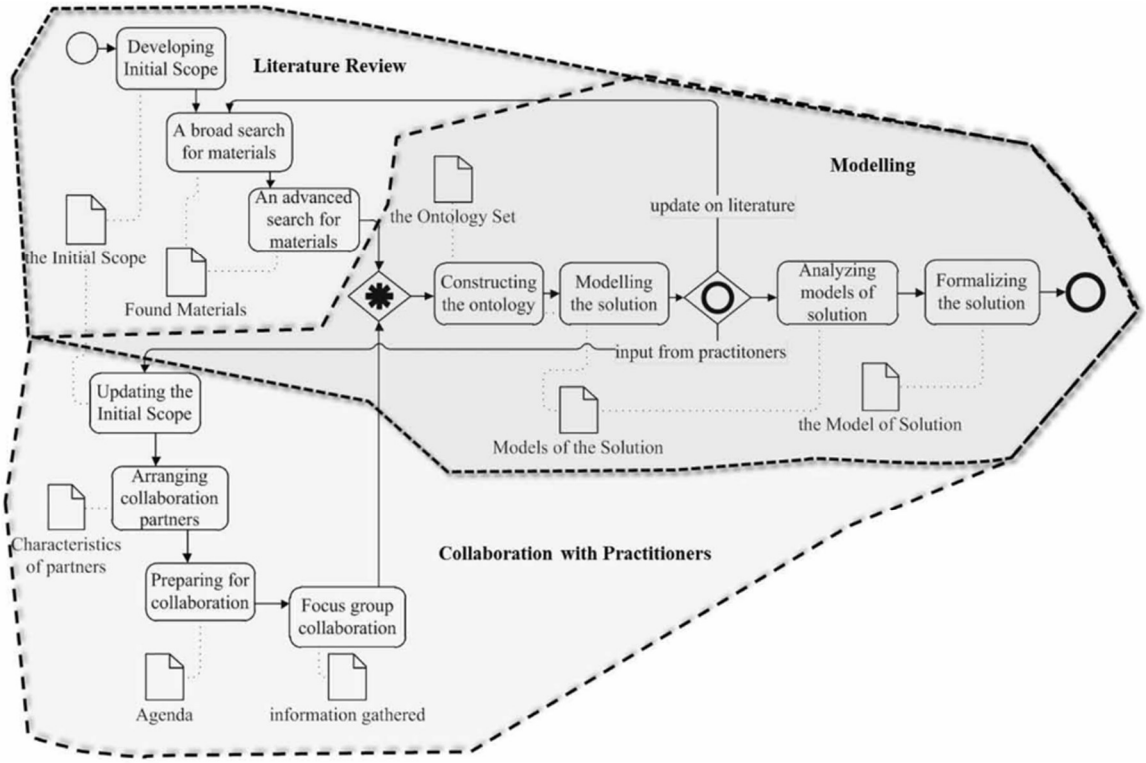
1. situated in the DSR paradigm;
2. simple to understand and implement; and
3. robust, yet simple enough, to accommodate academic DSR.

The embeddedness of the process model in DSR is an essential criterion because it accentuates the research objective. According to Ostrowski et al. (2014), an ontology construction process model built into DSR improves the quality of the artefact (ontology) by ensuring that quality information from the domain of interest is gathered and organized.

From the process models reviewed in Section 6.3., those adopted by Thuan et al. (2015), Porwol et al. (2016), and Ahmad et al. (2018) were framed in the DSR paradigm. However, I chose to adapt the broad outline provided by Ostrowski et al. (2014) to fit my research requirements. Ostrowski et al.'s (2014) process model depicted in Figure 22 is flexible enough to accommodate academic research, encompassing not just modelling and development, but also the required qualitative study and expert engagement.

Figure 22

Ontology development model framed in DSR



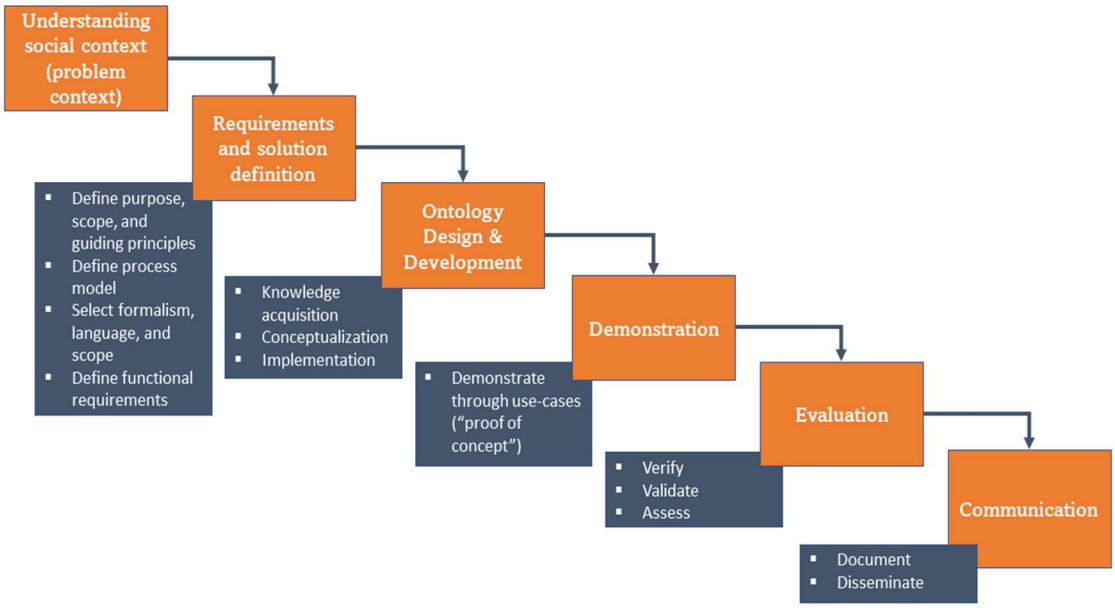
Note. From "Ontology engineering step in design science research methodology: A technique to gather and reuse knowledge", by L. Ostrowski, M. Helfert, and N. Gama, 2014, *Behaviour and Information Technology*, *33*(5), p. 445 (https://doi.org/10.1080/0144929X.2013.815276). Copyright 2014 by Taylor & Francis. Reprinted with permission.

While the general outline of Ostrowski et al.'s model (2014) is generic, and the iterative approach applicable, I found the detailed tasks to be overly cumbersome and outside of my academic remit. I, therefore, linearized their process model for easy deployment in my context. I replaced the detailed steps with simpler ones drawn from Uschold & King (1995), supplemented by insights from Johannesson & Perjons (2014) and Ahmad et al. (2018).

The process model proposed by Uschold & King (1995) is straightforward to implement and can readily fit into the DSR framework. Their process model was used to create some of the reviewed works, such as the privacy ontology of Gharib et al. (2021) and the crowd sourcing ontologies of Hetmank (2014) and Thuan et al. (2015).

Despite the linear appearance of the process model I developed through blending, as depicted in Figure 23, this was not the case in reality. The tasks were performed iteratively and incrementally, with fresh insights informing previous steps. Sections 6.5 through 6.8 go into greater depth about the practical implementation of the process model.

Figure 23
DSR-situated ontology development process model



Note. The process model depicted by the diagram presents the six steps followed in developing the HuCEAOn. Based on (a) "Towards a methodology for building ontologies," by M. Uschold and M. King, 1995, *Workshop on Basic Ontological Issues in Knowledge Sharing*; *held in conjunction with IJCAI-95*, Copyright 1995 by the Authors. (b) "An ontology for the waste management domain", by M. N. Ahmad, K. B. A. Badr, E. Salwana, N. H. Zakaria, Z. Tahar, and A. Sattar, 2018, *Proceedings of the 22nd Pacific Asia Conference on Information Systems - Opportunities and Challenges for the Digitized Society: Are We Ready?, PACIS 2018*, Table 1. Copyright 2018 by the Authors. (c) *An Introduction to Design Science* (p. 78), by P. Johannesson and E. Perjons, 2014, Springer. Copyright 2014 by Springer International Publishing.

6.4.3. Selection of HuCEAOn Formalism, Language, and Editor

Formalism, language, and editor selections are all interrelated and are typically dependent on the aim and principles of the ontology development process, as well as the tools accessible to the designer. Not all ontology editors support every language or every formalism. Hence,

it is important to first establish a set of criteria for selecting an ontology editor and supported language formalism.

In this research, the most important criteria for selecting an ontology editor (in no particular order) were:

- Capability of the tool to represent, edit, visualize, and extend the ontology.
- Free (Fee-less) access to the editor.
- The researcher's acquaintance with the formalism, language, and tool.
- Availability of online support.
- Popularity of the formalism/language and tool, which influences not only the availability of support but also its extensibility and reusability potential.

Although the general and related literatures have shown that several ontology environments exist, I have chosen Protégé 5.5 for the following reasons.

(1) Protégé (https://protege.stanford.edu) is a set of Java-based and domain-independent ontology design environment. Protégé offers default features and several useful plug-ins for creating, modifying, visualizing, and checking the consistency of ontology (Wyner, 2008).

(2) Protégé is a free, open-source editor with web and desktop versions.

(3) The researcher has some experience with Protégé.

(4) Protégé, at the time of writing in its version 5, supports OWL and can be serialized in several syntax formats such as turtle, OWL, OBO, and JSON, the default being RDF/XML.

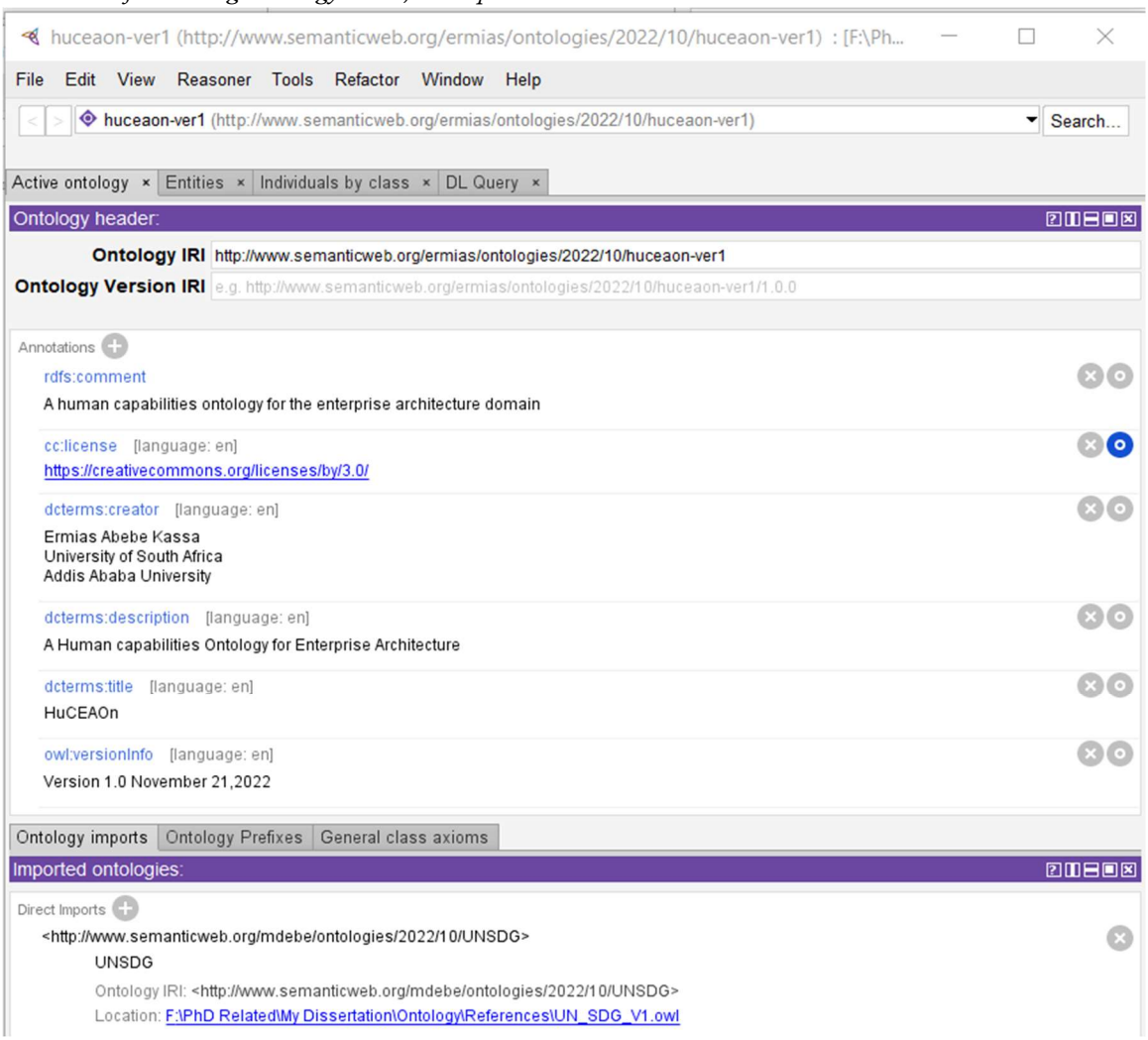
(5) Protégé is the most popular of all the ontology development environments in the reviewed works. The fact that it is developed using Java increases Protégé's portability and extendibility.

(6) Protégé boasts a thriving user and developer community that works together to improve its development, documentation, and online support.

A screenshot of the Protégé ontology editor is shown in Figure 24.

Figure 24

Screenshot of the Protege ontology editor, desktop version 5.5



Note. Annotations added to the HuCEAOn (the currently selected ontology) are shown in this snapshot.

Although several criteria for selecting ontology languages have been suggested, including by Uschold & King (1995), the most immediate requirements for my purpose were pragmatic rather than technical. Thus, in this research, having access to the ontology development tool(s) and online support were paramount in deciding on the language. I chose OWL, which is regarded as the de facto semantic web language standard, because Protégé supports it out of the box and there is a wealth of online training and support for the language (Wyner, 2008). In summary, I chose Protégé as ontology development environment and OWL as a language.

Following the typology of Hadzic *et al.* (2009), the HuCEAOn can be characterized as:

- rigorously formal, represented in OWL logic language;
- fine-grained, with attributes;
- application, domain, and task oriented;
- knowledge modelling, specifying the conceptualizations in the domain; and
- moderately expressive, more so than thesauri but needing further refinement.

6.5. Building the HuCEAOn

6.5.1. Knowledge Elicitation

The process aspect of the HCA mainly promotes participatory methods of identifying capabilities (Frediani, 2010). These strategies include deliberative group processes, genuine and iterative consensus-building mechanisms, and the use of experts to provide an analysis of people's values gleaned from empirical study.

However, deploying these strategies in an under investigated domain such as HCA in EA is not an easy task for several reasons. Particular to this research, logistical limitations of time, place, and cost meant that engaging the wider EA community in a participatory deliberative process could not be feasible. Even finding experts with a comprehensive understanding of the diverse knowledge domains required to produce consilience proved to be challenging.

Consequently, I relied on two strategies to identify capabilities: normative assumptions textualized in capability frameworks and authoritative data from public sources such as the Human Development Index (Frediani, 2010). Accordingly, I populate the ontology primarily from the existing literature and organisational documents (Pries-Heje & Baskerville, 2008). Nonetheless, a critical realism approach to textual interpretation was necessary because capability dimensions are not typically labelled or marked in documents.

A comprehensive listing of social issues, stakeholders and related factors were compiled from the literature that I sampled opportunistically. The knowledge obtained from various sources was first synthesised into a conceptual framework incorporating the HCA, sociotechnical systems theory, and stakeholder theory, followed by the creation of thematic codes (classes) to assist in cascading the instantiating knowledge elements.

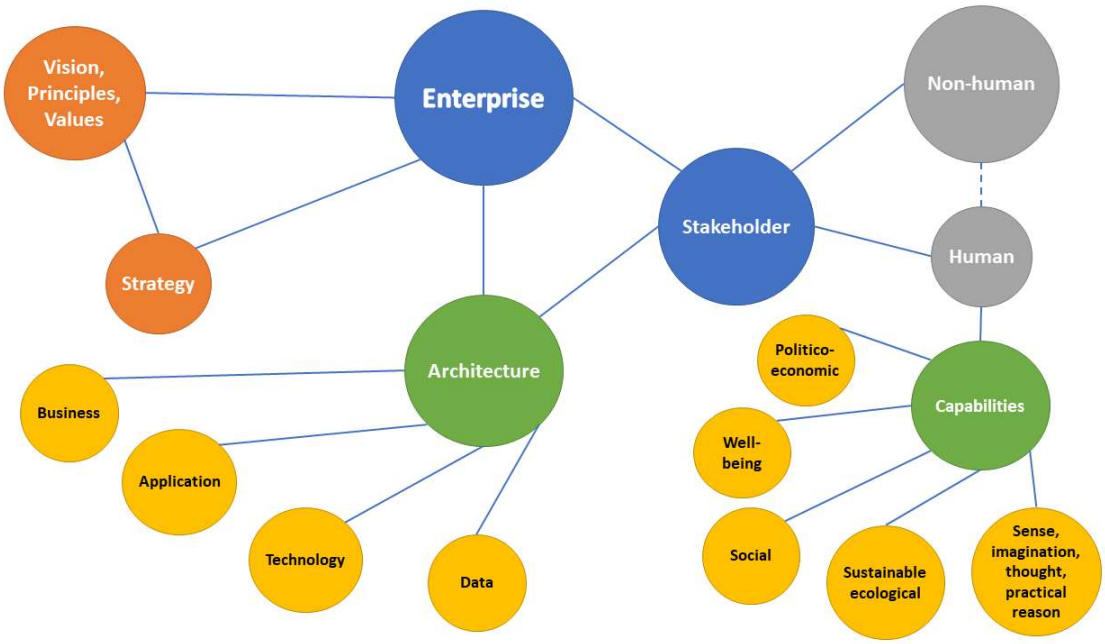
The list of research articles, book chapters, organisational resources used to populate the HuCEAOn is provided in Appendix B.

6.5.2. Conceptualization of the HuCEAOn

In Chapter 3, I showed that EA serves as a framework for integrating diverse enterprise perspectives into a cohesive whole. EA was presented as the holistic vision of the enterprise and the centrality of the enterprise in EA was asserted. The enterprise architect uses EA models to apprehend the enterprise's current and desired states. These models are driven by the vision, strategy, principles, values, and goals of the enterprise, the essence of which is expected to permeate the EA (W. Donaldson, 2017). Thus, EA is considered as the realization of the organisation's strategic vision in terms of processes, data, applications, and infrastructure. The enterprise works to meet stakeholder goals using EA.

In Chapters 4 and 5, I argued that the enterprise's raison d'être is to foster human flourishing, and that human flourishing can be conceptualized through the HCA's lens of agency and capabilities. Figure 25 illustrates a simplified conceptual model of human capabilities tailored for the EA domain.

Figure 25
High-level conceptual model of HuCEAOn



Note. This high-level conceptual model of the HuCEAOn shows the relationship established between the enterprise, its architecture, individual (human) stakeholders and their capabilities. This study does not aim to address the needs of non-human stakeholders like animals or other groups. The dotted line connecting the human and non-human elements is meant to illustrate the potential positive effects of human capability attainment on non-humans such as the ecosystem. Unlike the broader overview depicted in Figure 15, this diagram focuses specifically on stakeholders and their respective capabilities.

I systematically synthesised three HCA frameworks to compile a thematic set of valuable capabilities. The five capability themes teased out from existing frameworks, as originally presented in Table 22, are physical well-being, social, politico-economic, sustainable ecological, and sense-imagination-thought-practical reason.

The *physical well-being* capabilities represent all those aspects of individual health and safety such as enjoying good quality of life, low levels of stress, and freedom from intrusion in their bodily integrity. The *sense, imagination, thought and practical reason* capabilities allow humans to be able to use the faculties of sense and reason to experience the world and guide action. The individual capabilities are however constrained by social and environmental factors. Hence, individuals need *social capabilities* in order to live in harmony with themselves and the society. The *politico-economic* capabilities, on the other hand, pertain to humans need

to be able to freely engage in productive political and economic activities for personal and societal flourishing. Finally, the *sustainable ecological* capabilities define the relationship between the individual and their natural environment as affecting other species, current as well as future generations.

The high-level themes are considered appropriate to the study context and objectives. As suggested by Robeyns (2003, 2006), the capability list as well as the method of generating it is described and justified in Chapter 5.

6.5.3. Ontology coding

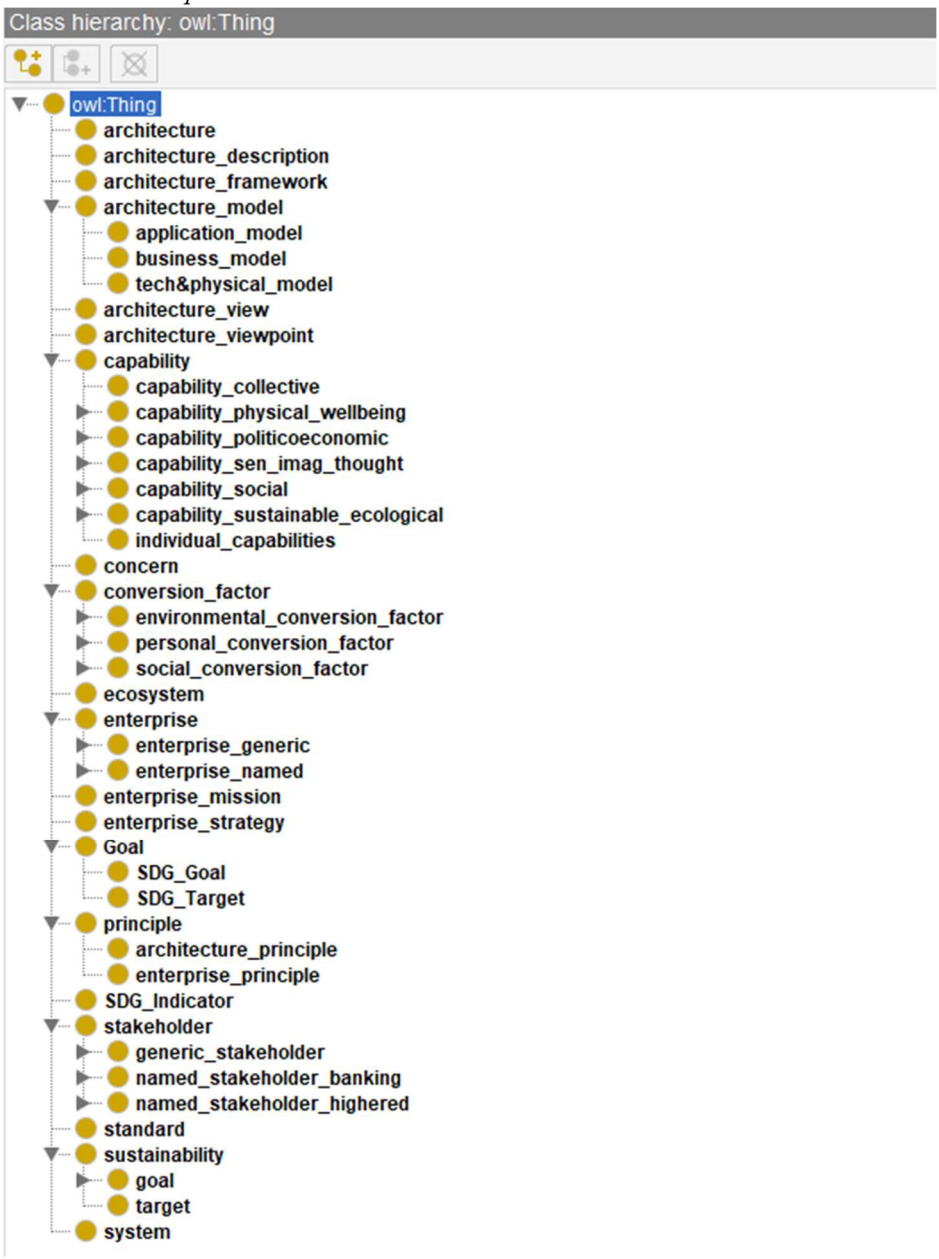
Ontology coding is the technical act of committing the conceptual ontology into a formal representation using some ontology language (Uschold & King, 1995). It entails structuring concepts, properties and relationships relevant to the domain of interest using formal languages such as OWL or RDF in a machine-readable format.

In the human capabilities-conscious EA architecture depicted in Figure 15, I outlined the key concepts and relationships pertinent to the EA domain. Those concepts are then represented in the HuCEAOn using OWL in the Protégé environment. The HuCEAOn provides a detailed representation of the concepts and relationships illustrated in both Figure 15 and Figure 25. However, the OWL ontology diverges from these conceptual models due to practical design considerations made during its development.

The proposed ontology, as depicted in Figure 26, captures over twenty major concepts. It is important to note that only the human capability aspect of EA is thoroughly addressed, while certain concepts are designated as placeholders for potential future development.

Figure 26

HuCEAOn Concepts

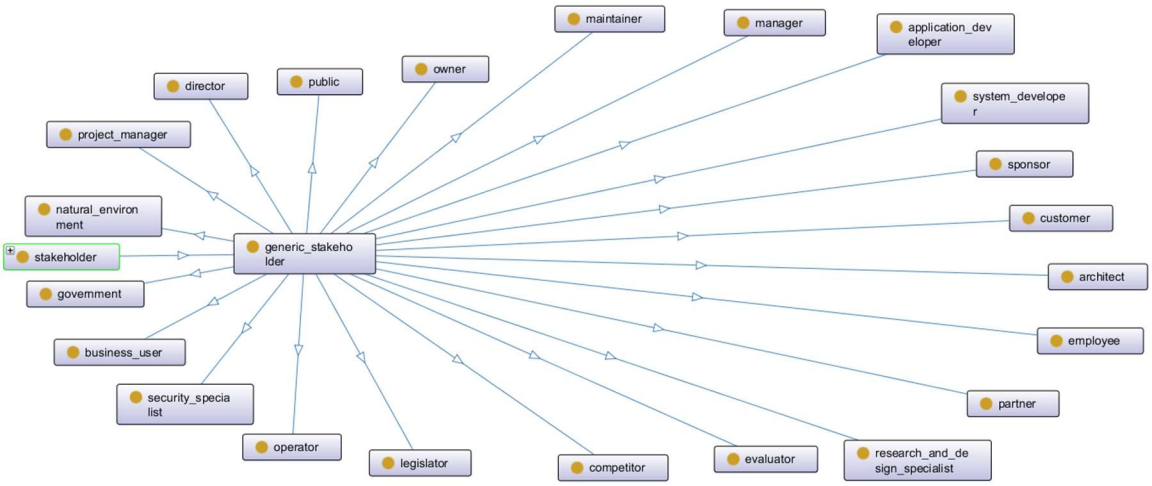


Note. This screenshot depicts the high-level concepts represented in the HuCEAOn.

In contrast to the conceptual architecture shown in Figure 15, the ontology representation in Figure 26 is more detailed. This is because the ontology concepts are iteratively elaborated through the synthesis of HCA frameworks, thematic analysis of literature, and ontology reuse. For example, the stakeholders are further elaborated as

generic and domain- or industry-specific. As an illustration, Figure 27 visualizes the sub-classes of the generic-stakeholder class.

Figure 27:
The "generic_stakeholder" class with its subclasses



Likewise, as depicted in Figures 28 and 29, the "conversion factor" and "capability" concepts respectively spawned several sub-concepts.

Figure 28:
Detailed view of the "conversion_factor" class

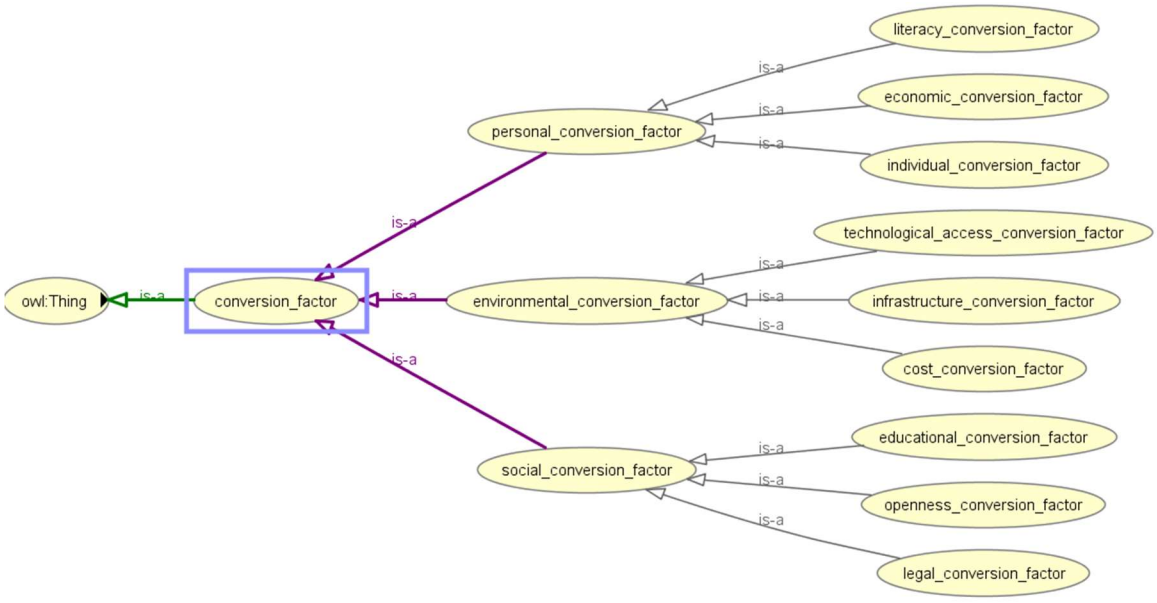
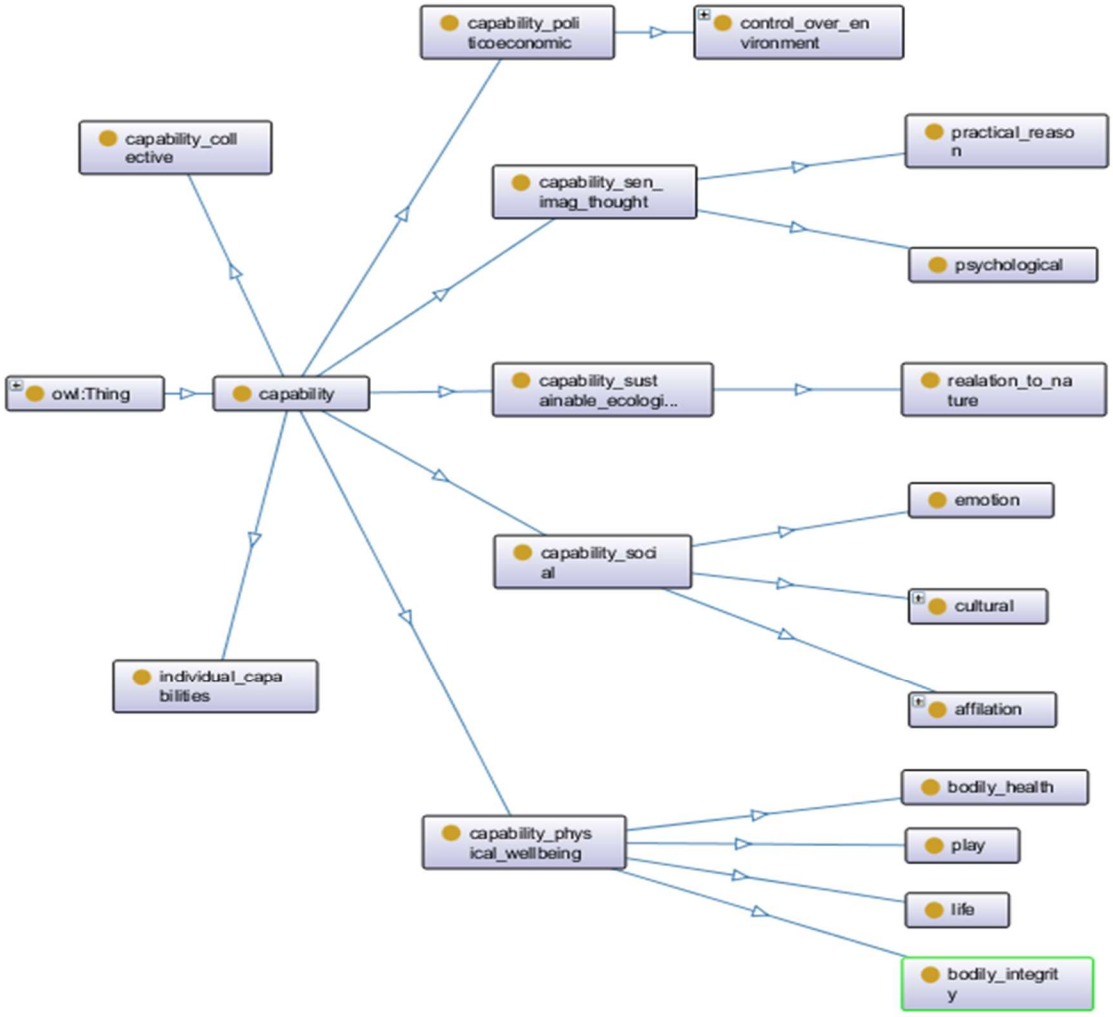


Figure 29

Human capability themes in the HuCEAOn



Note. This diagram depicts the five human capability themes which have been defined and represented in the HuCEAOn. Two more themes, namely individual capabilities and collective capabilities, have been included to facilitate the mapping of capabilities sought as a collective.

The relationships among the classes were coded as subsumption (subclass relationships), part-whole relationships, and associations. In Figure 29, "capability_social" is represented as a sub-class of the "capability" class. In Figure 15, "model" was represented as a part of the "view" class. The most prevalent relationship, however, is association between the classes. While all the relationships or object properties coded into the HuCEAOn are presented in Figure 30, an association relationship between "stakeholder" and " conversion_factor" is depicted as an example in Figure 31. One may note that for every

object property or relationship, an inverse property was created. For instance, the property " is influenced by conversion factor" was created as the inverse of "influences stakeholder."

Figure 30:
A complete list of object properties

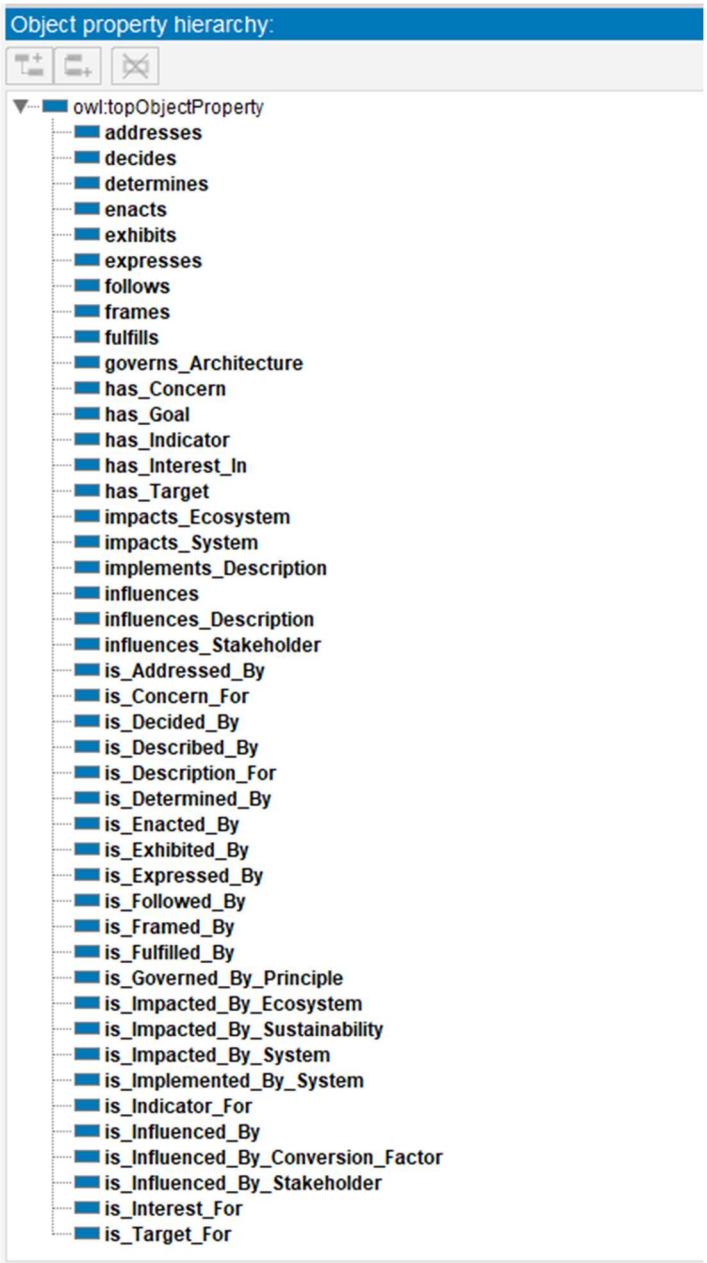
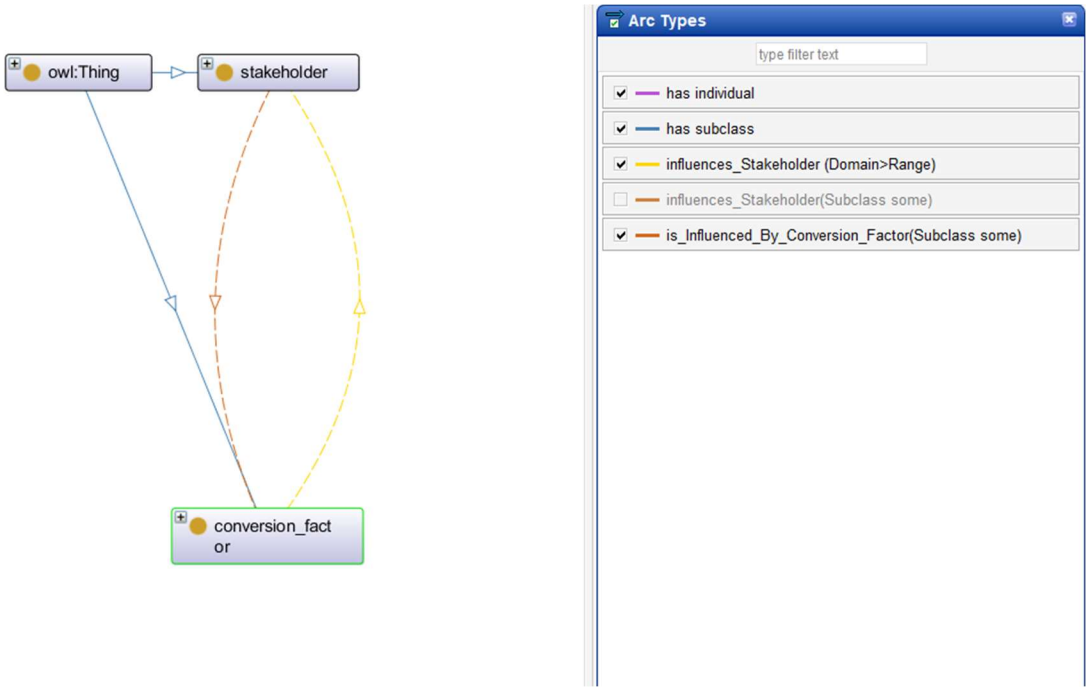
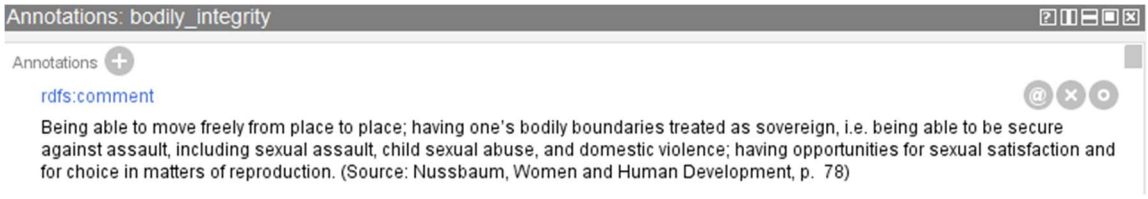


Figure 31:
Association between "stakeholder" and "conversion_factor" classes



After defining the classes and relationships, instances of the classes were populated to represent real-world data or knowledge within the domain. Thematic coding of organizational and scholarly documents was conducted in the Atlas.ti environment to identify relevant concepts or instances. Thematic coding was also vital for extracting definitions that were utilized to annotate the ontological concepts. For an example annotation, please refer to Figure 32.

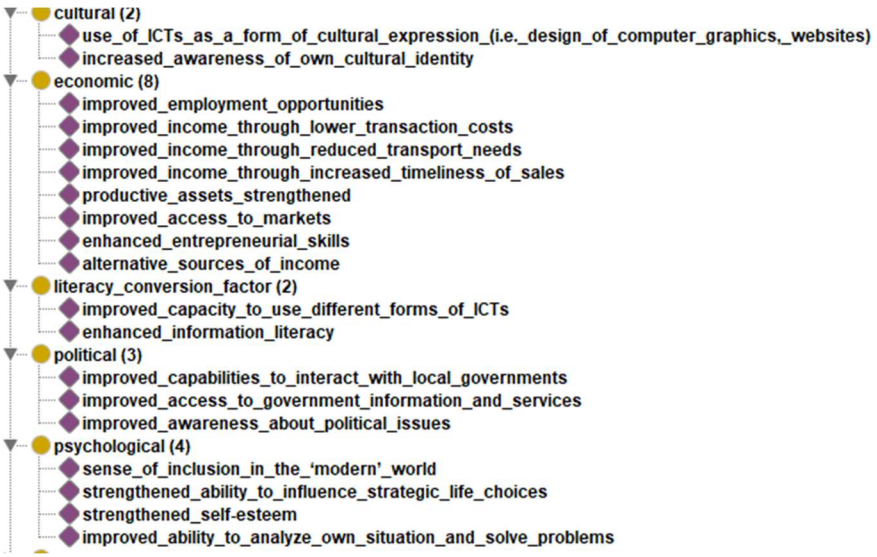
Figure 32:
Sample annotation defining the " bodily_integrity" sub-class



By conducting thematic coding of documents, I was able to identify crucial concepts to instantiate the ontology. For instance, in Figure 33, instance concepts related to conversion factors are illustrated. It is important to note that these instances represent only a

subset of the potential multitude. As the ontology evolves through continuous iterations, EA practitioners may introduce additional conversion factors specific to their domain of interest.

Figure 33:
Sample instances



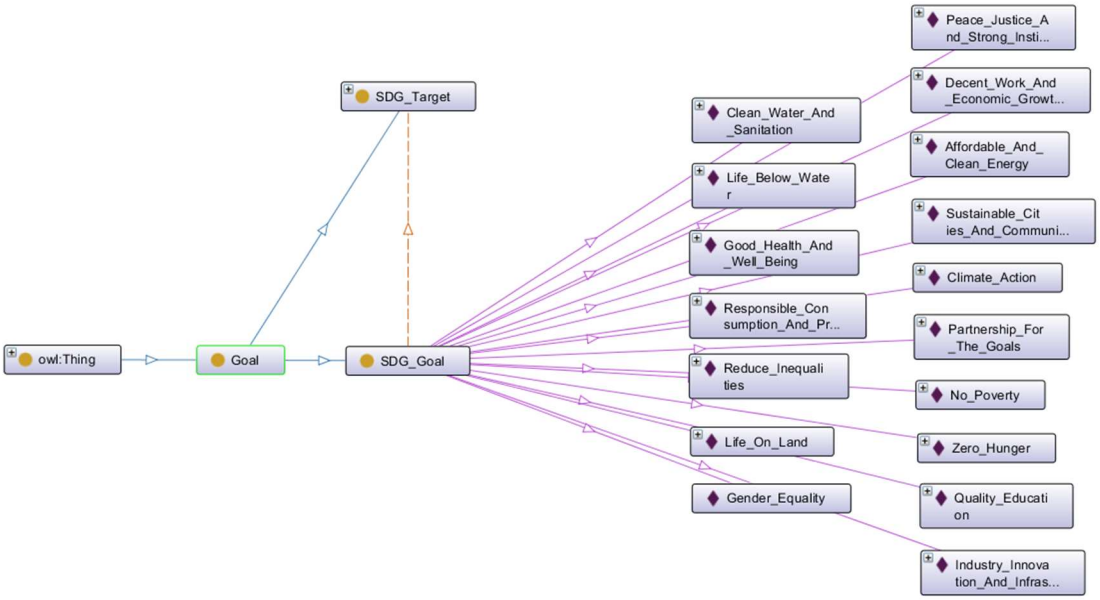
6.5.4. Ontology Reuse

Ontologies abound; thus, it makes little sense to reinvent the metaphorical wheel. Apart from saving time and cost by reusing existing ontologies, developers can also gain advantages by incorporating specialised domain concepts from other ontologies, thus expanding the scope of their own ontology (Hoekstra et al., 2009).

Almost all ontology process models encourage reuse of resources. Reuse is realised at several levels. One may reuse knowledge resources such as concept lists, themes, taxonomies, and even other ontologies. Reuse can also be imagined in the use of tools, techniques, procedures, etc.

I have extended the HuCEAOn by integrating the openly available *United Nations Sustainable Development Goals* (UNSDG) OWL ontology constructed semi-automatically by Michael DeBellis (2022). The sustainability domain, as I have shown in Section 6.3, has immensely benefited from knowledge resources. Therefore, I did not see the necessity to create sustainability-related classes and relations from scratch. The UNSDG ontology concepts are depicted in Figure 34.

Figure 34:
UNSDG concepts



The UNSDG ontology has three classes. SDG_Goal is a terse statement of high-level objectives. An SDG_Goal is refined via more than one SDG_Targets, which provide a more concrete and implementable objective. The SDG_Indicators help measure the achievement level of the objectives. For example,

- SDG Goal: “Eliminate poverty (No_Poverty).”
- SDG Target: “By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day."
- SDG indicator: "Proportion of the population living below the international poverty line by sex, age, employment status and geographic location (urban/rural)."

6.6. HuCEAOn Illustrative Use cases

In this section, I present two case studies, one from higher education and another from banking, to demonstrate the utility of the proposed ontology. I envisage to show how the

ontologist can extend the depth and function of the HuCEAOn by applying it to specific use cases.

6.6.1. Assessing Green IT Practices in Higher Education

In the first scenario, I present the case of a government funded HEI which seeks to assess green IT practices in its IT operations. Ecological sustainability is a goal recognized by the government and the institution itself. I show how the HuCEAOn can be put to use by the HEI to assess this goal in its business and technology architecture.

6.6.1.1. Case Context

Addis Ababa University is the oldest and the biggest government owned HEI in Ethiopia. In 2019, the University had more than 47,000 students in its 76 undergraduate and 350 graduate programs (Addis Ababa University, 2020). In the same year it had about nine thousand employees with the academic staff constituting a third of that number (Addis Ababa University, 2020).

Back in the 1970s, Addis Ababa University was among the first organisations to deploy information technology in Ethiopia (Debay, 2015). Though the use of computing systems continued in the 80s, it could not accelerate due to the political instability and economic hardships in the country. After years in the doldrums, computing started to pick again at the turn of the millennium with the launch of the AAUNet project when a massive infrastructure development project was implemented with the support of donors. In 2017, a new datacentre was setup housing the IT room, a powerhouse, and monitoring area. As of 2020, seven of the campuses are on a dark fibre network whereas the remaining are connected via virtual private network. Ethio Telecom, the country's national internet service provider, provides high-speed internet to all campuses.

The *Information and Communications Technology Office*, organized under the *Vice-president for Institutional Development*, is the coordinating unit empowered to develop IT strategy aligned to that of the University; develop and/or acquire ICT systems and infrastructures; and manage operations (Addis Ababa University, 2020).

6.6.1.2. Illustrative Problem Scenario

Green IT is the efficient and effective planning, design, development, acquisition, use, and disposal of information and communications technologies with the purpose of managing their negative impacts on the ecosystem (Deshpande & Unhelkar, 2011; Loeser, 2013). A more comprehensive conception of green IT extends the definition to include the deployment of IT in supporting environmental strategies including awareness creation (Faucheux & Nicolaï, 2011; Murugesan & Gangadharan, 2012). Thus, green IT can be considered as the study and practice of using IT (Deshpande & Unhelkar, 2011; Loeser, 2013; Murugesan & Gangadharan, 2012):

- efficiently and effectively to reduce its impact on the environment; and
- to foster green growth in other activities of the institution.

Green IT addresses not only environmental sustainability but economic and social sustainability as well (Dao et al., 2011; Faucheux & Nicolaï, 2011; Murugesan & Gangadharan, 2012; Philipson, 2011).

HEIs, including AAU, face challenges in integrating green IT practices. A key challenge is the lack of awareness regarding the environmental impact of ICT practices and the potential benefits of green ICT initiatives (Dalvi-Esfahani et al., 2020; Hernandez, 2019). Additionally, HEIs are hamstrung by energy-inefficient legacy systems and infrastructure, making upgrades and replacements complex, time-consuming, and costly (AlHarbi & Pattinson, 2016; Radu, 2016). While lack of finance for green IT investments, such as energy-efficient hardware, software, and infrastructure upgrades, exacerbates the issue, HEIs may also be constrained by an organizational culture that prioritizes academic and research activities over sustainability initiatives (Martin et al., 2023).

Overcoming these challenges necessitates a comprehensive strategy that involves raising awareness, securing funding, modernizing infrastructure, fostering a sustainability-oriented culture, and providing guidance and support for implementation.

An EA practice centred around human capabilities can play a pivotal role in aligning green ICT initiatives with individual capability needs and institutional objectives, facilitating the transition to more sustainable ICT practices. A human capabilities ontology can serve as a platform for raising awareness among stakeholders, promoting education, fostering democratic collaboration, and facilitating evaluation processes.

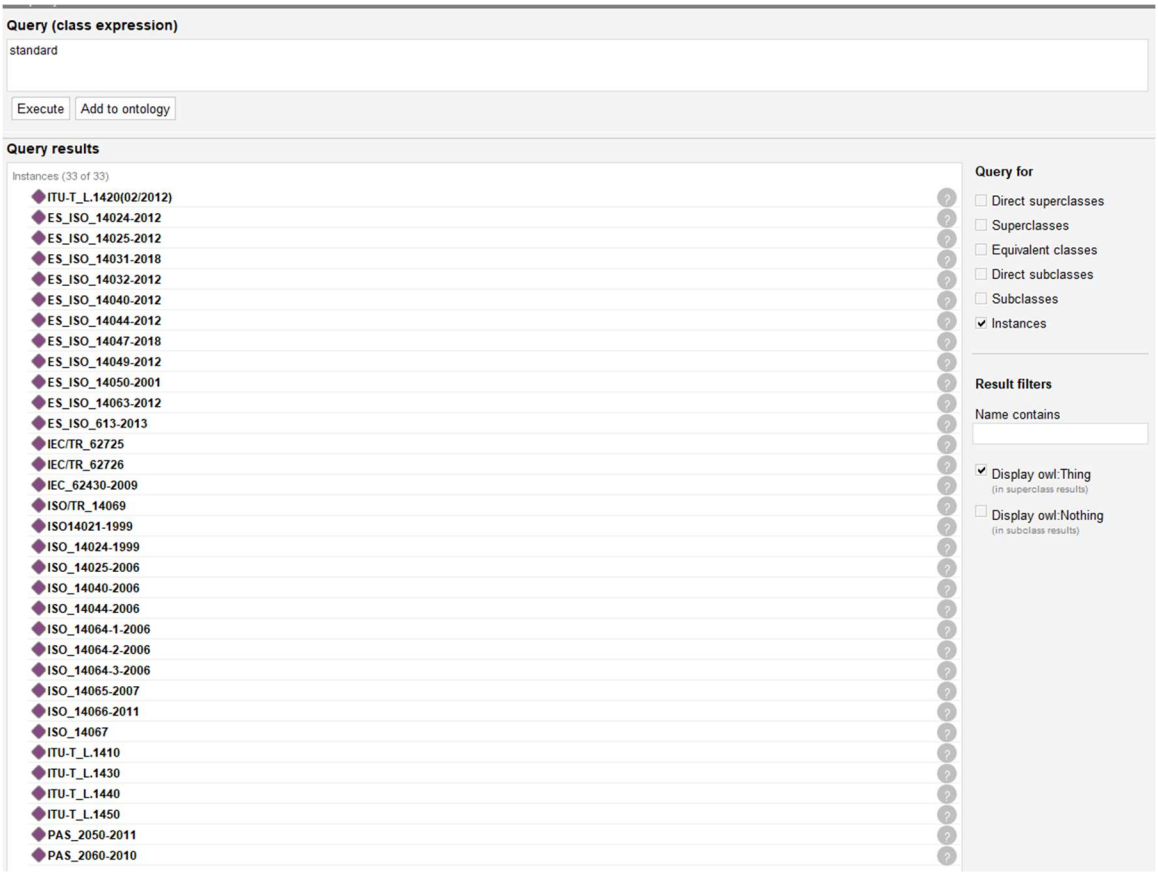
In a hypothetical scenario, the management of AAU's ICT office is embarking on a task to evaluate the alignment of ICT practices, such as planning, sourcing, use, and disposal of IT equipment, with sustainability requirements of stakeholders. The following are some of the envisaged use cases that could leverage the HuCEAOn.

- Shared definitions of terminologies which may help communication between management and EA planners.
- Representation and visualization of stakeholders.
- Representation and visualization of human capabilities and sustainability indicators and their relationships.
- Representation and visualization of standards relevant to green ICT assessment.
- Identifying appropriate purposes and options for new or continuing projects and activities.
- A holistic understanding of sustainability that connects strategy with reference architectures and implementations.

The ICT management can employ the HuCEAOn to align its goals and initiatives with a particular UNSDGs goal/target, such as "affordable and clean energy." As depicted in Figure 35, management can also identify relevant standards to consider when implementing infrastructure and procuring hardware and software.

Figure 35

A simple DL query listing relevant standards represented in the ontology



6.6.2. Banking the unbanked – Architecture of inclusiveness

The second scenario narrates a hypothetical case of a local banking giant which has been seeking to deliver banking services to millions of the unbanked population. The unbanked youth, mainly engaged in the informal sector, lack the trust, motivation, and official documents to get access to financial services (Demirgüç-Kunt et al., 2022). Physical barriers also hinder these low-income people from enjoying banking and finance services.

6.6.2.1. Case Context

Financial inclusion is a development agenda for many societies all over the world. Its macro- and micro-economic advantages are chronicled in the academic and professional literature.

Financial inclusion of low-income populations allows financial aggregation for the economy and delivers socio-economic benefits to individuals (Sarma & Pais, 2011).

According to the 2022 World Bank Global Findex data, more than 30% of the adult global population was unbanked in 2021. The statistic, shown in Table 25, was higher for sub-Saharan Africa at 45%. Only about 40% of the total adult population of sub-Saharan Africa had an account with a financial institution (Demirgüç-Kunt et al., 2022). On the other hand, according to the same source, the number of people with a mobile money account increased from 21% in 2017 to 33% in 2021 in the region. Sub-Saharan Africa registered an impressive growth in mobile money far above the world average of 10% in 2021.

Table 25
Total account holdings by demographics—Sub-Saharan Africa (2021)

Demographic group	Accounts (%)
Women	74.0
Adults in the poorest 40% of the household	71.9
Adults out of the labour force	65.4
Youth (ages 15-24)	65.5

Note. From *The Little Data Book on Financial Inclusion* 22 (p. 8), by The World Bank, 2022, The World Bank Group. Copyright 2022 by International Bank for Reconstruction and Development / The World Bank. CC BY 3.0 IGO.

Wherever people are denied formal financial services, they resort to prohibitively expensive and risky informal services such as usurers, money launderers, and underground banking (also called hawalas), which often put them into intractable debt traps. People, hence, need financial services that are easy and accessible for making savings and investments, domestic and international transfers, receive regular payments like wages and pensions, and complete insurance payments and settlements.

Financial technologies (Fintech) seem to hold the promise of delivering better inclusion of the underserved population. In this vein, Sironi (2022) argued for open and transparent conscious-banking platforms with a "human-centric perspective" (p. 193). Services that were previously offered by traditional banks as a package must therefore be "unbundled" and offered to specific customers with specific needs in an accessible and cost-conscious manner (Laboure & Deffrennes, 2022). It is this promise our case bank seeks to capture.

The Fintech revolution is taking the African continent by storm. The fact that most of the unbanked people in sub-Saharan Africa own mobile phones is a stimulus for this

revolution (Demirgüç-Kunt et al., 2022). Even basic mobile devices with ability to receive text messages can enable transactions, thereby reducing the need for branch banking. M-Pesa in Kenya and HelloCash in Ethiopia are just two examples of the numerous services that provide financial inclusion to low-income individuals.

Several benefits accrue to citizens and the society at large due to fintech. The following are but some of the Fintech benefits identified by Vučinić (2020), Laboure & Deffrennes (2022), and Sironi (2022).

- Fintech reduces the risks associated with storing cash in residences and anonymous peer-to-peer cash-based transactions.
- Low-income groups can get access to credit even when they do not have collaterals with better management of risks for the service provider.
- In addition to savings in the turnaround time for delivering mobile services, the finance service providers can accumulate knowledge about their customers for better innovation.
- Retailers improve the efficiency of payment collection.
- Fintech eliminates layers of intermediation allowing market information symmetry leading to improved income to producer and reduced product and services costs to the consumer.
- Governments will have a better chance of tackling corruption, fraud, and tax evasion. Money hoarded by households can be rechannelled to the formal economy.

The sum total of these positives is a virtuous cycle driving people on an upward trajectory toward better overall individual and societal well-being.

6.6.2.2. Illustrative Problem Scenario

Financial institutions face numerous policy and operational barriers that impede the incorporation of financial inclusion into their operations. A sizeable portion of these institutions remain constrained by outdated policies and systems focused solely on maximizing shareholder profits, often neglecting the needs of other stakeholders (Gabor & Brooks, 2017). The financial industry's strong focus on shareholder profitability obstructs the inclusion of underserved populations due to worries about credit, operational, and fraud risks associated with serving customers who have limited financial literacy or credit history

(Andrey, 2022). The financial inclusion needs of unbanked populations are hindered by policies like anti-money laundering and know-your-customer regulations (Arner et al., 2020; Omarini, 2021). While the endeavour to embed financial inclusion within entrenched legacy systems presents formidable challenges, the compounding effects of cultural and behavioural dynamics, as well as limited access to digital devices and Internet connectivity, further impede the participation of many communities (Geebren & Jabbar, 2021; Lopes et al., 2022).

The EA that must embrace financial inclusion along with other human ideals must therefore be holistic, involving all stakeholders including financial institutions, regulatory bodies, technology providers, and underserved communities (Saraf & Kayal, 2022). Utilizing the human capabilities ontology in EA practice can facilitate the design of flexible and scalable systems that prioritize financial inclusion objectives while ensuring compliance, risk management, and customer satisfaction (Nicoletti, 2021a, 2021b). Such EA initiatives must empower the unbanked population to access financial choices tailored to their personal, social, and environmental contexts (Nadela & Yulianti, 2022).

Reverting back to our case study, the bank, which operates hundreds of brick-and-mortar branches throughout Ethiopia, is struggling to reach the unbanked with innovative products. The Bank's business development manager is working with the chief information officer to plan out a broad outline of technology strategy identifying products that meet the needs of the low-income unbanked people. The following are few of the use cases envisaged.

- Shared definitions of terminology which may help communication between management and EA planners.
- Representation and visualization of stakeholders.
- Representation and visualization of human capabilities pertaining to financial services.
- Representation and visualization of relevant policies, strategies, and standards.
- Representation and visualization of internal and external resources allowing or limiting choice.

In particular, the HuCEAOn can, for instance, enhance the financial institution's portal to accommodate various levels of information detail and multiple media formats tailored to different user profiles, thereby reaching a diverse audience. This facilitates

increased awareness among the unbanked population while addressing educational disparities among various groups.

In general, in the finance sector, a human capabilities ontology holds promise for orchestrating digital disruption by dynamically and continuously monitoring the capability requirements of the banked and the yet to be banked. Envisioning financing for education, housing, entrepreneurship, travel, and more through diverse finance instruments and modalities becomes conceivable with the implementation of such capability architecture (Laboure & Deffrennes, 2022).

6.7. Ontology Evaluation and Assessment

Ontologies constitute a conceptual model of the domain of interest (Raad & Cruz, 2015). If the conceptual model is defective, its defects may propagate to subsequent processes and components (Shanks et al., 2003). Therefore, a rigorous evaluation and assessment procedure must accompany the ontology construction to increase the reliability and usability of the ontology developed.

Vrandečić (2009) argued that ontologies can yield the full benefits they are designed for if the ontologist manages to avoid omissions and errors. The process and product of ontology development must be evaluated to ensure quality of the ontology and guide future efforts. Further, the ontology must be assessed for relevance and usability by actual or potential end-users.

Hence, in the following sub-sections, I present findings of the evaluation and assessment conducted to measure the clarity, completeness, coherence (consistency), extendibility, completeness, relevance, and usability of the HuCEAOn. Given this research's scope and time constraints, the underlying premise was that, at this early stage of HuCEAOn's development, the primary focus was to optimize its technical capabilities, aim to achieve the defined goals, and capture the evaluators' personal impressions of the artefact. In this sense, the evaluation primarily manifests hermeneutic and sociotechnical inclinations (Klecun & Cornford, 2005). I cannot claim any a priori theoretical convictions, as both the evaluation and assessment were conducted in a theory-agnostic manner.

6.7.1. Evaluation

Ontology evaluation is the process of determining the quality of an ontology relative to a set of evaluation criteria (Amith et al., 2018; Gharib et al., 2021). In information systems development, evaluation is crucial to determine whether and to what degree the changes introduced result in the anticipated effect (Klecun & Cornford, 2005).

Gómez-Pérez (2001) identified two aspects of evaluation. The first – *verification* – answers if the ontology representations capture the requirements correctly (Gómez-Pérez, 2001; Vrandečić, 2009). *Validation,* on the other hand, involves determining whether the constructed ontology is an accurate description of the reality being modelled (Gómez-Pérez, 2001; Vrandečić, 2009).

As ontology evaluation may be based on multiple criteria, the ontologist must first establish the most pertinent principles to be satisfied by the ontology development process and the artefact itself, and then determine the specific techniques and instruments to be used to evaluate the ontology's performance relative to the criteria (Vrandečić, 2009).

The HuCEAOn is valid "by design" for two reasons (Porwol et al., 2016). First, the ontology's validity derives mostly from the DSR process I followed. Secondly, the CQs were used as the requirements that guided the ontology construction. However, formal evaluation was required to attest to the ontology's validity and verifiability. Hence, following Gharib et al. (2021) and Wyner (2008), I evaluated the HuCEAOn by: (a) querying it to determine if it satisfies the requirements stated in the form of CQs (see Section 6.4.1.); (b) evaluating the coherence (consistency) of the ontology using the Protégé's built-in Pellet reasoner; (c) detecting syntactic and semantic inconsistencies using VOWL and OntoGraf Protégé plugins; and (d) testing the ontology with OOPs! to see if it avoids the common pitfalls (Hetmank, 2013; Poveda-Villalón et al., 2014).

The HuCEAOn was developed over several iterations, with formative reviews performed whenever important modifications to the ontology were implemented. However, what has been reported here are the outcomes of the summative evaluation completed at the end of the process (Venable et al., 2016). The formative evaluation process, to use agile terminology, is a validated learning process in which each iteration or test leads to an improved product. The evaluation strategy can at best be termed as quick and simple (Venable et al., 2016). Table 26 summarises the methods used to evaluate the HuCEAOn.

Table 26
HuCEAOn evaluation methods

Criteria	Evaluation Method			
	Protégé	OOPs!	Researcher	Experts
Clarity		✓	✓	✓
Coherence	✓	✓	✓	✓
Extendibility			✓	✓
Conciseness	✓	✓		✓
Completeness	✓		✓	✓
Accuracy			✓	✓

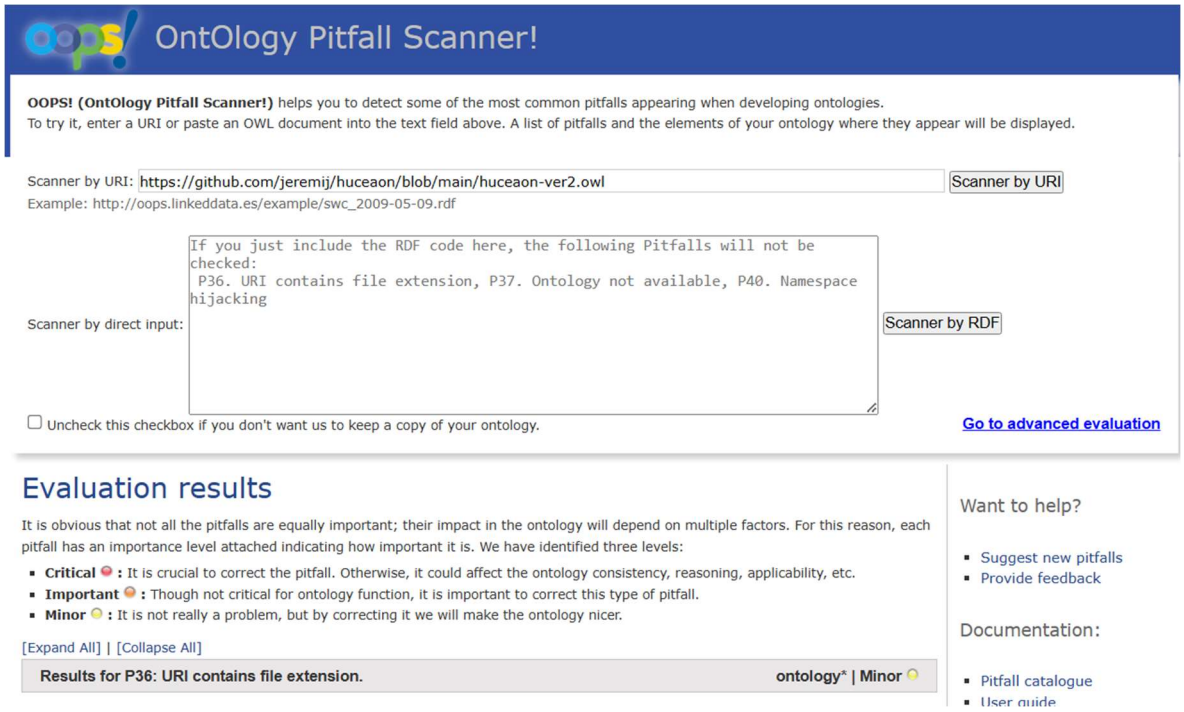
Note. "COPri v.2—A core ontology for privacy requirements", by M. Gharib, P. Giorgini, and J. Mylopoulos, 2021, Data and Knowledge Engineering, 133(2021), p. 13 (https://doi.org/10.1016/j.datak.2021.101888). Copyright 2021 by Elsevier Ltd.

I evaluated the ontology for its comprehensibility (clarity) and comprehensiveness. I additionally checked the ontology for missing disjoint axioms, missing domain and range, misuse of defined and primitive classes, and existence of unconnected elements using Protégé's built-in facility (Poveda-Villalón et al., 2014). The domain experts, on the other hand, helped validate the knowledge represented in the ontology. Due to their lack of familiarity, the experts were unable to augment the ontology with newer concepts and relationships. Nonetheless, they were cognizant of the human concerns of EA, allowing them to verify the applicability of the concepts and relationships contained in the HuCEAOn.

The internal consistency (coherence) of the HuCEAOn was validated using the Protégé Pellet reasoner and the OOPs! tool. Figure 36 depicts a screenshot of OOPs!, an online tool that evaluates an OWL ontology against more than 40 structural, functional, and usability pitfalls (Poveda-Villalón et al., 2014).

The practical relevance and universal character (extendibility) of the ontology were demonstrated by encoding concepts and relationships from two case studies in higher education and finance, as well as expert input from the two domains.

Figure 36
OOPs! Evaluation Result for HuCEAOn



6.7.2. Assessment

Assessment is the process of eliciting the opinions of actual or potential users regarding the usefulness and utility of the ontology (Gómez-Pérez, 2001).

I developed two instruments to assess the usability and utility of the HuCEAOn. The ontology usability matrix and the supplemental interview questions (Appendix A) are based on Brönnimann (2022), Casellas (2009), Lee et al. (2002), and Ma et al. (2018). I administered the two instruments to six experts with a minimum of an MSc degree and five years of experience. Profile of the experts is presented in Table 27.

Even though the experts were unfamiliar with the HCA jargon, they had sufficient grasp of the human element of EA. For good measure, I provided each of them with background information on the HCA and its significance to EA practice, and then invited them to relate it to what they already understood about of the human side of EA work.

Table 27
Profile of experts

ID	Gender	Education	Industry	Expertise
1	M	M.Sc. in Computer Science	Bank & Finance	Five years of experience in the banking industry as system architect and project manager.
2	M	M.Sc. in Computer Science	Bank & Finance	Over ten years of experience as software developer and project manager.
3	M	M.Sc. in Project Management	Technology Implementation and Consulting	Over fifteen years of experience as a project manager and consultant primarily in the finance industry.
4	M	M.Sc. in Information Science	Technology Implementation and Consulting	Over five years of experience as software developer, solution integrator, and project manager.
5	F	M.Sc. in Computer Science	Higher Education	Over five years of experience as teacher and IT consultant.
6	M	PhD in Information Systems	Higher Education	Over 20 years of experience as a teacher, enterprise architect, and IT manager in a variety of industries including government, higher education, and industry.

The first instrument allowed the experts to assess the ontology's usability on a five-point scale. Table 28 provides a summary of the findings from the assessment that was conducted in order to evaluate the usability of the HuCEAOn. The assessment yielded a cumulative average of four on each of the two measures of central tendency (median and mode). This supports the conjecture that the ontology is semantically plausible and readily usable by an expert user.

Table 28

Summary of usability assessment results

Usability Questions		User						Central tendency by question			
		A	B	C	D	E	F	Mean	Median	Mode	
The purpose of the ontology was clear.		4	5	5	4	4	5	4.50	4.5	4	5
I am confident I understand the conceptualization of the ontology.		4	4	4	4	4	4	4.00	4	4	
I could understand the conceptualization of the ontology without asking a lot of questions.		3	3	4	4	3	4	3.50	3.5	3	4
I found the ontology easy to understand.		4	4	5	4	4	4	4.17	4	4	
I do not need further theoretical support to be able to understand this ontology.		2	2	3	3	2	2	2.33	2	2	
I would imagine that most domain experts, particularly people involved in enterprise architecture, would understand this ontology very quickly.		3	3	4	3	3	4	3.33	3	3	
I do not need to learn any extra things before I could get going with this ontology.		3	2	3	3	3	3	2.83	3	3	
I found the ontology easy to use.		4	3	4	4	4	4	3.83	4	4	
I do not need the support of a person experienced with this ontology to be able to use it.		3	4	4	4	4	4	3.83	4	4	
I think that I could contribute to this ontology.		5	4	4	4	5	5	4.50	4.5	5	4
Central tendencies by user	**Median**	3.5	3.5	4	4	4	4				
	Mode	4	4	4	4	4	4				
		3									

If we dissect the responses further, there are two particular questions for which the experts gave a below-average response (nearer to disagreement). The first proposition was that the expert does not need further theoretical support to better understand the ontology. The average response for this proposition was 2.33 (nearer to disagreement). During preliminary conversations with the researcher, all the experts noted that the concept of human capabilities is foreign to them, although the human element of EA is not. Therefore, it is understandable that the experts still had doubts regarding what each human capability notion conceptually entailed and, more importantly, whether they could use these concepts to update the ontology.

The second conjecture to which the experts, on average, responded unfavourably claims that they do not require further knowledge or skills to use the ontology. This assessment question received an average score of 2.83 (close to indifference, but still reflecting disagreement). There are two possible explanations for this outcome. First, the experts may need some additional knowledge of ontologies and their practical applications in EA. From my interactions with the experts, I learned that virtually all of them (except one) had a rudimentary knowledge of ontologies but had never developed or implemented one. Since ontologies are typically enabling technologies that rarely allow direct interaction with the user, it is possible that the experts had used them even without realising it (Lehmann & Voelker, 2014; Milton, 2008). The second possible explanation is that they anticipated a knowledge/skills deficit if required to integrate the HuCEAOn into their EA practice.

Despite the fact that the experts may require more knowledge and skills in the HCA and the actual application of the HuCEAOn, all experts questioned assessed the ontology as easy to understand and use.

In a follow-up interview, which is summarized in Table 29, the experts were asked questions about the ontology's scope, relevance, completeness, and interpretability.

Table 29

Summary of expert interviews

Question (1)	Describe how you or your organisation embed, if at all, human values, and capabilities in EA efforts?	
Representative Themes	User requirements	"We gather user requirements before developing systems. Users are usually internal to the organisation. We rarely interact with stakeholders outside the boundaries of the organisation."
Glaring exceptions	"Our business development department usually gathers customer needs through surveys. It is based on these needs that ICT develops applications."	
Question (2)	What structural (individual, group, or organisational unit) factors influenced your actions in reference to #1.	
Representative Themes	Budget	"We do not have enough money to go out and interact with stakeholder groups and inquire about their personal needs. We therefore focus on system requirements of few internal experts."
	Education	"In my university studies, I remember about stakeholder engagement, but the only stakeholders we interacted with were end-users of systems.'
Glaring exceptions	"Working for the government, our projects are subject to several political influences. For example, the government has the policy that the UN sustainability goals must be considered in all project planning even though to what extent we comply with them is open for discussion."	
Question (3)	What individual, national, or organisational cultural factors influenced your actions in reference to #1.	
Representative Themes	Prior experience	"The overwhelming influence is experience. Individual and organisational experience guide our work. We do what we have seen others do in prior projects. It is occasionally that we change our ways.'

	Expediency	"Projects are expected to be completed in short period of time. Our bosses expect us to deliver as fast as possible. Hence, we seek short cuts."
Glaring exceptions	"In many projects political sensibilities are more forceful than technical performance or economic efficiency. That is why government projects take time. I attest that citizen participation is given some weight by our bosses even though the rhetoric is not usually supported by enough budget."	
Question (4)	Describe any observed events where people or groups acted to change the status quo to introduce human values consciousness in your organisation's EA planning.	
Representative Themes	"I honestly do not recall such an occasion. We trudge along the path opened by our seniors and superiors."	
Glaring exceptions	"Our Women and social affairs department is actively involved in project planning. Their agenda is mainstreaming women and social affairs through direct and indirect actions."	
Question (5)	Describe how your EA planning work is influenced by new tools and technique such as the ontology you are evaluating.	
Representative Themes	Poor investment	"We do not have that much investment on acquisition of new enabling tools and techniques. Our training budget is also limited. We use free and open-source resources or in some instances pirated ones. Even when we get the money the procurement process is so prohibitive and sluggish, we finally resort to using whatever resources are available from the internet."
Exceptions	"The good thing about the banking sector, whichever bank it is, is that there is significant investment on training and development. Even though, the procurement process is sometimes slow due to incapable local vendors, we get resources if we carefully plan for them."	

Generally, the experts had a favourable opinion of the ontology's completeness. They all agreed that the ontology includes concepts that they commonly face in their EA practice, among other things. Because they were unfamiliar with the HCA, they saw the inclusion of HC ideas in the ontology as an added value. One expert stated, "although I do not have any reference to other EA ontologies, I believe that the HuCEAOn is a comprehensive ontology covering the EA domain with a particular focus on human capabilities and sustainability." Another respondent chimed in saying, "the inclusion of sustainability concepts into the ontology is particularly useful for EA practice as we have been trying to align our policies and strategies to the UN sustainable development goals. We have never seen the relationship between sustainability and human capability and how EA influences the two."

The surveyed experts agreed that the concepts and relationships contained in the ontology are relevant to the domain. A few of them noted that the ontology's breadth is even larger than what they typically need. One expert from the banking industry indicated that for small-scale projects with tight schedules, the typical requirements gathering process entails referencing previous projects completed within the organisation or elsewhere. Such an ontology, he added, would be ideally suited for the creation of innovative products and service offerings, as it would provide a holistic view of EA.

While all the experts acknowledged the significance of the HuCEAOn for EA practice, some voiced apprehension regarding its immediate applicability in their local context. A number of them concluded that additional time might be necessary for themselves and their co-workers to familiarize themselves with human capabilities and their connections to EA.

Moreover, virtually all interviewees expressed concern regarding the interpretability of the concepts and relationships contained in the HuCEAOn. One expert said, "I have no trouble understanding the concepts and their interrelationships. However, if you ask me to employ these concepts in my EA practice or any IT assignment in the future, I may struggle because I may need further training and experience." Another respondent concurred, stating, "the concepts are not challenging to grasp when I have your assistance. However, I may need some more time to put it to practical use."

6.8. Communication

Communication is an essential relevance requirement of for any DSR and, by extension, any information systems research (Benbasat & Zmud, 1999). Knowledge acquired and artefact built as part of a DSR need to be documented and communicated to communities of research and practice (Dresch et al., 2015; Peffers et al., 2007).

Documentation and communication are considered as core elements of ontology development, as the primary purpose and utility of such an artefact is to facilitate knowledge sharing (Uschold & King, 1995). The development of an ontology is rendered meaningless without documentation and communication.

To fulfil these objectives of the research endeavour, the knowledge acquired throughout my PhD work and the resulting artefact are shared through this dissertation, journal papers, and seminar presentations. Additionally, the HuCEAOn is made accessible for download on GitHub.

6.9. Chapter Summary and Conclusion

This chapter's primary design objective was the development and validation of a human capabilities ontology that may contribute to the humanization of EA. I started the chapter by defining what ontologies are, why we need them not only as tools of knowledge management but also as instruments of stakeholder deliberative engagement. Next, I reviewed ontology development principles, processes, and tools, which served as the foundation for my research and design choices. Accordingly,

- Considering the constraints imposed by the purpose and goal of the ontology, and availability of resources, I opted to extract ontology concepts and relationships from documentary sources.
- I identified five human capability themes, namely physical; social; sense, thought & practical reason; politico-economic; and sustainable-ecological, based on a synthesis of three well-known human capability frameworks,
- While many of the ontology concepts and relationships were generated from documentary sources, I chose to extend the HuCEAOn by reusing the UNSDG ontology by Michael DeBellis.

- Because of the DSR method followed and the CQs that guided the construction the ontology, the HuCEAOn was taken to valid "by design." However, as formal validation is necessary to complete the DSR process, the ontology was evaluated and assessed using a combination of methods.
- Two case studies, from the Banking and higher education domains, were prepared to demonstrate the relevance of the ontology.
- The follow-up usability assessment revealed that the surveyed experts deemed the ontology to be semantically plausible and readily usable by an expert user. They also agreed that the ontology is complete, and concepts and relationships contained in the ontology are relevant to express the domain. However, the experts indicated that they require additional knowledge and skills about the HCA and the practical application of the HuCEAOn.
- Despite the fact that all of the experts acknowledged the relevance of the HuCEAOn to EA practice, several of them expressed concern that it may not be immediately applicable in the local context because they and the people they work with may require additional time to become familiar with human capabilities and their relationship to EA.

In Chapter 7, I will conclude the thesis by summarising the results and drawing appropriate inferences and recommendations.

7. Summary, Conclusions, and Recommendations

7.1. Introduction

This chapter opens with a summary of the material covered in earlier chapters, followed by a discussion of the projectability of the research artefacts. In then proceeds to outline the conclusions drawn from the research findings. As I round off the chapter, I discuss the study's contributions and limitations, and offer recommendations for both researchers and practitioners.

7.2. Summary of Findings

This thesis may be seen as an addition to the cumulative research on EA and the HCA. The aim of the research was to first explore and conceptualize the HCA in the context of EA, and subsequently, to develop a computational ontology containing relevant concepts and relationships pertinent to the domain.

I forwarded four research questions with the aims of exploration, description, and prescription. I set out to answer what place human capabilities have or would have in the context of EA and which human capabilities should be taken into consideration by EA research and practice. These knowledge-based questions were subsumed under the design goal of creating a human capabilities ontology for the EA domain.

A blend of inductive and deductive procedures was implemented in a manner suited each research question. Based on the assumption that the envisaged artefact (ontology) is real, evolving, and open to interpretations, I established that critical realism was the most appropriate research paradigm for this research. As the primary goal of this research was the construction of a computational ontology, the DSR was chosen as a research approach. In a scheme of data, theory, and methodological triangulation, multiple theories, data sources as well as data gathering, analysis, and synthesis techniques were used. Amartya Sen's HCA, as well as stakeholder and sociotechnical systems theories, were combined to form a conceptual framework for human capability conscious EA, which has the potential to extend the opportunity space open to individuals.

Based on a background study, the HuCEAOn was developed following the DSR process. The internal consistency (coherence) of the HuCEAOn was validated using the Protégé Pellet reasoner and the OOPs! online tool. The ontology's practical significance and universal character (extendibility) were demonstrated by encoding two case studies of higher education and banking. Experts were engaged to assess the usability and utility of the ontology.

The following were the major findings of the research.

- A look back at EA's history has revealed that it is gradually shifting from a purely technology focus to a broader ecosystemic focus, to wit, a holistic, strategic, stakeholder-focused, regulative, and ecosystemic conception of EA is being promoted. From a systems perspective, enterprises should, of necessity, put in place an EA that not only accounts for economic, social, and ecological consideration but also for human choices. From the perspective of ethics and sound business strategy, the value of all stakeholders must be emphasised in corporate decision-making.
- The definitional study of EA's constituent terms has revealed that a holistic perspective is encouraged and the higher purpose of serving humanity is emphasised in both architecture and organisational management. This change in emphasis is being reflected in the missions, principles, and strategies of organisations.
- Stakeholder value is central to both sociotechnical systems theory and stakeholder theory, to the point where problem understanding, solution design, and implementation all require understanding the stakeholders' roles, responsibilities, concerns, perspectives, and success criteria.
- The integrative worldview appropriate for human capabilities conscious EA is holistic, critical realist, multistakeholder, and multimethod.
- Based on a synthesis of Nussbaum's, Gigler's, and Harris's capability frameworks, five capability themes of physical well-being, social, sustainable ecological (Natural environment), politico-economic, and sense, imagination, thought and practical reason were identified.

- The HuCEAOn is considered valid by design since the ontology construction process followed the DSR approach and was guided by CQs.
- The usability assessment has yielded a cumulative average of four for both central tendency measures applied, namely median and mode. That shows an agreement with the conjecture that the ontology is semantically plausible and readily usable by an expert user.
- However, the surveyed experts have indicated that the concept of human capabilities is foreign to them, although the human element of EA is not. The idea that they do not need any further training or expertise to utilize the HuCEAOn was likewise met with mostly negative responses from the experts. All of the experts surveyed claimed that the ontology was simple to use and comprehend, even though they may need more training in the HCA and the practical use of the HuCEAOn.
- The surveyed experts have a positive assessment of the completeness of the ontology, stating that it contained concepts they typically encounter in their EA practice. Since almost all of them are new to the HCA, they viewed the incorporation of HC concepts into the ontology as an added benefit.
- The surveyed experts agreed that the concepts and relationships contained in the ontology are relevant to express the domain. Some have even argued that the ontology's breadth is more expansive than is practically needed.
- All of the experts agreed that the HuCEAOn was relevant to EA practice, but a few expressed their concern that it might not be immediately applicable in the local setting because they and the people they work with might need more time to become familiar with human capabilities and how they relate to EA. Similarly, almost all surveyed experts considered interpretability of the ontology concepts and relationships to be an issue.

7.3. Design Principles

Design principles are a class of theory which prescribes the purpose, structure, methods, means, and context of designing and using an artefact (Gregor et al., 2020; Kruse et al., 2015). Depending on the context, they may signify principles of form and function, design

patterns, technical rules and propositions, or generic computing principles (Gregor et al., 2020). While not having deterministic outcomes, design principles express affordances or potentials for action and aid in capturing and generalizing design knowledge (Kruse et al., 2015).

Guided by the literature on HCA, sociotechnical systems design, stakeholder theory, ontology design principles, personal experience, and the assessment of the HuCEAOn, I have distilled the four principles (DPs) of design and action presented in Table 30 (Gregor et al., 2020; Kruse et al., 2015; Mohr & Dessers, 2019b; Nguyen et al., 2021). The principles are framed in terms of their material constituents, affordances, and constraining boundary conditions (Jalowski et al., 2023; Kruse et al., 2015). The principles offer limited insights into the general design of ontologies, as such generic principles are extensively discussed elsewhere. Instead, they centre on the utilization and expansion of the HuCEAOn.

Table 30
Design principles

Design Principle	Source
DP-1: Consider the composition of the user base In an environment where stakeholders have limited knowledge and skills in using the ontology, ensure that the HuCEAOn is equipped with an intuitive user interface for its effective deployment and sustainable use in task collaboration and knowledge sharing.	▪ HCA ▪ Sociotechnical systems design principles ▪ Ecosystemic EA view ▪ Stakeholder theory ▪ HuCEAOn Assessment
DP-2: Apply human capability concepts Wherever human value orientation is called for, leverage the ontology's capability themes and concepts to guide the design and evaluation of EA components.	▪ HCA ▪ Sociotechnical systems design principles ▪ Ecosystemic EA view
DP-3: Foster democratic dialogue Provide the ontology with knowledge base through engagement of stakeholders in contexts where collaboration is possible and capability elicitation knowledge and skills are available.	▪ HCA ▪ Sociotechnical systems design principles ▪ Stakeholder theory ▪ HuCEAOn Assessment
DP-4: Reuse Where the usability and effectiveness of the HuCEAOn hinge on its scope and given the availability of numerous OWL ontologies covering diverse aspects of EA, extend the ontology through reuse.	▪ Sociotechnical systems design principles ▪ Ontology design principles

7.4. Projectability of Design Knowledge

Projectability is an aspect of design knowledge required to make *valid projections* from an artefact, its design principles, operational use cases, and the evaluations made as part of the development process (Baskerville & Pries-Heje, 2019; vom Brocke et al., 2020; Winter & Aier, 2020). While design knowledge generated within the context of a research endeavour

may be fit for its intended purpose, its broader value to the problem domain depends on its projectability to other contexts (Baskerville & Pries-Heje, 2019).

In what follows, I discuss the projectability of the artefacts and the design principles produced as part of this research.

7.4.1. Projectability of artefacts

The potential of the artefacts developed as part of this research is demonstrated through two illustrative use cases. The two use cases were intentionally selected from business and public service domains to show the range of application of the ontology.

For application in other EA domains, such as transportation, health care, social services, or whole of government, specific capabilities and design features must be elicited from relevant stakeholders, experts, and documents. On the other hand, I only took up a single concern of each of the illustrative cases. For example, I zoomed in on green information technology to demonstrate the ontology's potential in enhancing the ecological sustainability of HEIs. Consequently, the ontology's potential remains to be explored in addressing other higher education concerns. For example, the HuCEAOn may be extended to account for such capability concerns of HEI students as accessibility and inclusion, on-time completion of programmes, gainful employment after graduation, or managing capability-limiting student loans. Diverse use cases for the ontology can also be explored in the banking and finance domain.

In the business sector, competing interests are prevalent, and the application of the HCA is often limited. Hence, the projectability of the artifacts to other business domains, beyond those outlined in the illustrative use case, could be constrained by the power dynamics in the domain of interest. Initiating awareness-building efforts within the domain may be a more pressing priority. Conducting a risk assessment prior to deploying the artifact may also pave the way to its successful implementation.

In passing I must emphasise that the scalability of the capability elicitation method is a critical requirement when moving to broader contexts of use.

7.4.2. Projectability of Design Principles

DP-1: Consider the composition of the user base

The HuCEAOn is projected to have utility in broader contexts of information system development. However, in the usefulness and usability assessment, I noted that the evaluators, despite their advanced academic credentials, have little or no appreciation of human capability concepts. This limits the knowledge sharing and collaboration utility of the ontology artefact. Hence, in order to project the principles in wider contexts, one may need to enlighten stakeholders about the potentials of the conception.

Furthermore, in a situation where knowledge and expertise are limited, it is imperative to provide the ontology with an intuitive user interface for efficient deployment and sustainable use. Enabling online accessibility of the ontology could also facilitate enrichment in contexts where the utilization of OWL technologies is viable.

In general, an epistemology cognizant of the diversity of stakeholders and their equally diverse needs and desires is appropriate. Pragmatic application of multidisciplinary and multimethod approaches is encouraged to apprehend the true nature of the practical, functional, and applicable knowledge we seek.

DP-2: Apply human capability concepts

Human capability informed ecosystemic EA design creates shared values among stakeholders. Human capability themes and concepts should inform the design and evaluation of EA components. This principle applies broadly, except in rare cases where solely technical factors are paramount, emphasizing the importance of human-centric approaches in situations requiring value orientation.

The synergistic holism derived from the synthesis of stakeholder-centric and capabilities-promoting sociotechnical systems approaches prioritises the well-being of humans in their relationship to the ecosystem. The HuCEAOn may thus be integrated into information systems, including web portals, knowledge management systems, enterprise software, and project management practices, all aimed at serving humanity in synergy with the natural ecosystem.

DP-3: Foster Democratic Dialogue

This research has relied on documents and expert knowledge to craft the artifacts, reflecting pragmatic choices given the artifacts' limited scope and functionality. Yet, to extend its applicability across a broader problem domain, the ontology needs to be augmented with a comprehensive knowledge base, achieved through stakeholder engagement alongside the utilization of extensive document collections and expert involvement.

In the ecosystemic view of sociotechnical systems design, the quality of the end product is dependent on the quality of the process of design. While expert knowledge and machine learning techniques offer efficiency and scalability, they cannot substitute for the precise capability requirements articulated by domain stakeholders. As van Eijnatten (1993) noted, democratic dialogue connects language and practice through everyday vocabulary. Therefore, it is recommended to identify human capabilities using collaborative and democratic approaches. Assessing the ontology in a broader context, involving a diverse range of experts and stakeholders, may be crucial for enhancing the applicability of this principle.

DP-4: Reuse

In information systems, reuse stands as a generic design principle that readily projects to various contexts. The possibility of extending the ontology is demonstrated through the reuse of the UNSDG ontology. By leveraging other domain-specific or task-specific ontologies, HuCEAOn can be enhanced to cater to wider contexts.

7.5. Conclusions

The conclusions of the research are summarised under each of the research questions posed in Chapter 1 and reproduced here. The answers to these four sub-questions aggregate into a comprehensive response to the core research question: "**how can we model a human capabilities ontology that would support EA practice?"**

SQ-1. What roles do human capabilities play in EA?

The first research question was aimed at revealing the current state of human capabilities understanding in EA. This knowledge question was answered through the review of the relevant literature. Using concept analysis and systematic literature reviews, I

attempted to address the question systematically by forwarding five propositions and arguing for the fundamental role that human capabilities should play in EA research and professional practice.

- *In the extant EA literature, the relevance of human capabilities to EA research and practice is not directly recognized as yet. In other words, the EA literature has not yet given human values and human capabilities the place they deserve in EA design. However, the centrality of human values to enterprise design is widely acknowledged both in the EA literature and associated practices such as organisational design, architecture, technology design, and sustainability. Enterprise information system design that is reoriented toward the humanization of the enterprise, sustainability thinking, and the affordance of meaningful work that puts human capabilities front and centre will be the future of conscious EA.*

SQ-2. What human capabilities should EA practice account for?

The second research question sought to create a synthesis framework of human capability themes applicable in the EA domain by identifying pertinent human capabilities. Through concept analysis of the domain literature and synthesis of pertinent theoretical frameworks, the question, which had both descriptive and prescriptive purposes, was addressed.

- *Notwithstanding the possibility of having a more fine-grained classification, EA practice must account for five high-level themes of human capabilities. The physical well-being capabilities represent all those aspects of human health and safety such as enjoying good quality of life, low levels of stress, and freedom from intrusion in their bodily integrity. The sense, imagination, thought, and practical reason capabilities allow humans to be able to use their faculties to experience the world and guide their actions. Humans require social capabilities to live in harmony with themselves and the society. On the other hand, the politico-economic capabilities relate to people's need to freely engage in productive political and economic activities for personal and societal flourishing. The sustainable-ecological capabilities define the relationships between humans and their natural environment, which impact both current and future generations of humans and other species.*

SQ-3. How can we support EA practice by designing a human capabilities ontology?

This is a *how* question mainly addressed by designing a human capabilities ontology relevant to EA research and practice. The research that went into the design was based on literature and document reviews.

- *A human capabilities ontology provides a dynamic representation of the human capabilities that need to form a common understanding among professionals and researchers. Design of an artefact such as a human capabilities ontology demands the full engagement of both the designers and the users, all sharing each other's space. From a process perspective, the ideal scenario is to elicit capabilities through the long-term engagement of concerned communities. Where purpose and logistics are major limiting factors, as in this research undertaking, using established knowledge sources such as the UN Capabilities Index or scholarly publications yields a satisfactory result. Furthermore, it is crucial to remember the value of incremental development, which allows for the enhancement of early versions of an artefact by adding missing features or processes.*

SQ-4. Is the ontology of human capabilities usable and useful for enterprise architects and information systems practitioners?

This knowledge question was answered by assessing expert opinions on the relevance and usability of the HuCEAOn through questionnaires and interviews. The assessment was preceded by a multi-dimensional evaluation process.

- *The HuCEAOn is valid by design since it was developed following the DSR approach and the CQs guided the ontology construction. Based on the assessment survey that was completed, I also concluded that the ontology is semantically plausible and readily usable by an expert user.*

7.6. Originality and Contributions

A DSR project is expected to produce design knowledge, which may manifest as explanatory, descriptive, or predictive Omega knowledge, alongside prescriptive Lambda knowledge (Gregor and Hevner, 2013). Such design knowledge constitutes not only a delineation of the problem space but also a comprehensive presentation of the proposed solution (Venable, 2006; vom Brocke et al., 2020; vom Brocke & Maedche, 2019). In the problem space, it is imperative to define the purpose, scope, and meta-requirements. In the solution space, on the other hand, the proposed solution must be outlined through design

entities, such as constructs, models, methods and instantiations, as well as design theories, which encapsulate the insights amassed during the evolution of the design entities (Drechsler & Hevner, 2018; Vaishnavi & Kuechler, 2008; vom Brocke et al., 2020).

In this thesis, I introduced a computational ontology of human capabilities tailored for the EA domain. The ontology was founded on a human capability framework made-up of capability themes drawn from several established frameworks. The artefact was developed using a formal modelling approach and underwent both technical and empirical evaluations.

In conducting this research, my goal was to inject human capabilities conception into EA research and practice. It is my hope that the entire research process—the problem domain knowledge, the solution description, as well as the evaluation knowledge—may make a valuable addition to scientific method as a whole. While Table 31 summarises the contributions of this research to design knowledge, the subsequent subsections portray how this thesis is expected to advance the state of knowledge and practice in the fields of EA, information systems, and HCA.

Table 31
Summary of contributions to design theory

Component	Contributions
Purpose and scope	The purpose of the artefacts is described. Meta-requirements in the form of competence questions are specified to guide the design of the ontology.
Constructs	A catalogue of human capability concepts or constructs relevant for the EA domain is provided. These concepts, organized into a formal ontology, facilitate collaboration and ensure consistency (S. T. March & Smith, 1995; Niederman & March, 2012). The relationships among these constructs form models that serve as descriptions of both the problem domain and its solutions (S. T. March & Smith, 1995; Niederman & March, 2012).
Principles of form and function	A synthesis framework of human capabilities, which laid the groundwork for the development of the HuCEAOn, is described. Additionally, the process of designing, coding, and evaluating the ontology, along with the ontology's features, is outlined.
Artefact mutability	The projectability of the artefact is described. Recommendations for enhancing the artefact are provided.

Component	Contributions
Justificatory knowledge	The research is based on established theories, frameworks, and design theories. Sociotechnical systems theory, stakeholder theory, and the HCA are employed to justify the design of the ontology (refer to Figure 8 for a graphic summary).
Principles of implementation	The research process, structured within DSR approach, is described in terms of specific methods of executing key research activities. This includes defining the problem statement, designing the synthetic framework, identifying concepts, constructing and populating the ontology, and evaluating the ontology. Principles for eliciting capabilities, as well as using and extending the ontology are distilled. Additionally, the projection of the artefacts in possible worlds is outlined.
Exposition of instantiations	The synthesis framework is instantiated as a computational ontology in the OWL language. This instantiation is output knowledge**,** which encapsulates the ontology artefact as well as knowledge from its evaluation.

7.6.1. Understanding the Problem Domain

According to vom Brocke & Maedche (2019), one of the contributions of a DSR project is the description of the problem domain. Similarly, Gregor & Jones (2007) identified the statement of purpose and scope as an essential component of design theory. In this thesis, I have provided a detailed account of the problem space by laying out the rationale of the research undertaking, exposition of the research context, and definition of the meta-requirements. One of the contributions of this research is characterization of EA, its stakeholders, and disparate perspectives that come together to paint a holistic, ecosystemic picture of the domain.

In line with Orlikowski & Barley (2001), I made an effort to understand the complex interaction between the enterprise structure, business, technology, and human capabilities. The main benefit of such intersectionality is the unique ontological and epistemological perspective it permits, which neither of the research domains could afford independently. As Orlikowski & Barley (2001) argued, this kind of hybridization results in a synthesis of concepts and methods "that fuse accounts of human agency, material constraints/affordances, and institutional dynamics into richer explanations of techno-social change" (p 159).

To the best of the researcher's knowledge, this is the first attempt to develop a human capabilities ontology in the EA domain. Although previous studies investigated human capabilities in the context of ICT4D, technology design, and business governance, this is possibly the first attempt to look into human capabilities in EA. By identifying the pertinent literature and theories, highlighting the research gaps, emphasizing the key concepts and their relationships, and investigating potential research paradigms and methodologies, this study contributes to future explanatory and design research.

7.6.2. EA and Information Systems Theory and Knowledge

Since much of the effort has thus far been focused on reinforcing EA praxis rather than on building the theoretical foundation, the strengthening of EA's theoretical foundation is identified as a worthwhile endeavour (Lapalme et al., 2016).

Researchers in the fields of EA and information systems, in particular those concerned with the dearth of literature about a holistic approach to EA, may find this work illuminating. An aspect of EA theory that is gaining traction is the drive towards holism and the question of elevating EA to a platform of sustainability (Lapalme et al., 2016; Sutherland & Hovorka, 2014). Although EA has historically been primarily viewed as a technical domain, there is a growing recognition of the importance of the social aspect for the successful implementation of EA (Nuryatno & Dobson, 2015). The trend toward a holistic conceptualisation of EA is acknowledged by the Federation of Enterprise Architecture Professional Organizations (FEAPO), among others (Lapalme et al., 2016).

Researchers may also find instructive the fact that this research took a sociotechnical stance, positioning EA at the confluence of the enterprise, its ecosystem, and technology. There are compelling arguments for such a holistic treatment of EA. To begin, EA is predicated on the concept of the enterprise, which may be seen as a sociotechnical system (Kloeckner & Birkmeier, 2010). Despite the numerous contributions of various scientific management theories, organisations and their governance cannot be explained solely through the use of engineering theories, techniques, and tools (Bolman & Deal, 2017). Secondly, technology is implemented in a social context (Brey & Søraker, 2009). Even when technology operates autonomously, as in self-driving cars, its application and consequences cannot escape social scrutiny. Though EA researchers have attempted to cover more ground

by investigating EA through the lens of economic, environmental, and social sustainability, there is still room for improvement in addressing the *individual problem* (Bernus et al., 2016; Lapalme et al., 2016). That is, examining human capability requires looking at both the individual's capability, which is grounded in atomistic anthropology, and relational capability, which looks at humans in their economic, social, and ecological contexts (Renouard, 2011).

An ontology is considered as "content theory" (Chandrasekaran et al., 1999, p. 20) or "taxonomic theory" (Larkins & McKinney, 1980, p. 13). Further, Akkermans & Gordijn, (2006) indicated that taking such content theory "really seriously as first-class citizens … will actually increase the contribution of ontology engineering to the development of scientific method in general" (p. 112). Hence, the design knowledge generated through this research is anticipated to have broader implications for information systems.

7.6.3. EA Practice

According to one of the relevance criteria put forth by Benbasat & Zmud (1999), information systems research must address problems and issues that are currently of essence to information system practitioners. By providing a thorough description of the problem space and developing design artifacts, this thesis is anticipated to inject more innovation into EA practice.

According to Gartner's emergent architecture principles, stakeholders are becoming more *goal-oriented*, aiming to advance their interests without necessarily prevailing over organisational objectives (FirstPost, 2009; J. Morgan, 2014). They also becoming *rule-bound,* preferring to operate flexibly within the constraints of a minimal rule set (FirstPost, 2009; J. Morgan, 2014). In this research, the individual takes centre stage in EA design, emphasising their agency and choices. I emphasise that individuals pursue their own goals alongside organisational or social goals. This is a transformative view in that the individual is often considered as a mere user or operator of systems, and their role in architectural design is confined to their formal roles within the organisation.

Benbasat & Zmud (1999) called for information systems research to yield artefacts or, in the case of empirical research, implications that can be readily put into effect in order

to solve a current problem. The primary contributions of this research are the human capabilities for EA framework and ontology that may be used to guide EA practice and research. The HuCEAOn is a mechanism of dynamic adaptation which could allow practitioners align systems to the ever-changing needs of their stakeholders (Peristeras & Tarabanis, 2004).

The HuCEAOn creates a conceptual model of the real world and a shared understanding of a knowledge domain among EA practitioners (Shanks et al., 2003; Tudorache, 2020). Software may use the ontology to answer questions, interoperate with other systems, and reuse knowledge bases (Gruber, 2009; Lehmann & Voelker, 2014). As a component part of a larger system, the ontology may also be used to integrate, filter, and present information (Milton, 2008). To ensure the adoption and adherence to principles, rules, and guidelines that prioritize human capabilities in EA design, the HuCEAOn could prove beneficial (Leenheer, 2009). It may also be used as an instrument for participation and collaboration in the design and construction of EAs.

The principles of form and function generated, along with methods of procedure employed in this research, could provide guidance for designing other ontologies within the broader information systems domain. Furthermore, the concepts and themes identified could contribute to the management of organizational knowledge. For instance, the ontology could be used in the design of repositories that effectively categorize documents and organizational communications. Similarly, it may help catalogue organizational initiatives.

Contemporary technological, sociological, psychological, and organisational progress suggests that the future will see massive transformations in the form of advances in technologies as well as in human consciousness. There is a growing understanding that enterprises, in principle, can and should be ethical, resulting in what Mackey & Sisodia (2014) referred to as *win*^{6}, which is a collective win for investors, employees, customers, suppliers, society, and the natural environment. By providing a better understanding the relevant concepts and relationships, this research promotes human capabilities-conscious practices in EA. By applying the HCA, I demonstrated how enterprises can implement EA that takes into account not only economic, social, and environmental factors, but also the human capabilities of stakeholders. Drawing inspiration from Mackey & Sisodia (2014), I

dubbed the new EA, founded on these tenets, as *conscious EA*. The *conscious EA* is a logical extension of the *enterprise ecological adaptation* school of Lapalme (2012).

7.6.4. HCA Literature

The capabilities approach has been applied more often in national development settings than in business settings. In this study, I attempted to disentangle the HCA from the existing developmental approach and demonstrate its potential applications in corporate and public EA planning. This was accomplished by demonstrating how the HCA is consistent with the notions of CSR and business ethics. By exploring a new territory for its application, this research opens up research opportunities for the HCA in the business setting. Furthermore, it shows how information systems theories like stakeholder and sociotechnical systems theories can help to bolster the HCA, particularly in enterprise information systems research.

7.7. Limitations

The following are some of the limitations of the thesis, suggesting potential avenues for further investigation.

- Human capabilities are under-researched in the context of EA. Perhaps mine is the pioneering effort to bring the concept to the fore. For that reason, the discovery of relevant literatures, articulation of the problem(s), clarification of concepts, and formulation of tentative hypothesis consumed a substantial amount of time and effort, which might have interfered with the full implementation and extensive evaluation of the ontology artefact.
- Human capabilities are defined as those doings and beings that people value and have reason to value. My research focused on determining the capabilities people find valuable. Teasing out the rationale for valuing the capabilities is a key component of the definition, but it fell outside the purview of my research.
- I only made modest claims with regard to the epistemological and scope questions brought up in design for well-being research (Brey, 2015; Van de Poel, 2012). My research focused on identifying EA stakeholders, understanding their capability concerns, creating a computational ontology of these capabilities, and devising a strategy to accomplish these goals. Even though an attempt has been made to assess

the useability and usefulness of the ontology, conducting a complete accounting of the kinds and duration of the outcomes of the design was outside the scope of this research.

- In continuance of the previously mentioned limitation, I attempted to partially address the other two design concerns, aggregation and specification. A tentative solution to the specification problem, which asks how to translate well-being values into design specifications, was offered using the capability hierarchy depicted in Figure 18. On the other hand, the aggregation problem, which deals with how different, perhaps may be conflicting, well-being values can be accounted in a single design, was left unanswered.
- While human capabilities were considered along with sustainability challenges, the scope of this research was limited to sustainability topics that could be further explored through human capabilities. The thesis falls short in covering the whole gamut of sustainability-related issues, which might have to wait for additional research.
- The HuCEAOn only addressed a part of the complex problem of embedding human capabilities into EA practice. In its current iteration, it can be considered as a minimum viable product that was prototyped to show the potentials of the model. As the first attempt in embedding human capabilities thinking in EA, the HuCEAOn could contribute towards the better diffusion of the concept in the domain and may form a solid base for the development of more complete ontologies. Further iterations may address specific EA processes and aspects, including the organisation and its business, application, data, technology, security, and governance architectures.
- Although the HCA literature typically advocates for employing democratic community engagement to identify capability concerns pertinent to a specific stakeholder group, due to practical constraints, I solely relied on existing literature and organizational documents.
- The case studies developed to illustrate the relevance of the ontology were drawn from organisations within a single country, Ethiopia. Similarly, due to practical

constraints, the experts tasked with assessing the ontology's usefulness and usability were based in Ethiopia, which could limit the research's generalisability.

- Due to logistical factors, only sic experts were engaged in assessing the ontology. Generally speaking, a larger sample size might have yielded a different outcome than was obtained and might have strengthened the validity of the assessment.
- In-depth user requirement gathering, more rigorous assessment of the HuCEAOn, and easily accessible training and documentation would have enhanced the usability of the ontology in actual organizational practice.
- The absence of comparable studies made it difficult to juxtapose this research's output with the existing literature.

7.8. Recommendations

In light of research's anticipated contributions and acknowledged limitations, I forward the following recommendations.

7.8.1. Directions for further research

- This research covered a broad spectrum of topics to gain a better understanding and delineation of the problem space. Further descriptive, explanatory, and prescriptive research is needed to delve deeper into the specific areas highlighted in this study. For instance, delving into specific design principles, such as those pertaining to data architecture or business architecture, could yield more comprehensive and valuable insights. Similarly, concentrating on one or two stakeholder groups within a particular industry and conducting more detailed investigations may aid in the development of task-specific ontologies.
- As Brey (2015) suggests, capabilities are "decontextualized phenomena," which means that understanding the particular context and individual characteristics is as much a challenge as identifying the capabilities themselves (p. 375). While I was preoccupied with identifying valuable capabilities in the context of EA, I neglected to elicit the rationale for valuing the capabilities. Psycho-social investigations that involve individual stakeholders within a particular context might be required to uncover their justifications for valuing their list of capability (Austin, 2020). A more

thorough examination of similar other conversion factors, which influence how resources—such as technology—give shape to capabilities, may be required.

- The synthesis framework might require further application, critique, and refinement. For instance, as my background and biases may have influenced the synthesis process, researchers may introduce fresh perspectives to enhance it, particularly in the context of EA or information systems work in general. Further, determining the optimal number of capability themes applied in thematic coding of documents needs more work. While I endeavoured to determine an ideal number fit for my task, arriving at the optimal number of capability themes is contingent upon a continuous process of engaging with both human and documentary sources.
- Gray and scholarly literature were consulted and thematically coded in order to identify relevant concepts for populating the ontology. In contrast, Senian HCA places a strong focus on the participatory element of the capabilities articulation process. One avenue of research may be to look into potential deliberative methods for eliciting capabilities from EA stakeholders and experts. A second strand could involve identifying remaining concepts, refining those that have already been coded, and developing a fine-grained ontology through a stakeholder-driven process of deliberation.
- The thematic coding approach I employed to populate the ontology, while effective for academic purposes, may not be scalable in practical settings. Alternatively, one could consider populating the ontology from extensive text corpora using data mining techniques. This approach holds promise, especially given the increasing popularity of data-driven machine learning methods in other fields. It would be fascinating to compare the results of machine learning techniques with the methods I employed, as well as those mandated by Senian and socio-technical democratic approaches.
- In terms of describing the design space comprehensively, I only managed to provide a provisional and incomplete solution for the specification problem. Recognizing that capabilities might be overly abstract to provide adequate direction for design, future investigations could expand upon Jacobs (2020) or comparable methodologies to explore ways of bridging the divide between capabilities and

design requirements. Additional research is also imperative to address the aggregation issue, which revolves around determining whether a capability design yields a net positive or negative impact on well-being, as well as how to navigate trade-offs between two or more competing capabilities.

- A core element of DSR is a set of form and function principles that delineate the kinds of design solutions capable of fostering human capabilities. For example, studies of user profiles may help align design principles of shape, colour, and material with emotions. By the same token, further research on design principles is necessary in order to identify the kinds of technologies that could promote improved communication between educators and students. This may provide a more effective solution to the specification problem, but that is a task left for future research.
- As indicated in the limitations section, this thesis did not fully address the entire spectrum of sustainability-related issues. I recognize the complexity and depth inherent in the broader sustainability discourse, which may necessitate additional investigations. Future research endeavours could delve deeper into exploring the various dimensions of sustainability, investigating their interconnectedness, and examining the trade-offs involved.to provide a more comprehensive understanding in the context of EA.
- Expanding the research's sample size and enlisting experts from diverse countries could enhance its generalizability. For instance, addressing a challenge faced by experts assessing the HuCEAOn—namely, their unfamiliarity with the concept itself—can be tackled by including more knowledgeable individuals in the assessment process through a broader sampling frame. Furthermore, enhancing the projectability of the artifact could be achieved by developing additional usage scenarios.
- Combining the HCA with insights drawn from other approaches like Value-Sensitive Design (VSD), Emotional Design, and Life-Based Design could offer valuable contributions to EA research and practice.

7.8.2. Recommendations for Practice

- The ontology may give rise to specialized ontologies for certain use cases and elements like business, application, data, technology, security, and governance architectures. The complete specification and representation of the ontology, with all the relevant concepts and relationships is also still outstanding.
- Before the ontology can be employed in an organizational practice, more extensive user requirement gathering, rigorous evaluation and assessment, easily accessible training and documentation, as well as detailed human and technical risk assessment are needed (Venable et al., 2016). The proposed design principles could aid in effectively deploying, using, and expanding the ontology.
- HuCEAOn's concepts and relationships, which can be expressed as requirements and principles, may be used to reinforce EA design methodologies and frameworks with human values. Embedding the HuCEAOn into other ontologies, software tools, and services has the potential to yield field-based data for enhancement of the ontology, while also fostering positive changes in the workplace.
- Senian HCA is contingent on sustained democratic dialogue. Utilizing the ontology concepts can bolster the process aspect of capability design by instigating democratic dialogues regarding capabilities and well-being design features within the sociotechnical systems design tradition.
- The principles of form and function, along with the methodologies employed in this research, can serve as a blueprint for designing ontologies in other domains. Moreover, the concepts and themes identified may aid in organizing concepts and initiatives, such as in the development of repositories aimed at effectively categorizing documents and online communications. The potential for expanding the HuCEAOn through the integration of existing ontologies was exemplified by incorporating an open-access sustainability ontology. By leveraging other ontologies, such as those reviewed in Section 6.3, the HuCEAOn could further extend its scope. Although not within the thesis's scope, alignment with meta-ontologies would have augmented the endeavour.
- The aggregation and specification problems of capability design are best left to practitioners and other researchers due to the formers' context-specific nature,

which varies case to case, from domain to domain, and from stakeholder group to stakeholder group. As design is often guided by "tacit understanding and rules of thumb that are specific to local situations and technological configurations" practitioners may contribute to design process in an efficient manner compared to empirical studies (P. Nightingale, 2009, p. 366). Hence, practitioners and practitioner-researchers who are intent on conducting action research may be able to provide new perspectives to the processes of capability elicitation, aggregation, trade-off, and conflict resolution. For instance, practitioners may resolve conflicts of capability interests within a community through innovative communication and decision-making processes that reflect the ethical and political dimensions of human capability.

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Appendix A. Ontology Assessment Instruments

A.1. Ontology Usability Matrix

Ontology Usability Questions (Semantics and pragmatics only)	Highly disagree (1)	Disagree (2)	Indifferent (3)	Agree (4)	Highly Agree (5)
1. The purpose of the ontology was clear.					
2. I am confident I understand the conceptualization of the ontology.					
3. I could understand the conceptualization of the ontology without asking a lot of questions.					
4. I found the ontology easy to understand.					
5. I do not need further theoretical support to be able to understand this ontology.					
6. I would imagine that most domain experts, particularly people involved in enterprise architecture, would understand this ontology very quickly.					
7. I do not need to learn any extra things before I could get going with this ontology.					
8. I found the ontology easy to use.					
9. I do not need the support of a person experienced with this ontology to be able to use it.					
10. I think that I could contribute to this ontology.					

A.2. Supplementary Interview Questions

Realist Context

1. Describe how you or your organisation embed, if at all, human values, and capabilities in EA efforts?

2. What structural (individual, group, or organisational unit) factors influenced your actions in reference to #1.

3. What individual, national, or organisational cultural factors influenced your actions in reference to #1.

4. Describe any observed events where people or groups acted to change the status quo to introduce human values consciousness in your organisation's EA planning.

5. Describe how your EA planning work is influenced by new tools and technique such as the ontology you are evaluating.

Appropriateness

How do you assess the appropriateness of the concepts and relationships provided by the ontology?

Completeness

How do you assess the completeness of the ontology? Are all pertinent concepts and relationships captured?

Interpretability

How do you assess the interpretability (ease of interpretation) of the concepts and relationships provided by the ontology?

Relevance

Is the ontology relevant to your work? Do you think it will improve or discourage enterprise architecture planning?

Appendix B: Sources used to populate the HuCEAOn

To populate the HuCEAOn, the following documents have been utilized, alongside the various scholarly publications referenced in the thesis, particularly highlighted in Section 4.5 as pertinent to the objective.

1. Archimate 3.2 specification. https://pubs.opengroup.org/architecture/archimate3-doc/

2. Bergh-Hoff, H., Sørensen, C.-F., Garshol, J. E., Jakobsen, B. H. M., Vangen, G. M., Pettersen, Ø. D., & Hansen, J. (2015). ICT Architecture Principles for the Norwegian Higher Education Sector. September 3, 2015. UNINNET. https://www.uninett.no/sites/default/files/ict_architectural_principles.pdf

3. The IFRS Foundation. Education Sustainability accounting standard Version 2023-12. Sustainability Industry Classification System (SICS) SV-ED. https://sasb.ifrs.org/standards/download/

4. ISO 26000 - Guidance on social responsibility (ISO, 2010).

5. UN Guiding principles on business and human rights. https://www.ohchr.org/sites/default/files/documents/publications/guidingprinciplesbusinesshr_en.pdf

6. UNDP (United Nations Development Programme). 2022. Human Development Report 2021-22: Uncertain Times, Unsettled Lives: Shaping our Future in a Transforming World. New York. https://hdr.undp.org/content/human-development-report-2021-22

7. University of Birmingham. 2014. Open enterprise architecture principles (version 0.1). https://www.dragon1.com/getDocument.ashx?doc=/sites/dragon1/documents/Enterprise-Architecture-Principles.pdf

8. United Nations Environment Programme Finance Initiative (2024). Driving impact on Financial Health and Inclusion of Individuals and Businesses: From setting targets to implementation. Geneva. https://www.unepfi.org/industries/banking/financial-health-inclusion-guidance/

Appendix C. Software Tools Used

Tool	Use
Qualitative Research and Referencing	
Herzing's Publish or Perish 8	Compile literature
Atlas.ti	Qualitative Analysis
Mendeley Desktop	Citation Management
Ontology Development	
MS Excel 365	Ontology concept organisation
Protégé 5.5	Ontology editor
Pellet	Ontological reasoner
OntoGraf	Ontology visualizer
VOWL	Ontology visualizer
Word-processing and Graphics	
MS Word 365	Typesetting
MS PowerPoint 365	Graphics
Lucid Chart	Graphics
Modelio 5.4	Graphics

Appendix D. Copyright Documentation

Ontology

UNSDG ontology by Michael DeBellis. Licensed under GNU General Public License v3.0. https://github.com/mdebellis/UNSDG. Accessed December 2022.

Images

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Appendix E. Ethical Clearance

The following ethical clearance certificates were issued by UNISA for the conduct of the research reported in this thesis.

1. ERC Reference #: 2021/CSET/SOC/013. Secondary Data Ethics Approval from 2021/05/14 for five years.
2. ERC Reference #: 2022/CSET/SOC/032. Humans involved Ethics Approval from 2022/09/09 to 2025/09/09.