Sustainable Architectural Design between Inscription and De-scription: The Case of Masdar City

A thesis submitted to the University of Manchester for the degree of Doctor of Philosophy (PhD) - Architecture in the Faculty of Humanities.

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Abstract

Name of University: University of Manchester
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Lay Abstract

The thesis aims to deconstruct the traditional dualities between design and use and blend the boundaries between them. It characterises design as a process that is complex, dynamic, and integral to other processes, such as use. The thesis utilises Latour's concept of the collective. Although this concept has been applied to architectural contexts in previous studies, this thesis expands the collective to include actors of use. The thesis elaborates on the inscription and description of technologies inspired by Akrich (1992). It shows how the collective is shaped and reshaped through such processes. Building parallels with previous studies, it analyses the importance of fluidity and fluid actors in de-scribing technologies and reshaping the collectives.

The thesis utilises the case of Masdar City, which has been designed in the UK by the architectural and urban planning firm Foster + Partners and implemented in the Middle East, specifically in the United Arab Emirates. The thesis focuses on its first developed stage represented by Masdar Institute of Science and Technology (MIST). Based on a qualitative and inductive approach, the conducted research utilises interviews and site observations with the designers, users, and other main contributors. Through this approach, the thesis reflects on the concept of sustainability that is itself contested, changeable, and vague.

The thesis concludes that sustainable design processes should be seen as continuous loops between design and use. In acknowledging this, it is further suggested that concepts such as the living laboratory, which support the adaptation of designs and learning from use, are adopted at the outset in architectural production.
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To my youngest child, Malak, who saw the world and decided to join me from her early days at the beginning of my journey.
Chapter 1: Introduction

1.1 Deconstructing the Dualities of Architectural Designs

This thesis explains the process of architectural design as it travels from the design studio to a particular context involving processes of inscription and de-scription. The study attempts to collapse distinctions between design and use as well as inscription and de-scription by presenting architectural production as a series of recursive learning processes and loops. In this way, the usage of the word “travel” addresses a design, or a technology, that proceeds through time and place in such continuous loops, which defies the linearity and steadiness of such processes. It reveals architectural production as complex and ongoing, producing unpredictable outcomes through which unanticipated futures emerge.

The thesis utilises Science and Technology Studies (STS), and more specifically the Actor Network Theory (ANT) scholarship of Callon (1980, 1986, 1987, 1991), Latour (1986, 1987, 1993, 1996, 2004, 2005), Law (1987, 1992, 2003, 2007), Law and Callon (1988), Law and Mol (2001), and Murdoch (1997, 1998), to develop an understanding of designs and technologies that are not attributed to a single actor nor shaped in a singular, straightforward, and detached manner. On the contrary, designs and technologies involve actor-networks or collectives that evolve in more complex ways. Whether or not the actors and contexts are integrated in the design, they ultimately contribute to the collective that grows and keeps growing as the design is received, adapted, or appropriated. Of interest here is the fact that non-human actors have equal roles and effects as human actors as they similarly contribute as part of the actors of design and use. The thesis goes further to show how the contributions of the actors of use might feed back to the actors of design, who might reshape it to be reused in a continuous loop. Designs and
technologies are then co-produced through such loops of interactions. The study focuses on such process by providing a closer inspection of the interactions between design and use. It also uncovers the hidden realities that are embedded within such interactions. This approach does not view architectural design as end product or final outcome. Rather, it views design as emergent. In other words, architectural designs are not static and the contexts where they are applied are not passive receivers. Rather, architectural designs affect and become affected by the different contexts where they are situated.

1.2 Uncovering the Travel of Architectural Designs through a Case of Sustainability

The selected case is Masdar City, which has been designed by the architectural and urban planning firm Foster + Partners in the UK (F+P) and implemented in the Middle East, more particularly in the United Arab Emirates. It is a globally renowned example of sustainable urban master plan that supports research and application of technological breakthroughs and innovations. The project is still being implemented and provides an opportunity to follow design processes in the making. Within such a case study, emphasis is given to Masdar Institute of Science and Technology (MIST), featuring its first stage and representing its core pillar.

The thesis utilises a case study of a sustainable project, which in itself appears to be of interest and relevance being connected to sustainability as a concept tackled by authors such as Adams (2001), Frampton and Moore (2001), Guy, (2005, 2009, 2010), Guy and Framer (2000, 2001, 2007), Guy and Marvin (1999), Guy and Moore (2005), Moore (2001), Pepper (1996, 2000), Redclift (1984, 1992, 2005), Williams (2010), Williams and Millington (2004), and Williamson and colleagues (2003). Sustainability is viewed through a technological lens in the field of architecture and urbanism. Through such a lens, sustainability focuses on efficiency in matter,
energy, and space, utilizing building science as a main approach and emphasizing physical attributes and their applications on buildings. Such analyses attempt to document the extent to which buildings and cities are, or are not, sustainable through the use of realistic interpretations, numerical conceptions, and indicators of footprints, flows, and other values. It also relies on best practices as standardised, global, and exchangeable strategies or guidelines that direct sustainable designs and technologies along a specific set or predefined developmental path towards a particular end goal.

This focus on efficiency and best practices implies directness, stability, and predictability of the sustainability concept. However, the concept reveals itself as complex and contested, ultimately linking to other perspectives and providing different areas of emphasis. It is fuzzy and flexible to adapt to such shifts and changes. It is also unclear and open to multiple ways of understanding that are hard to predict.

Another particularity of the case is that it falls under the eco-cities phenomenon, which is a particular strand of sustainable architecture and urbanism studied by authors such as Cugurullo, (2013), Joss (2009, 2011), Joss and Molella (2013), Rapoport and Vernay (2011), Register (1987), and Roseland (1997). Eco-cities are distinguished from other sustainable cities and characterised by specific aspects as they are of substantial scale, materializing across multiple sectors, and supported by policy and processes. In addition, eco-cities are highly reliant on technologies to realise environmentally-friendly and economically-acceptable designs. It is based on efficiency that takes the form of various solutions and aims. Another aspect distinguishing eco-cities is their reliance on best practice and, at the same time, their aspiration to deliver models and exemplars for architectural and urban sustainability to achieve their returns and benefits at both the local and global scales. They are then vehicles of travelling designs and
technologies sweeping to vast areas of the world in a relatively short period of time. This places eco-cities in an important position within modern architectural and urban sustainability agendas, which highlights the need for further exploration of their concept.

Although they tend to be defined by specific parameters, eco-cities continue to exhibit diversity, adaptability, and vagueness. This becomes clearer following the different stages through which such phenomenon has developed from a normative term to a further standardised and regulated notion, where each of these stages has its own impact. This is evident in different types of eco-cities, from changing or expanding existing towns to building new ones. In this way, eco-cities are connected to a diversity of meanings and applications representing complex ideas that cannot be represented by a single perspective. This is due to the spread of the concept, the different meanings associated with it, and the variety of projects adopting this label.

The case study makes new connections between the discourses on STS, ANT, sustainable architecture, and eco-cities. It provides a specific contribution by exploring the travel of designs and technologies as it relates to a sustainable project of an eco-city. The study reflects on how sustainable architecture and urbanism, embedded in such eco-cities, transform and change as they move between the conceptual debates to actual application. They change their main intentions as focused on technological aspects emphasizing efficiency and best practices and viewing other aspects from such angle within the prepared drawings, models, and diagrams to debate what appears to be different when it comes to real experiences. Such shifts create designs and technologies that are not the same at the beginning of the process and feed back into their relevant concepts.
1.3 Exploring the Travel of Sustainable Architectural Designs

The main aim here is to provide an understanding of the sustainable architectural designs and technologies as well as their travel from where they are initiated or designed to where they are implemented or used or from where they are inscribed to where they are de-scribed by embracing the inherent contestation, dynamism, and unpredictability. Because the thesis is centered on a case study of sustainable architecture and urbanism, it also reflects on the sustainability as a concept that is in itself complex, changeable, and vague. It views sustainable architectural design as not pre-set or determined but negotiated through the ongoing conflicts over design and use.

The objective of the thesis is to follow sustainable architectural designs and technologies from where they are conceptualised or inscribed in the hands of the designers to where they are situated, contextualised, and implemented or de-scribed in the hands of users. In other words, it traces the designs and technologies as they proceed from their intentions, assumptions, and imaginations to different modes of use, inhabitation, and adaptation that sometimes contest these designs and technologies by changing them in a variety of unexpected ways.

Through this process the thesis considers how the dualities between design and use can be deconstructed and how the process of design can be explored through the lens of the collectives that are reshaped between inscription and de-scription processes. Specifically, the thesis addresses the following research questions:

- How can sustainable architectural designs be explained and understood as collectives?
- How do sustainable architectural designs proceed from design to use, or between inscription and description?
What does this tell us about sustainable design processes?

To meet such aims and objectives and to answer these questions, the thesis is structured in seven chapters. The second chapter establishes the theoretical framework to interpret the travel of technologies from design to use or from where they are initiated to where they are implemented. It shows that technologies do not merely land, remain stagnant, and stop evolving because their travel is continuous, feeding back into multiple sources including where they were shaped and created. Of particular focus in this chapter is the concept of the living lab that reflects on the co-production of design between where it is initiated and where it is implemented, while involving the collective of actors including users. Through such interaction, the design is implemented, tested, and then refined to be implemented and tested again within an ongoing learning loop.

The third chapter describes the methodology and clarifies the research methods employed to answer the research questions. The case study methodology is inspired by ANT to follow the travel of designs and technologies. The chapter describes the methods of data collection and analysis based on the case study methodology and explains the structure of the subsequent empirical chapters.

The fourth chapter provides a bridge between the theoretical framework and the empirical findings. It summarises how sustainability is inscribed in the master plan of Masdar City, including its main factors and key aspects that relate to specific project aims and targets. Of particular interest is the inclusion of the living lab concept in the original project conception. Although presented as a living lab, Masdar City is revealed to be a more conventional urban laboratory that tests and refines technologies rather than promoting iterative design involving
user input. This chapter provides a foundation to follow the travel from of technologies from
design and development to real use in the following two chapters.

The fifth chapter represents an external narrative to describe the inscription and decription of
sustainability in the mobility network in Masdar City. It uses the Personal Rapid Transit (PRT)
as a point of departure. The sixth chapter represents an internal narrative to describe the
inscription and decription of technologies in household spaces in Masdar City with a particular
focus on lighting strategies. The two chapters present two different examples of the interaction of
design and use and the gradual evolution of the utilised living lab through such interactions. In
other words, what has been originally an urban laboratory slowly transforms into a living lab
through its specific ways of implementing, testing, and refining designs in particular stages and
re-implementing and retesting them again to be refined in later stages. Such change has its
impact on the designs themselves. Addressing sustainable designs in particular, it also provides
its potential reflection on the sustainability concept that is no more the same as the beginning of
such processes.

The seventh chapter provides the conclusion of the thesis. It explains the main contributions and
key findings of the research with respect to the theoretical framework as applied to empirical
findings. It suggests how the study findings could be utilised in future architectural production
activities by embracing notions of co-production and living laboratories. In conclusion, the thesis
argues that sustainable architectural designs should be seen as complex, dynamic, and
unpredictable and societies and contexts where the designs proceed as heterogeneous with
localised specific needs and expectations. They should be dealt with from the start in accordance
with such considerations. It also argues that the process of travel of sustainable architectural
designs should be explicitly considered. The designs should be followed and traced to provide feedback loops from the beginning of the design process to inform further stages and projects.
Chapter 2: Architectural Designs and the Travel of Technologies

2.1 Introduction

This chapter tackles the process through which technology travels from the lab to reality or from design to use. For that purpose, I\(^1\) consider the lab as the design studio or practice, where new designs are trialled, including the variety of technologies they have, and new concepts are generated in relation to such technologies. Although I problematise this distinction between lab and reality as well as design and use, I start with such simplified design trajectory so that I show later how such distinction collapses and the boundaries between them are blurred, where designs and technologies are a product of recursive learning processes and loops. In this way, and when I utilise the word “travel”, I address a design or a technology that proceeds through time and place from where it is initiated to where it is implemented. Such technology might go further beyond that to feed back into multiple sources, including the ones that witnessed its creation and shaping. The process is then continuous, where technology does not land, remain stagnant, or stop evolving.


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\(^1\) Inspired by authors who have undertaken site observations and ethnographic studies such as Houdart (2008) and Yaneva (2009). I use the first person through some passages of the thesis (Sections 3.5, 3.6, and 3.9, for example) to reflect such engagement with the research and to engage the reader. Further to these aims, I also present some “stories” from my ethnographic observations (Sections 5.2, 6.6, and 7.1).
architectural designs. It accordingly utilises the same approaches in the first part to explain such travel and draws on the work of Houdart (2008), Loukissas (2012), and Yaneva (2009a,b,c, 2013), who are inspired by STS and have applied it within the architectural domain. This part also uses the literature on architecture and the user inspired by STS through the work of Brian (1994, cited in Yaneva and Guy, 2008) and Gieryn (2002) and the one inspired by architectural theory and history through the work of De Certeau (1984), Hill (2001, 2003), and Lefebvre (1991). The third part discusses how the design proceeds after it travels from lab to reality or from design to use. It introduces the living laboratory concept and draws on the work of Evans and Karvonen (2011), Konig and Evans (2013), McCormick and Kiss (2015), and Trencher and colleagues (2014a,b) to show how reality and use can feed back into the lab or design. The chapter concludes with the contribution of the research, where the travel of design is mutable, convertible, and changeable through its continuous interaction.

2.2 From the Lab to Reality


Technologies as Collective Achievements

There are two models of power on how technologies proceed through time and place. Latour explains:
A diffusion model of power in which a successful command moves under an impetus given to it from a central source is contrasted with the translation model in which such a command, if it is successful, results from the actions of a chain of agents, each of whom “translates” it in accordance with his/her own projects (Latour, 1986, p. 264).

In other words, he presents the movement or displacement of a command or a technology through the diffusion model as direct and reliant on its own qualities in its singular form. With the translation model, such movement or displacement is more complex and connected to other aspects, which are interlinked with a technology that is no more single.

Akrich and colleagues (2002a) provide a further critique of the diffusion model and debunk its linearity and directness, where technology evolves and spreads because of its intrinsic properties. With such model, there is an inherent separation between technology that is designed and the context within which it is applied. Akrich (1992) explains this by referring to an example of technology transfer, where in such a case the relation between supply and demand is not directly aligned. In other words, there is a lengthy and effortful process through which technology would proceed. The example she analyses is a lighting kit designed in France and applied in Africa. The reason behind it was to help the French industry by creating a market and promote new African energy resources, which were in urgent need and demand. Its developing engineers assumed directness and simplicity of how the model should proceed, where they took all efforts and covered all grounds to ensure its technical readiness. Akrich clarifies:

When I first heard about the industrialists and designers talking about the lighting kit, it appeared to be a very simple array with three functional elements. There was a panel for
producing electricity, a storage battery, and a lamp that consumed the electricity (Akrich, 1992, p. 209).

What happened, however, is that the kit has not proceeded successfully. Akrich (1992, p. 209) adds “once I arrived in Africa, and started to study the ways in which such kits were actually used, the picture rapidly became more complicated.” The reason is that the travel of the kits does not depend merely on the technology itself, excluding and eliminating other contributors or influencers.

An additional model that Akrich and colleagues (2002a,b) propose is the model of interessement, which comes in line with the model of translation. Callon, (1986) describes interessement as a “moment” through which translation happen, which reflects the overlap between Latour and Akrich and colleagues views. In such a model, technology travel depends on the continuous interaction between all those who relate to its design and use. Technology is interlinked with the surrounding context in a more complex way than through a simple and straightforward manner. In other words, the technology creates a group of links and associates itself with other participants and contributors that appear and engage throughout its travel. With such association, Akrich and colleagues (2002b, p. 209) add, “The model of interessement allows us to understand how an innovation is adopted, how it moves, how it progressively spreads to be transformed into a success.” Back to the lighting kit example, it becomes clearer that the way it has proceeded has not depended only on the configuration of technical aspects, but also on the created and shaped links with other contributors or influencers. In other words, the kit has followed a translation or interessement model, where its technology has been interpreted and experienced by such contributors that should have been included and incorporated in the process.
In this way, what Latour (1986, 1987) confirms through STS, and more specifically the Actor Network Theory (ANT) tradition, is that technology, as it travels from the lab to reality or from design to use, is not single, linear, or separated. Rather, technology comprises a sociotechnical mix of actors and networks, each having its role and place, affecting and being affected by the other, reshaping and recreating technology itself. This approach aligns with the work of multiple researchers including Callon (1980, 1986, 1987, 1991), Law (1987, 1992, 2003, 2007), Law and Callon (1988), Law and Mol (2001), and Murdoch (1997, 1998). Through such perspective, the objective blends with the subjective, the technical with the social, and the non-human with the human as all mesh together. With such a mix, it becomes hard to differentiate each of the aforementioned entities from the others. According to Akrich (1992, p. 222), “technical objects and people are brought into being in a process of reciprocal definition in which objects are defined by subjects and subjects by objects.” She adds that, with such relation, any definition attempt that occurs in separation or inclusion of the other is not possible.

In order to include this mix, Latour (1993, p. 4) refers to the term “collective” “to describe the association of humans and non-humans and ‘society’ to designate one part only of our collectives, the divide invented by the social scientists.” He explains that later by writing:

The apparently reasonable division between material and social becomes just what is obfuscating any enquiry on how a collective action is possible. Provided of course that by collective we don’t mean an action carried over by homogeneous social forces, but, on the contrary, an action that collects different types of forces woven together because they are different (Latour, 2005, pp. 74 – 75).
Latour (2004, 2005) also refers to the term “collectivity” to reflect upon similar associations and blends. Serres and Latour (1995, p. 201) argue that “collectivity is produced by this double circulation of objects that create social relations and social relations that create objects,” which explains the mutual relations among the different actors and networks, where each of them defines the other. I use the terms “collective” and “collectivity” in this thesis to refer to this perspective as the relations within the collectives or collectivities are not straightforward but networked. Latour (1987) also uses the term “network” or “socio-technical network” for the same aim.

The usage of these terms within the thesis, or more specifically the collective, would allow us to have a closer look into technologies and their relations with different actors and networks. It is important here to realise that these associations within the collective could reflect on a concept that is borderless and continuously growing. However, such associations are framed by the angle through which the technology is seen. For example, when Akrich (1992) was looking at the adaptability of the lighting kit, the focus was on the associations between designers, users, and any related non-human actors that could affect the adaptability of the technology; this is how the collective is used in the thesis. Looking at the technology through different angles would then result in a different collective framing.

Time and space take shape within the mentioned actors and networks and merge into their relations rather than being abstract containers. In this way, abstract and conventional notions of time and space make way to relational views. The focus is then on how all aspects come together or split apart within the actors and networks, which act as a reference in the estimation of time difference or space distance, rather than actual history or geography (Harvey, 1997; Latour 1987, 1996; Murdoch, 1998; Tait and Jensen, 2007). Two distant points, in time or space, might be
actually connected to one another while two neighboring ones are actually disconnected. They are accordingly able to shape and be shaped by each other, even if they are at a time difference or physical distance. In this way, the divide between the global and local, the far and near, the big and small, as well as the inside and outside diminishes as all blend with these configurations.

The described characteristics have their use and relevance in the study of technology travel. Technologies proceed from lab to reality or from design to use through a process of “translation” (Callon 1980, 1991; Latour 1986, 1987; Law 2003, 2007). Such process involves the consideration of human and non-human actors and networks that correspond to the varying historic and geographic contexts that start from where the technology initially originates as it proceeds to where it is implemented or even beyond that. With the process of translation, the different actors and networks attain new relations with other actors and networks. Translation then relies on putting together people and objects that could be different or maybe distant in time and space through a process of making connections and creating associations. This entails continuous involvement and dis-engagement of the different actors and networks that build or dismantle such relations.

The travel of technologies is not simple or separated anymore within such a relational perspective as it is contested while being associated with actors and networks that shape them as collectives or networks and involve them in translation processes. Each of such actors, human or non-human, has a specific agency to act and contribute through a particular role in the collective itself (Latour, 2005). What adds to this complexity and entanglement is that the translation process is continuous, where the agency could be distributed and shared differently. Hence, the involved actors and networks are not stable as they are under ongoing emergence. Akrich refers
again to the kit that has gone under continuous negotiation from France to Africa, highlighting the related length and required effort of the process by writing:

The materialization and implementation of this technical object, like others, was a long process in which both technical and social elements were simultaneously brought into being - a process that moved far beyond the frontiers of the laboratory or the workshop (Akrich, 1992, p. 210).

While Latour (1986, 1987), Akrich (1992, 1993), and Akrich and colleagues (2002a) develop their interpretation on a collective or networked nature of technology that is involved in translation processes, De Laet and Mol (2000) show a different perspective on this aspect. They explain that technology is fluid, adaptable, and responsive with boundaries that correspond to such flexibility. With this, they do not formulate the move from design to use in terms of actors and networks and their shifting associations. What is different here is that, in addition to technology itself that corresponds to its actors, the boundaries around it become narrower or wider in accordance to the affecting or affected actors.

De Laet and Mol (2000) provide an example reflecting on the adaptability of the Zimbabwe bush pump; a lever action based pump used in Zimbabwe and other parts of Africa to extract water from a bore hole well. They present it as a fluid and simple technology, which has different identities; a mechanical object, a hydraulic system, a device serviced by the community, a health promoter, and nation-building apparatus. Each of these identities encompasses different actors and activities with its own vague and moving boundaries resulting in different shades of workability and grades of success. They explain that this fluidity is not a matter of interpretation of the technology. Rather, it is one of its inherent qualities. With these characteristics, they
confirm the difference between such fluid object and another rigid one. For them, “an object that is not too rigorously bounded, that doesn’t impose itself but tries to serve, that is adaptable, flexible and responsive – in short, a fluid object – may well prove to be stronger than one which is firm” (De Laet and Mol, 2000, p. 225). Law (2007) emphasises that such fluid, loosely-associated designs do not work by insisting on rigidity as they change their shape to blend and achieve a certain degree of workability and success.

This corresponds with Akrich (1992, 1993), who shows in a number of her studies that rigid technologies are subject to less successful adaptation. As an example, she explains the reasons behind difficulties that have confronted the lighting kit mentioned earlier. The wires linking its different components were fixed and not easy to alter in length, its components were not easily replaceable, and its maintenance was not possible by local electricians. This technology, based on rigid factors and forced adaptation, did not work (Akrich, 1992). Similarly, she provides another example of the “Gasogene” technology that was designed in France and implemented in Costa Rica to improve rural electrification. The wood-burning-based technology did not function properly to burn wood in that new locality because of its high-moisture content. With such rigidity of the technology that could not adapt to the type of wood it had not met before, it did not work either (Akrich, 1993). In both cases, and from the point of view of Latour’s (1987) collective or networked nature of technology, what has happened is that it has been too rigidly-constructed by the designers, who shape it in that specific way to delegate most of the agency to technology. Accordingly, they did not allow the involvement of other actors, or they included them in specific ways, dismantling most of the relations with them. In other words, depending on whether the collective is more or less rigid or flexible, it is translated in particular ways, being more or less successful. In light of that, I base the rest of the chapter on the idea of the collective
or network of Latour (1987) and Akrich and colleagues (2002a,b) and the translation they involve, in addition to the fluidity of De Laet and Mol (2000) and the boundaries it constitutes that connect to the former and ease the translation it involves.

*Designs as Processes of Inscription and De-scription*

Latour (1986, 1987) and De Laet and Mol (2000) offer different ways to understanding technology and its travel although both of them reflect on its complexity and contestation and at the same time its dynamism and changeability. With such emphasis on both approaches, the designers, or the inventors, receive a special focus as the main contributors that influence technology. With their intentions, imaginations, and expectations, they envisage the ways of use, adaptation, and appropriation of technologies in reality. They plot the way through which technology proceeds from lab to reality and from design to use through a process that Akrich (1992) calls “inscribing” the vision of design to be “de-scribed” later in reality. The concept of inscription is a focus of this thesis and is used here to discuss how architectural designs reflect designers’ ideas about how buildings and technologies will be used. Akrich and colleagues (2002a, p. 188) describe the entrepreneurial character of the designer as “the mediator, the sheer translator, who brings together two universes with distinct logics and horizons, two separate worlds, each of which would not know how to survive without the other,” highlighting the designer as the main actor in the process.

Callon (1987, p. 84) provides an example where Electricité de France (EDF) engineers presented a plan for the electric car they developed that determined “not only the precise characteristics of the vehicle” but also “the social universe in which the vehicle would function.” Accordingly, they did not only seek to improve the cars, but also produced a sociological analysis highlighting
their consumption. Callon (1987, p. 83) adds, “whether they want to or not, they are transformed into sociologists, or what I call engineer-sociologists.” From the perspective of collective or network configurations of technology, designers are the ones responsible to configure its design in relation to use. Having this done, they decide to include or exclude the potentially-involved actors from the side of design and use. Through such configurations, they create specific relations between the differing universes that go beyond the technical object to include the social. In other words, they ease and facilitate a particular way of translation of design intentions to use experiences.

In addition to such explanation, Akrich and colleagues (2002a, p. 189) emphasise the designer as an actor that is actually one of multiple actors that form the design body and participate in the process in different ways. In other words, there is no single entrepreneur, but many contributors. For them, innovation “is more and more a result of a collective activity and no longer the monopoly of an inspired and dedicated individual.” They further write that innovations “are no longer the property of an individual, but become collective virtues, during the emergence of which the art of governing and managing plays a key role.” With such explanation, they hint that the design body or authority that configures the collective or network of design as well as its relation to use, is in itself part of it, relating to others in a specific way, and they are accordingly involved in the translation process itself.

For De Laet and Mol (2000, p. 227), and from the perspective of fluidity, such a main actor, or main actors of design, receives similar focus. They position him through the example of the Bush pump as a modest and serviceable inventor, rather than a manager. They explain in page 227 that “the success of a technology does not necessarily depend on an engineer who masters the situation and subtly subdues everyone and everything involved. A serviceable (or even
submissive) inventor may help spread technologies just as well – or even better.” They add that he is a facilitator rather than a dominator, who fluidly dissolves into what can help assembling people and objects and even referring achievement to such multiplicity rather than standing out and sticking to the image of a single hero. The design needs to be more flexible while created by actors that further enhance this flexibility, being themselves part of it. The designer then flexibly widens or rigidly narrows the design boundaries and blends it with use in certain ways.

With reference to the previous examples, and beyond the fact that the designers comprise many contributors, they appear to further extend. The designers are actually “actors of design” including both human and non-human actors and reflecting the mix and involvement between the different actions and interactions. This is why Akrich (1992), for instance, gives an emphasis on illustrating the included components in the design of the lighting kit in details, explaining later their contribution. Akrich (1993) even goes further with the example of the Gasogene to explain the designed qualities of the machine that uses specific wood. Similarly, De Laet and Mol (2000) emphasise the elements and components of which the Bush pump is designed as each has its contribution, including joints and bolts that, although appear of minor contribution at some stages, would prove later to have a more significant role.

Beyond these actors of design, there is a whole spectrum of other actors that could participate, marginally or comprehensively, in devising and adapting technologies. Part of such actors are the users, who occupy specific focus as they interpret and experience the design intentions, expectations, or imagination in particular ways. In Akrich’s (1992) words, they “de-scribe” what is “inscribed” for them. The concept of de-scription here is central to this thesis and is used to present the ways through which users interpret and experience what was envisaged for them by the designers, which could be in alignment or misalignment with them. De-scription, however, is
much more than alignment or misalignment of users with the designers' use-visions, as there is a spectrum of interpretations and experiences through which the user could present grades or shades of adaptation and resistance. Latour (1987, p. 259) for example argues that “the fate of facts and machines is in later users’ hands; their qualities are thus a consequence, not a cause, of a collective action.” Similarly, Akrich and colleagues (2002a, p. 202) explain that “the evaluation of the disadvantages and advantages of an innovation is entirely in the hands of the users; it depends on their expectations, their interests, on the problems which they raise.” In this way, they present them as co-producers of technologies, where Akrich (1992) recommends that there is a need to go back and forth between design and use to follow technology co-evolution as a result of their collective effort. Oudshoorn and Pinch (2003) confirm that with the different forms of use, we can never take designed technologies for granted as they might change in many ways, pointing to the co-production of technology between the design and use. Such arguments hint to the complex, dynamic, and unpredictable nature of technology that is under continuous configuration and reconfiguration as a result of ongoing action and interaction dialogues.

In other words, and from a perspective of the collective or network configurations, the technology needs to integrate itself and build relations with other actors who accept, adapt, and support it. If this excludes such actors and dismantles their relations, it stands a higher chance of being ignored, resisted, or even rejected by them. In other words, it does not translate as intended by the designers. In the lighting kit example, Akrich and colleagues (2002a) explain that the designers developed it in alignment with their interests, including other French industrialists, a handful of African researchers and a government agency. On the other hand, they alienated themselves from users as they were seen as mere receivers of this technology. Parallel to that, they did not allow such actors to interact or have any active role in supporting, maintaining, or
fixing the technology. The technology itself and all its elements stood between the design and use, aligning with the designer and dis-involving the user, or involving him in specific ways, resulting in a technology that did not work or operate as the designers intended.

In line with that, De Laet and Mol (2000) explain the importance of such actors through their perspective on fluidity. They argue that these actors extend the design limits, exceeding its borders and blending it with their aspects of use. In case of the bush pump, they clarify how the designers have allowed user interaction, including the surrounding community, through consultation and participation as important aspects to keep it operational. This has guaranteed that the users had the ownership and responsibility to pick its site, install it, operate it, and maintain it as they use it with reference to its instructions and manuals. The bush pump aligned with the designer and at the same time allowed interaction with the user to co-produce it and keep it functioning. While affecting them, it has been reshaped in different ways.

This comes in line with another case explained by Lindsay (2003) of the TRS-80, an early version of personal computers that were introduced by Radio Shack in 1977. For him, although the designer did not necessarily mean to include users as participants in the design, users contributed in developing the technology, constructing new programmes and functions, distributing and commercializing them, and bringing new requirements back to the designers. In other words, their contribution was not only through their use, but also through taking the technology further and suggesting ways of alignment and improvement. The TRS-80, in other words, went beyond its designers and involved the users, as it allowed them again to co-produce it and keep it functioning in different ways.
In both explained cases, users have become “actors of use” composing human and non-human actors and reflecting the mix and involvement between the different contributors. Users, for instance, have utilised the manuals in De Laet and Mol’s (2000) bush pump and produced the programmes in Lindsay’s (2003) TRS-80, which act and interact with the design and keep it evolving and changing.

Although the preceding examples show the involvement of the users at late stages of the design, other more specific initiatives reflect their engagement at much earlier stages. In co-design, participatory design, and user-centered schemes, designers and users draw on the shared visions and mutual understanding of the design and use (Robertson and Simonsen, 2013). In other words, they reflect the design involvement that inherently includes both. These initiatives aim to guarantee more fruitful results, reflecting on the importance of such actors in the process of technology travel.

As technologies transform through their move, they result in other changes. Akrich (1992) argues that new technologies, lead to new arrangements of people and objects. This depends on how the collective or network of technology has such actors and their relations arranged around it, which grows and keeps growing through the translation process. With their perspective on fluidity, De Laet and Mol (2000) mention how design boundary extends and widens through a new technology that makes the actors as much as the actors make it; it re-organises them around it. Drawing on their example of the bush pump, it has arranged its actors of use, composed of the surrounding community, through gathering and inducing users to follow its instructions, inviting them to sit in its push bars or dancing around them, and luring them into taking care of it. Such re-organization is not limited to the community as it also applies to the nation at large. The bush pump involved the government, universities, organizations, companies, and the concerned
community members to boring new wells, upgrading available ones, and constructing pipelines to the needed places. The distribution of the pumps themselves corresponded with the site where it was locally produced, instead of following the organizations that originally supported them. In this way, the bush pump created arrangements and orders around it, involving the community as well as the nation with its effect.

An important element to emphasise is that the dynamics of the collective, as the technology travels, introduces contingency, where consequences are barely expected before the designed technology is already in place and in use. Between the lab and reality, the design and use, what is inscribed and what is de-scribed, is a long spectrum of unforeseeable circumstances, changes of need, and deflection of technology itself. Akrich and colleagues (2002a, p. 195) emphasise that “innovation by definition is created by instability, by unpredictability which no method, however refined, will manage to master entirely.” They also add on page 201 that “innovation leaves us to be exposed all of the uncertainties which surround it and above all, the impossibility of relying on indisputable criteria or procedures to make the innumerable decisions which further it.” According to such views, multiple collectives or networks could be configured or reconfigured, multiple actors could be excluded or included, and multiple relations could be developed or dismantled through a variety of translations.

In relation to that, the dynamic of the collective provides a focus on temporary arrangements within the collective or network, which reflects on the significant work and the lengthy processes needed to translate technologies. This is why an emphasis is provided by Akrich (1992) to the stabilization of the resulting actors and networks within the process of technology travel, where they start to function and produce knowledge. Parallel to the emphasis of the temporary arrangements of the network, the focus on fluidity introduced by De Laet and Mol (2000) shows
continuous and progressive processes of producing technologies, where both insights reflect on their ongoing emergence and happening.

Such discussion unravels how to approach technology travel on a more detailed and elaborate level through a specific relational perspective, where it is not anymore a binary movement between the design and use. It is not anymore a mere shift from point A to point B through single or even multiple lines as it is much more than that. Firstly, technology is a specific collective or network that includes or excludes technical and social actors and networks and forges them into particular times and spaces. It further creates or dismantles a bundle of relations between them. This makes it complex and entangled to translate them rather than straightforward or simple.

Secondly, changes of actors and networks as well as their relations transform and shift technology, which in turn changes its surrounding. In other words, the collective keeps changing and growing through the translation processes. This reflects on technology as more fluid and adaptable to these changes rather than rigid and frozen. The actors creating technologies are facilitators, who embrace and enhance such flexibility while dissolving into it. Thirdly, these transformations result in an unpredicted technology that is embedded with different possibilities and constraints, rather than being expected or anticipated. The next section uses such key themes and applies them on the field of architecture.

2.3 From Architectural Design to Use

Drawing on the work of Houdart (2008), Loukissas (2012), and Yaneva (2009a,b,c, 2013), this section applies the relational perspective explained earlier to the production of architecture. It uses the travel of technologies to understand how the architectural designs and products proceed from where they are created by the architect or designer to where they are implemented and dealt
with by the user; in other words, from what is “inscribed” in design to what is “de-scribed” in use. This section also follows the insights on how architectural designs and products change in the hands of the users combining the views based on STS (Brian 1994, cited in Yaneva and Guy, 2008; Gieryn, 2002) with the ones of architectural theory and history (De Certeau, 1984; Hill 2001, 2003; Lefebvre, 1991) to tackle the matter.

Fallan argues that:

Architects like to talk of how their job is to create places for people and spaces for social interaction. Yet, when their work is presented and mediated visually, you do not see construction sites and you do not see buildings in use. Usually, there is not a single human being in sight. It is the stasis of perfection (Fallan, 2008, p. 88).

He argues that this occurs when the architectural product is uncontaminated, pure, and even glossy as it features in a speech or an architectural magazine. However, the argument here is that architecture is much more than that. The process through which this product is designed, developed, constructed, maintained, and used reflects on its travel from the hands of the architect in a way that is more complex than being reduced to elegant speeches or glossy images. Such talks and presentations show the shifts and changes through which the architectural product goes as stable and frozen. The question is how do we uncover the contestation and dynamism of an architectural product and how this connects to the ideas of collectivity, relational influence, and flexibility introduced in the previous section?

To start with, the inherent connection between the architectural master and the product needs further discussion. Schon (1982, 1987) and Cuff (1992), through their insights in architectural theory and history, show how the architectural product does not rely entirely on the architectural
master but exceeds him in different ways. With his focus on architectural education, Schon (1982, 1987) stands against the absolute faith in the master utilizing systematic, linear, and direct ways of knowledge. He discusses the “reflection in action,” as an approach through which the architect gets involved in a virtual negotiation with the design or the product. Basing his work on studio situated reflexivity in architectural school, he reflects on the involvement of the master with the student and shows how architectural learning and design production adapt joint reflection involving a dialogue between the master, the student, and the design.

Beyond the architectural education, and with more focus on architectural practice, Cuff (1992) also deflates the myth of the architectural master in his singularity, separation, or detachment. Following a number of US practices, she shows the relation between the master and other architects and professions in the design studio, reflecting on a similar kind of collaboration. Actually, this is apparent through the large numbers of architects, draftsmen, engineers, analysts, and other types of workers in offices such as Gehry partners, Foster + Partners, and Zaha Hadid architects. This is also reflected on the large number of contributors including delivery, support, maintenance, and other facilitators to accomplish the task. Architecture is then not based on singularity but on a multiplicity that comes together to shape the different products in a variety of ways. There is no one architect that conducts the jobs, but many architects and other contributors that act and interact to produce architecture.

Apart from such studies introducing the thinking beyond the individual and embracing the collective, and inspired by Latour’s (1987) work on the scientific lab, a whole body of studies has been developed to look at the design studios as mini labs, where concepts are generated and designs are experienced. Callon (1996, cited in Yaneva, 2009c, p. 4) is the first to suggest transferring methods of the scientific lab to an architectural design lab. With this, he reflects on a
new wave of approaching the processes of architectural designs and products. As they travel from design to use, they depend on collectives or networks that do not only include the social contributors, as emphasised by Schon and Cuff for example, but also the socio-material heterogeneous elements.

This aligns with the work of Houdart and Minato (2009), Loukissas (2012), and Yaneva (2009a,b), who follow architectural practices embracing the collective or network of the design and product, including the social and the material. A first case to explain is the work of Houdart and Minato (2009), who have followed the practice of Kuma Kengo, based in Tokyo Japan. Through this work, they show how drawing boards, 3D drawings, and models make up the material architects use to design. Such material aspects contribute in providing a ground for negotiations, producing different versions, and engaging in experimentations. With these interactions, they embrace paper, polystyrene or wood, glass or plastic, and pixels with architects, students, builders, engineers, specialists, and clients to shape and coordinate the material and at the same time shape the culture. With focus on 3D drawings and computational models, Houdart (2008) shows how such material aspects offer a wide range of operations and create hybrid worlds, putting together people and objects with specific effects, textures, and light. With these qualities, they contribute in assisting conceptions, paving the way for communications, and expressing new social configurations.

A second case that follows architectural practices is the work of Loukissas (2012, p. 2), who has engaged with Arup, the British multinational design firm based in London, UK. Through his work, he presents computer simulations in the architectural process as technologies for collective imagination. He clarifies, “creating advanced computer simulations means engaging a network of people and powerful machines.” For him, they involve architects, engineers, and experts as
co-designers and transform their relationships as they produce and re-produce the architectural reality.

A third example that traces architectural practices is the work of Yaneva (2009b,c), who has followed the office of OMA, an architectural firm based in Rotterdam and associated with the renowned Dutch Architect Rem Koolhaas. Through her work, she uncovers the architectural dynamics of the design process while revealing its material, cognitive, and cultural perspectives. She writes:

Design at the OMA often begins with collective experimentation at the table of models and not with a single-authored sketch; it is made by and ‘is a response to a certain network’ of architects, engineers, contractors and consultants, drawing software and drawing hands, boards and tracing papers (Yaneva, 2009b, p. 11).

She exerts particular interest in the foam-models as they are translated from 2D to 3D and back to 2D, scaled and rescaled, and experienced through different views and interactions. She explains how they in turn act, simulate architects’ thinking by making, and pave the way for negotiation enrolling a variety of other participants including clients, users, stakeholders, and representatives that contribute to the emergence of the building in reality.

These three monographs that have been done through the past ten to fifteen years present the architectural product not as a result of a single, separated, or detached actor but complex. They are associated with other human and non-human actors and networks that shape them as collectives or networks and involve them in continuous translation processes. Each of such actors has a specific agency to act and contribute through a role in the collective itself. What adds to this complexity and entanglement is that the translation process is continuous, where the agency
could be distributed and shared differently. Hence, architectural products are not rigid, frozen, or static but dynamic, reacting and interacting with their actors. With such fluidity, the boundaries around them become narrower or wider in accordance to the affecting or affected actors, emphasizing the ideas presented in the previous section.

These studies and analyses, while embracing the collective or network of the designs and products and including the social and the material, emphasise user contribution in some occasions as part of them. For example, Yaneva (2009b) explains the proto-users brought to OMA office as contributors to evaluate the Whitney project and ultimately change and shift it in different ways. Latour and Yaneva (2008, p. 80) hint to similar contribution as they argue that buildings, as they continuously proceed, are converted and transformed by their users.

Other work that is also inspired by Latour (1987) develops the point of view of the user and takes it further. They are also interested in how design proceed to use but they target it with specific focus on users, paying more attention to their side. They reflect on the fact that designs or products are initiated by the architects in a specific way to be implemented to the users or, in other words, they are inscribed by the former to be decribed by the latter. Brian (1994, cited in Yaneva and Guy, 2008, p. 3) builds on Callon’s (1987) term “engineer sociologist” explained in the previous section, to show the relation between technology and society and apply it to architects who “define both the characteristics of the artefact and the ‘social universe’ in which it is to function.” In line with that, Gieryn (2002, p. 42) argues that “designers who sketch out material artifacts also create human users and even an entire society among which the machine or building can thrive.” In this way, the architect as part of the actors of design, configures the collective while being part of it. As he does this, he contributes in deciding to include or exclude the potentially-involved actors from the side of design and use. Having done this, he creates and
dismantles certain connections and associations that go beyond the technical to include the social. The architect is again the “mediator” that puts the different actors together within the collective and the “facilitator” that supports the translation. The created collective or network needs to be more flexible while being created by actors that further enhance such flexibility being in themselves part of it. The architect then flexibly widens or rigidly narrows the design boundaries and blends it with the use in certain ways.

Other authors of architectural history and theory target the relation between the architect and the user in similar ways. Hill (2003, p. 34) suggests different paths through which architects envisage users. He explains that they might regard a user as “a passive spectator observing the ‘game’, an involved but reactive participant, or one of three principal creative agents in a feisty dialogue, the others being the architect and the building.” With focus on the two extremes of the passive and creative users, they could still include within the spectrum between them a variety of other types, the first extreme implies hierarchy between the architect and the user, or separation of their spaces, where the user could be subject to denial or control. The second extreme implies that the architect and the user are on the same level, and at the same space, where both have their own role and effect in transforming architecture. Hill (2003) goes further to argue that the first view on the user implies rigidity while the second implies flexibility, allowing the architectural product to transform between the design and its use.

An example of the first case is the Frankfurt kitchen, which was designed in 1927 by Grete Schütte-Lihotzky for architect Ernst May's social housing project in Frankfurt, Germany (Bell and Kaye, 2002; Hessler, 2009). In such a project, the architect assumed the user to be predictable and homogeneous with universal and standard needs. The kitchen targeted producing a space that eliminated unnecessary additions. Each function took place with the minimum effort
and within minimum space. In such a case, as the architect envisaged the user’s usage of the kitchen and inscribed his vision accordingly, he expected the user to follow such inscriptions.

An example of the second extreme is the Kunsthall, which was designed in 1992 by Rem Koolhaas in Rotterdam (Koolhaas and Schwartz, 1998). In such a case, the architect foresaw the user as unpredictable and heterogeneous with localised and specific needs. The building was described by Koolhaas as a continuous circuit, as the building accommodated different functions and varied routs, allowing the user to construct his uses and journeys within it. As the architect envisaged the user’s ways of using the Kunsthall and inscribed his vision accordingly, he expected the user to embed different functionalities and meanings within such inscriptions being more flexible and adaptive.

Beyond such issues of whether or how the architect creates the design, the user adapts it in many ways. In other words, as the architect envisages or inscribes his vision to the user, there is an array of possibly ways by which the user could describe this vision. Inspired by Akrich’s (1992, 1995) work and similar STS insights, Guy (2006), Ornetzeder and Rohracher (2006), and Rohracher and Ornetzeder (2002) argue that users could play roles aligned with what is intended for them or they could go beyond such scenarios, playing different roles and embedding new meanings and functionalities in the design. In alignment with that, Gieryn (2002, p. 44) argues that “once unleashed by designers and builders, artifacts become available for later reconfiguration as they are returned to the hands of human agents for more or less creative redefinition, reevaluation and even re- (or de-) construction.” With this, he agrees to the fact that the design could or could not proceed to use in the intended way. In other words, regardless how the architect shapes the collective or network, including or excluding the users, the users form part of the collective or network and contribute to it as co-producers to the design in different
ways, evaluating it and deciding its fate. Regardless of how the architects create or dismantle relations with the users, they shift and change these associations while being affected and influenced by such change, translating the design in different ways. Whether or not the architect decides to flexibly widen or rigidly narrow the design boundaries and blend it with use, users extend the design limits, exceeding its borders and blending it with their aspects of use.

In line with such insights, many studies from architecture theory and history show how designs or products created by architects adapt to users that contribute to their production and reproduction and how these products go through dialogues between the architects’ intentions and users’ practices and interpretations. This is clearly reflected in Hill’s (2003, p. 70) argument when he writes that “there is not a clear linear route from the architect to the user. To use a building is also to make it, either by physical transformation, such as moving walls or furniture, using it in ways not previously imagined, or by conceiving it in a new way.” Lefebvre (1991) defies the notion that architecture is produced through architects, who have their vision and geometry in a specific space. Here, the complexity and politics of space fade and users turn into passive consumers. He suggests and supports another notion of producing architecture, through which the complexity and politics are more apparent. Users are active producers of architecture in their own space regardless of whether the architects integrate them in their design or not. De Certeau (1984) as well defies the notion that architecture is produced through architects, who he describes as looking down on the city from a high-rise building, as he suggests that architecture is produced through users’ walking activities. While they follow the thickss and thins, they write the urban “text” without being able to read it. Hill (2003, p. 70) agrees with this argument as he clarifies, “just as the reader makes a new book through reading, the user makes a new building
through using,” where all such contributions show a complex and dynamic contribution between
the architect and the user, resulting in a complicated and transformative architectural product.

Building on these insights and drawing on the examples provided through the literature on
architecture and users from STS and from architectural theory and history, I suggest a number of
categories, or typologies, of users depending on their reactions and interactions with the designs.
One category could support the design through their use. Ornetzeder and Rohracher (2006), for
instance, explain such a case through an example of solar heaters in Austria. In this case, users
did not only collaborate with the designers to build their own systems, but also adapted and
refined them. As they found the heaters producing more heated water than required by the
household, users diverted them into the bathrooms, where hot water was more in demand. In
such a case, the users included other actors of use like the pipes and created relations with them
to ease the design usage. The pipes themselves, being added as part of the design and working to
divert the hot water to the bathrooms, shaped the initially-created relations.

A second category of users could make minor amendments and adjustments or tinker with the
design through their use. Gieryn (2002) demonstrates such case through the design of Cornell
biotechnology building by architects from Davis, Brody and Associates in Ithaca. They initially
designed the building to accommodate scientists, which meant that it represented pure academic
research and accordingly consisted of multiple lecture halls and identically designed labs. The
building later changed to host applied science programmes in light of more business sector
involvement, where different preparations and arrangements were in demand. Users conducted a
number of adjustments, replacing for example the bench that was associated with the original
structure of the lab aiming for further space to accommodate more machines and facilities.
Another example was the less reliance on the classrooms, originally providing confined and
dedicated spaces for specific traditional learning purposes, in favor of more practical learning aims that were not bound to a particular space. In such a case, the user excluded some actors of the original structure and included others to replace them. They reconfigured the bench and the classrooms, changing the relations with them. The bench and classrooms themselves, being shaped within the design in a specific way, created different relations than the intended ones.

A third category of users could conduct major changes or reconfigure the design through their use. Huxtable (1981) and Boudon (1972) explain such a case through the example of the row houses at Pessac near Bordeaux, which were designed in 1920 by Le Corbusier. The development included a community of 51 houses that addressed the need of the limited income inhabitants and delivered a laboratory for new domestic and aesthetic ideas. As the design relied on open plans, open facades, and open windows, which did not align with its residents, they drastically changed the design creating passages as well as private sitting and living rooms. They further extended parts of the house at the expense of the garden and replaced the large windows with smaller ones. In other words, users excluded some actors such as the open facades and windows and included other actors to close them, dismantling specific relations and creating others. The facades and windows in themselves, being opened and then closed, played a role in shaping the relation between the design and use.

A fourth category of users could confront, resist, or completely abandon the design through their use. Rohracher (2003) explains such case through the example of controlled ventilation in Austria. The system required users to keep their windows shut, but they insisted upon opening them. Going further beyond that, as the system did not allow sufficient control to its users, some of them went to the extreme and blocked the air outlets as a sign of confrontation, rejection, and complete abandoning of the system. In this way, users excluded some actors like the closed
windows and opened outlets, dismantling old relations and recreating others. Such windows and outlets, being reshaped, played a role in cutting or recreating the relation between the design and use. Table (2.1) summarises the mentioned examples and their categorization.

Table 2.1: Examples of user de-scriptions (Source: author).

<table>
<thead>
<tr>
<th>Category</th>
<th>User “de-scription”</th>
<th>Example</th>
<th>How the collective is shaped</th>
<th>How other actors of use reshape the collective</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Supporting user</td>
<td>The case of solar heaters in Austria explained by Ornetzeder and Rohracher (2006)</td>
<td>The designers include the actors of design as well as the actors of use to shape the design</td>
<td>The user includes other actors of use that do not affect the design comprehensively but supports its usage</td>
</tr>
<tr>
<td>Second</td>
<td>Tinkering user</td>
<td>The case of Cornell biotechnology done by architects from Davis, Brody and Associates in Ithaca explained by Gieryn (2002)</td>
<td>The user excludes some actors of use and includes others that could not change the design comprehensively but align it to his needs</td>
<td></td>
</tr>
<tr>
<td>Third</td>
<td>Reconfiguring user</td>
<td>The case of the row houses at Pessac near Bordeaux, which were designed in 1920 by Le Corbusier explained by Huxtable (1981) and Boudon (1972)</td>
<td>The designer includes the actors of design, but the actors of use are either excluded or included in a specific way.</td>
<td>The user excludes more actors and includes others. He might also exclude himself in some cases, which could reshape the design and create it as a different one</td>
</tr>
<tr>
<td>Fourth</td>
<td>Resisting user</td>
<td>The case of controlled ventilation in Austria explained by Rohracher (2003)</td>
<td></td>
<td>The user excludes himself from the design.</td>
</tr>
</tbody>
</table>

Such categories, or typologies, do not mean to reduce the relation between the design and use into specific types, nor do they imply the exclusivity of the proposed user behavior categorization. They aim to present the variety of responses and the diversity of the potential
contributions that go much beyond the architectural practice or the design studio. The architectural product is not only there upon its implementation, as it keeps transforming and changing through its use. Such change could start from the extreme of being minor through minimum interaction with the design as a result to its high level alignment with the user. It could also end with another extreme on major changes with maximum interaction as a result of low alignment. Between the two ends, a variety of responses and a diversity of contributors exist that could interact in different ways with similar or different products.

It is important here to realise that the users themselves are not homogenous but heterogeneous, which results in different reactions and interactions with the same or different designs or products, depending on their different ideas and interests (Guy, 2006; Rohracher, 2005; Rohracher and Ornetzeder, 2002). What adds to such complexity and dynamism is what is argued by Brand (1994) that user reactions and interaction change with the same design over time as they constantly change and get refined. Users contribute to the designs and widen their boundaries. This results in designs that are not straightforward but much more complex as they proceed with the users of different interests and stages. The designs are also not stable but much more continuous and ongoing through their interaction with such users in a series of predicted and unpredicted ways.

Between the architects and users, architecture is manipulated in different ways through lengthy contributions and arrangements as well as effortful production and re-production. Gieryn (2002, pp. 41 - 42) mentions that “design is both the planning of material things and the resolution of sometimes competing social interests.” In other words and as Peltonen (2011, p. 807) puts it, such notion “acknowledges the endurance of buildings as bearers of distinct design ideas and conceptions of intended users and usages.” At the same time, design “is always a product of the
negotiations between the normative aspects of building design and layout and the potentially creative appropriations and reconstructions of the societally embedded users.” The architectural products are then co-produced and mutually related to their contributors.

Design is mutable, convertible, and never fully determined by the intention of architects or by the technical requirements or qualities of the technologies themselves as they are continuously configured and reconfigured by the different contributors in different ways in response to a variety of interests. There is no one architecture; there are multiple architectures that emerge and re-emerge in response to the different configurations. The interest here is not in the architectural designs as inherent and intrinsic qualities by themselves. Instead, the interest is in how they emerge, or come into being in a process of dynamic co-production and mutual relations involving all the technical and social actors.

2.4 From Reality Back to the Lab

This section sheds light on how a technology proceeds after it travels from lab to reality or from design to use. In other words, what happens to a technology when it goes beyond the reality where it is used, appropriated, or adapted by the different contributors to feed back into the lab where it was initially created? This section accordingly draws on the work of Evans and Karvonen (2011), Konig and Evans (2013), McCormick and Kiss (2015), and Trencher and colleagues (2014a,b) to introduce the concept of the living laboratory (or lab), which reflects similar ideas of multiplicity, mutual influence, and flexibility that are described in the previous two sections. It also shows the complexity, changeability, and unpredictability of the travel of technologies more explicitly. The living lab is a concept that overlaps with or even enhances the collective and its dynamism. This section introduces the concept of the living lab and discusses
its alignment with the collective that is further investigated empirically later on to show how it changes and produces different collectives with its transformation.

Evans and Karvonen (2011, p. 127) write that “the living laboratory approach offers promise for redefining what it means to experiment and innovate in the remaking of the world.” What is different between the “laboratory” and the “living laboratory” is that the latter provides a new approach that further expands the experimentation and innovation research. Such difference can be highlighted through multiple aspects. The first aspect is the type of place where the experimentation is conducted. The lab is a privileged space that highlights and demonstrates the power of science. It takes place in an artificial and separate environment that entails detaching experiments from reality and allowing examinations under controlled conditions dictated by specific demand rather than being faced with any unpredictable issues or ambiguity of any sort. The ability and power comes from the fact that knowledge cannot be produced in other conditions outside the lab, except in another lab with an insider environment of appropriate conditions (Evans and Karvonen, 2011; König and Evans, 2013). Contrary to that is the concept of the living lab, which “blurs the distinctions between lab and field, inside and outside, controlled and uncontrolled” (Evans and Karvonen, 2011, p. 3). As Kareborn and colleagues (2009) put it, instead of firmly limiting the innovation to internal forces, such a concept suggests opening the internal forces to the external ones, where the boundaries of innovation-making become wider. With this blend, the experiments are natural and integrated, where experimentation is not anymore isolated from reality and examination is not anymore subject to framing or control within predicted conditions.

In this way, instead of labs where experimentation takes place in specific spaces, in the living lab cities turn into “real implementation fields,” which constitute tangible, concrete, and actual life
settings (Konig and Evans 2013, p. 2). With such difference and in terms of design or inscription, it is not anymore isolated, separated, or detached as it proceeds beyond the lab where it is designed to the field where it is implemented, it is actually done directly on the field where it is applied or de-scribed. Within such spaces, design does not only take place and become ready, but goes through application, testing, and refinement. Evans and Karvonen (2011, p. 1) provide a variety of space types that could host living labs, arguing that they could range “from a single plot of underdeveloped land to a degraded waterway, from a clogged transportation corridor to a completely new city.” The living lab then constitutes a built form, bounded, and protected space to facilitate such processes of generating practical solutions to applied problems (Evans and Karvonen, 2011; König and Evans, 2013). Still the idea of the bounded and protected space could be questioned, as argued by Konig and Evans (2013) to reflect on a more open, interactive system.

The second aspect distinguishing the living lab is the knowledge produced. In the case of the lab, and as experimentation can be repeated in another lab of appropriate conditions, the knowledge produced is of a “one size fits all,” universal, replicable, and not prone to change or manipulation (Evans and Karvonen, 2011; König and Evans, 2013). Contrary to that is the case of the living lab, where the knowledge produced depends on the outsider environment from where the data is collected. It is accordingly specific, local, and non-exchangeable. In other words, and in terms of design, it is not timeless or placeless, it is specific to the time and place in which the design takes place or gets inscribed. Instead of being separated, the design does not only connect to the users, who adapt and de-scribe it, but also to the locality in which it is implemented. Konig and Evans (2013, p. 3) agree by arguing that it is “locally-situated, context-dependent knowledge, adopting a relatively sophisticated learning process through which technologies and social norms are co-
produced.” Evans and Karvonen (2011, p. 129) add that “the living lab approach interpolates technology into society at the most basic level as co-evolving entities.” In this way, there is a recursive process that involves technology and society and results in producing, refining, and returning knowledge in a continuous loop of learning. Kareborn and colleagues (2009, p. 7) argue for the heterogeneity of realities, where following a localised context is not straightforward but complex. They add that “what is viewed as the reality for one person does not necessarily mean the same for another person,” reflecting on the contingency and dependency aspects.

A third aspect highlighting the living lab are the incorporated actors in the process. The case of the lab reflects on experimentation that adapts a top-down, managerial, and hierarchical approach that stands restricted to specific actors. Contrary to that is the case of the living lab that adapts a bottom-up, adaptive, and flat approach that is open to incorporate other actors (Konig and Evans, 2013; Schaffers and Turkama, 2012). In other words, stakeholders are not divided anymore between the ones responsible for design, research, and development and the ones who use, adjust, and appropriate, between the ones inscribing and the ones de-scribing the designs, as all contribute and collaborate in innovation making. Konig and Evans (2013, p. 3) explain, “at stake here is the move from a closed style of innovation typical of traditional corporate Research and Development, to a more open collaborative style in which innovation is knowledge-based and takes place in a wider community of stakeholders,” reflecting on the difference between the two approaches.

Such stakeholders incorporate a wide range; from private companies, universities, and the public sector to include academics of a variety of disciplines, practitioners, and users of space. With this, a collective of stakeholders of diverse backgrounds and perspectives that have different knowledge and experiences come together with no boundaries or restriction between them to
generate new forms of urban living (Konig and Evans, 2013; McCormick and Kiss, 2015; Leven and Holmstrom, 2008). Schaffers and Turkama (2012) describe that as open-collaboration networks or innovation networks, which are based on the communications and partnerships between the different stakeholders that blend and mix together in the process. Such collaborations contribute in different ways as its participants “work together to create, prototype, validate and test new services, businesses, markets and technologies” (Niitamo et al., 2006, p. 349). Konig and Evans (2013, p. 6) add that they contribute in the “formulation, monitoring, assessment and evaluation, negotiation, conflict resolution, agreement, and coordination of action,” reflecting the diverse processes among the different actors to generate products and services. This argument, putting the design contributors together as well as opening and merging its boundaries, starts to build on the ideas explained in the previous two sections of the collective by Latour (1987) and of the fluidity by De Laet and Mol (2000) that have their connection to each other.

The involvement of stakeholders reflect contestation and dynamism in the living lab approach for two reasons. Firstly, with such joint, collaborative, and interdisciplinary process, each of the involved diverse and varied stakeholders provides different, overlapping, or contradicting interests and motives. Kareborn and colleagues (2009, p. 7) mention that “what is important and motivating for one partner, is not necessarily important to another partner, which is a rationale for why it is crucial to involve a diversity of perspectives in the innovation process,” calling for admitting and recognizing such variations. In other words, the collectives or networks include or exclude diverse technical and social actors and networks. They further create or dismantle different relations between them. This makes it complex to translate them rather than
straightforward. They are then orchestrated by a “mediator” that assembles them together and configures their relations.

Secondly, what adds to this contestation and dynamism is the fact that there is an ongoing activity of stakeholder enrolment that contributes to the process and transforms other stakeholder roles (Konig and Evans, 2013). This drives Higgins and Klein (2011) as well as Bjogvinsson and colleagues (2012) to describe such process as “open-ended”, where more stakeholders become involved, changing and being changed by others. In this way, the collectives or networks including their actors and networks as well as their relations keep changing through the translation processes. This reflects on technology as more fluid in response to these changes rather than rigid, with boundaries that shift with them. This requires a “translator” or a “facilitator” that eases such processes.

Through the same sense of involvement, there is an emphasis on the users. This addresses the fourth aspect that highlights and even distinguishes the living lab approach. Higgins and Klein (2011, p. 32) compare the user in the traditional lab, where he has a determined role of receiving technologies to the one in the living lab, where his role is more open. He explains, “the human (user, citizen) is now recognised as a source of innovation and not just as a user or consumer in a narrow sense, as being an object for R&D activities.” Similarly, Kusiak (2007, p. 870) argues that “the main difference between the traditional consumer research programmes and the living lab approach is in the multi-role and multi-faceted involvement of the customer.” Liedtke and colleagues (2012, p. 108) add that it is about “engaging users rather than restricting them or designing around them.” In other words, rather than the design that excludes the use, design and use combine together as what is inscribed merges with what is de-scribed to produce innovation.
Consequently, use is not the end of the journey of the linear design process but a new beginning, where such designs are defined and refined, inscribed and de-scribed in a continuous loop.

This is why Eriksson and colleagues (2005), for example, describe the living lab as a user-centric research. Niitamo and colleagues (2006) explain that users are not only participants, but also contributors in the innovation making processes. Kusiak (2007) mentions that users take active roles as co-creators and co-shapers of services and products. Kareborn and colleagues (2009, p. 6) further suggest that users are “active and competent partners and domain experts.” In this way, the living lab reflects on such integration in which all of them “offer innovative ideas, validate the design, and become involved in a dialogue with a producer” (Kusiak 2007, p. 870). Eriksson and colleagues (2005, p. 4) add that they also contribute to “sensing, prototyping, validating and refining complex solutions in multiple and evolving real-life contexts,” reflecting the different processes among the various users to generate products and services. Building on what is discussed in the previous sections, users are then part of the collective as they are co-producers of technologies. Through such production they do not only use, maintain, or operate technologies. They also take them forward in a process of involvement with the designer’s work. Users extend the limits of what is produced and widen its borders.

User involvement, however, bears its own contestation and dynamism for multiple reasons. Firstly, and as emphasised by Kareborn and colleagues (2009), such users are heterogeneous with different interests and motives, where they need to be identified and accommodated. Secondly, the continuous involvement of users contributes to the process and transforms other stakeholder roles. This comes in alignment with the explained facts that users are only part of the collective or network of the involved stakeholders that are in themselves complex and dynamic.
with a multiplicity of interests and motives that could even change over time. This emphasises their turns within the fluid contributions and changeable boundaries of technologies.

The living lab is then open to the outside, context dependent, and involves a complex and dynamic collective or network of stakeholders, including the users. Such discussed aspects strengthen and distinguish it as an approach, where what a typical lab produces is different from what could result within a living lab. Instead of producing designs that are used or not, adapted or resisted, accepted or abandoned by their users, the produced designs are more useful and usable. Instead of linear designs that proceed directly to use with or without checking, the designs go through further validation and authentication within the iterative process of implementing, testing, and refining as a result of the interaction between design and use and a recursive loop of learning (Evans and Karvonen, 2011, 2014; Konig and Evans, 2013; Kusiak, 2007). Niitamo and colleagues (2006) recommend that there is no clear, determined, or definite path of such learning as it remains open for possibilities and unpredicted circumstances. In other words, the travel of designs moves on beyond use, where they are implemented to feed back into the initial design so that a new form of use could materialise through open paths of development and debate. In this way, living labs formalise the co-evolution of technologies between the designers and the users, bridging the gap and blending both together, aligning and even going beyond what was discussed in the previous sections. With the produced useful, authentic, and validated knowledge, Kareborn and colleagues (2009), Evans and Karvonen (2011, 2014), Kusiak (2007) argue that the living lab can have a social impact, support technical breakthroughs, and also stimulate economic benefits and values.

This said, the produced designs are not confined within their lab or limited in their domain, as they are highly visible, spreading beyond the lab and inspiring social and technical changes...
(Evans and Karvonen, 2011; Konig and Evans, 2013). In other words, the process of design travel is continuous, not only feeding back into where it was initiated but also to other dimensions and through different directions inspiring similar or different initiatives around the world. According to Konig and Evans (2013, p. 1), “in addition to addressing specific local challenges… living labs can serve as platforms for visioning processes to define needs, what progress means and how to realise it, with the power to stimulate changes beyond their boundaries.” Inspired by the literature of transition, Evans and Karvonen (2011) and Konig and Evans (2013) suggest that living labs form niches, which implies small scale, specific, and protected experiments, paving the way for incremental learning through the co-evolution between technology and society. Such niches, they argue, could spread beyond their boundaries and encourage change on larger scales, although Evans and Karvonen (2011) still question the possibility and the mechanism of this influence. The collective of technology through the living lab then grows and keeps growing with the different translations as its boundaries well exceed its original intention.

To further extend the living lab effect, Niitamo and colleagues (2006) suggest that the networking between such initiatives could increase the possibility and facilitate the mechanism of their spread and inspiration. Trencher and colleagues (2014b, p. 154) describe this networking as mutual learning that goes between local stakeholders and expands across “trans-border networks”. In this way and connected to such visibility and ability to spread, there is a demonstrative as well as expository power and potential of the living lab in not only presenting knowledge, but also delivering its effect and influence into wider scales.

With such usability, authenticity, visibility, and spreading ability of the knowledge produced in the living lab, the concept is considered distinguished, recognised, and globally supported. This
is why it could spread and get accepted easily and rapidly in multiple disciplines and within a variety of areas, especially with newly-introduced issues that are accompanied by a number of challenges (Niitamo et al., 2006). An example of such areas are green buildings and spaces as well as sustainable technologies, where the question of technological shift through societal interaction requires investigation.

Within such areas, there are multiple examples of actual living labs taking place, part of which are developed within universities through their ability to ensure the collaboration of different stakeholders inside and outside their boundaries. One example is the Oxford Road Corridor based in UK and led by the University of Manchester (Evans and Karvonen, 2011). This living lab aims at promoting a “Green Laboratory” to achieve and sustain a low carbon economy. This living lab aims to promote solutions in energy, communication, and transportation. Another example is the living lab of the University of British Columbia (UBC) in Canada, which features as a learning experience that transcends campus boundaries (Konig and Evans, 2013). It considers sustainability as emerging from societal conversations about the world we would like to live in, pursuing sustainability through human activity. It thus provides a base for co-developed projects and initiatives through the collaboration of researchers, local and regional governments, as well as multi-nationals, introducing comprehensive changes to its surroundings.

This said, and drawing on the description of the living lab, it is not easy nor straightforward to define it as there are many possibilities of approaching it. It can be realised by multiple researchers or policy makers through various means, can be adapted by different stakeholders through different paths, and can be used for a variety of aims and targets. In addition to its complexity, it is transformative in a way that can change over different places and different periods of time.
Embedded with such a concept is the endless narrative and continuous journey of learning that inspires co-produced technologies and designs in a recursive and continuous loop. The concept of learning itself needs to hold within it openness and flexibility as explained through the previous aspects. Such features and qualities start from the restricted actors to the multiplicity of influencers and from a rigid path to more flexible issues to cater for all the complex and potential dynamic processes and actors that could predictably or unpredictably emerge within it.

What could be interesting to follow through the living lab concept, connected to such learning narrative or journey, is the travel of designs or technologies that do not stop while they are delivered from where they are initiated to where they are implemented, as there is much more beyond that. As designs proceed through such a concept, they go through a process of iterative production and reproduction, involving all the technical and social contributors and participants. This comes back to the fact that the travel is ongoing, continuous, and never ending starting from the moment the design is initiated until it is implemented for use through to when the living lab continues the process addressing design and use again within a relentless evolving cycle.

2.5 Conclusion

This chapter has focused on the travel of architectural designs through time and place from where they are initiated by the architect or designer to where they are implemented and dealt with by the users; in other words, from what is inscribed in design to what is described in use. I have further illustrated how such travel might even go beyond that to feed back into multiple sources, including the architects and designers themselves or from description to inscription. The main aspect of it is that designs and products do not proceed as single, linear, or separated. On the contrary, they proceed through a collective or a network of actors and networks, where
each one has its role and place in affecting and being affected by the other, reshaping and recreating the design or product itself. Time and place are part of such actors and networks and they are forged into the relations. The interactions are also fluid and flexible to allow for the dynamics and mutual relations between the actors.

Such a view entails going beyond the myth of the single architect, who shapes the design or product in a singular, straightforward, or detached way. This main actor grows to involve and incorporate a collective of other actors. This starts from where the design or product is initiated, including other actors from similar or supporting professions, in addition to the actors that are deployed, harnessed, and involved to complete the job. This is also not restricted to the human, but exceeds it to include non-human contributors. As the architect with other actors form part of such a collective, they shape and create the design or the product. They inscribe it in a way that either engages or disengages it from its users and integrates or disintegrates it from its surroundings to translate in specific ways.

As the design or product proceeds, and whether or not its users and surroundings are integrated, it is received, adapted, or appropriated through a variety of responses and a diversity of reactions among the users. Non-human actors form part and contribute to such interactions. Through these responses and reactions of the users as well as the interactions with other non-human actors, the design or product is described in a way that might support the main architect’s intention, tinker, reconfigure, and resist it. In this way, the users and other actors are part of the collective that translates the design or product in different ways.

As the design or product changes, it recreates new arrangements and configurations, shifting societies and places in different ways through a collective that further grows through its
continuous translation. Such mutual relation does not end at this particular point as the design or product could go back to its architect, who shapes it in a different way and hands it again to its users in a continuous process of creating, configuring, and reconfiguring the design or the product. The collective follows such changes and shifts and goes ahead with its translation.

This chapter has presented the designs or products as far from being simple as a result of one actor or entity, as they are embedded in contestation as a result of the multiplicity of actors that contribute to them. What adds to this complexity is that the actors involved are not homogenous as they are different, exerting heterogeneous beliefs and practices that could further change over different times and places. Architectural designs or products are not static, following one way or a linear path as they are changeable following multiple options and different paths through which they could potentially proceed. Architectural designs or products are not predictable as there is a wide arena and a series of potential pathways through which they could proceed. Rather than being material and based on rational decisions, negotiations take place among different incorporated actors, creating and recreating the products in different ways. Rather than being replicable and irrespective to societies and places, variety takes charge among the designs and products that, in turn, diversify their societies and places.

With focus on sustainable design strategies, the contribution of this study addresses three aspects. Firstly, although much has been written about how technologies travel from design to use (e.g. Guy, 2006; Ornetzeder and Rohracher, 2006; Rohracher and Ornetzeder, 2002), and about the living lab concept in sustainability contexts (e.g. Evans and Karovonen, 2011, 2014; König and Evans, 2013), this thesis has aimed to tackle the design-use interaction putting the two approaches together and addressing the continuous chain of interaction, where technologies and designs do not merely land and stop evolving upon their delivery.
Secondly, the thesis has aimed at focusing on the process of interaction with the travel between the design and use. In other words, it unravels what happens in-between them without any judgment to be made on a completed event, without any criticism or celebration of the final output, and without emphasizing the cause and effect of these results. This approach does not view sustainable designs as end results or final outcomes. Rather, it views them as emerging and happening.

The third contribution of the thesis has been to reveal the hidden reality or realities, when sustainable designs travel from their design source and get delivered, materialised, and situated. Sustainable designs are not static, and the surroundings where they are delivered are not passive receivers in a binary or straightforward movement. Rather, they affect and become affected by the different surroundings in different ways that my research has aimed to continuously explore and unpack. Such explorations do not only explain the travel of such designs, but also provide a new angle from which they could be seen.
Chapter 3: The Research Methodology

3.1 Introduction

This chapter aims to describe the followed methodological research approach and clarify the selected empirical project. It is based on the main aims and objectives as well as the research questions that tackle understanding designs and technologies and their travel in Masdar City. They explain the shaping of their collectives through the inscriptions and de-scriptions they go through. In doing so, I am particularly inspired by Yaneva’s quote:

I construct and compare the epistemological positions of the hasty sightseer and the slow ethnographer of architecture. The first demonstrates an understanding of architectural objects as static surfaces where meaning can be projected; the second refers to the more dynamic understanding of the processes (Yaneva, 2013, p. 122).

Adapting the position of the slow ethnographer, I use a qualitative and inductive methodology that captures the complexity, dynamism, and unpredictability of the designs and their travel. Laws and McLeod (2006) suggest some essential characteristics of qualitative and inductive research. The researcher is a primary source of extracting the perspectives and investigating the direct experiences. Fieldwork is an important source of data collection with a deeply focused direction of analysis and a thoroughly descriptive nature of findings.

3.2 The Case Study Approach

The main methodology of this research is an in-depth case study. The importance of such approach is its focus on concrete and local interpretations and experiences. According to Yin (2009), case studies permit explanation, description, and exploration of events or phenomena in the everyday contexts in which they occur. He stresses that they present further importance when the boundaries or differentiation between a phenomenon and its context is not clearly evident. Flyvbjerg (2001, 2006) argues that this opposes neat formulae, general, or universal theoretical knowledge and emphasises practical realities. He adds (2006, p. 228) that “formal generalization is overvalued as a source of scientific development, whereas ‘the force of example’ is underestimated.” Case study research goes beyond the study or analysis of singular and isolated incidents. The relevant case study data is likely to come from multiple sources of evidence that are bound together and to the context in different ways.

In this way, while they are not the only valid form of scientific research, case studies provide exemplars that are crucial to making scientific disciplines relevant to contexts. This comes in line with Geertz’s (1983) argument for replacing thin descriptions with thick descriptions, where knowledge and practices go beyond the superficial queries as what is achieved is deeper, more thorough, and more profound. Mills and colleagues (2010) recommend the utilisation of such type of description in case studies that emphasise stories and narratives. As it is impossible to tell the full story, the aim is to tell as much as might be collected through observations and interactions.

Among case study types that Flyvbjerg (2006) explains, the selected case study in this thesis is not crucial nor an extreme case to the travel of designs and technologies. It is a practical example
that contributes to the understanding of such process while producing knowledge and encouraging practices. With this specific input that it provides and as Yin (2009) clarifies, a single case study as a type that represents and demonstrates the process under inquiry and investigation is comprehensive and sufficient compared to multiple cases.

The selected case, Masdar City, is designed by the architectural and urban planning firm Foster + Partners in the UK and implemented in the Middle East, more particularly in the United Arab Emirates. The city is considered one of the first sustainable cities in the Middle East on such a comprehensive scale. I utilise such case as it presents multiple points of interest. First, it shows a case of technologies travel, where the design and implementation are not directly related considering the fact that designers, being from a Western firm, are far away from the project implementation. This gains interest with the fact that, at the time of the study, the city is still being implemented, which gives an opportunity to follow the design processes in the making with the learning loops that emerge within them. The selected case also allows for reflecting the ideas of design-use interaction on sustainable designs and the concept of sustainability, where similar loops could be potentially followed and specific ideas about sustainability as a concept could be extracted.

MIST represents the first stage of Masdar City, which is the focus of this study. I emphasise the first and second phases and I take the student residential buildings as a case. The reason for choosing the residential buildings is that their design entails specific technical and social assumptions as they affect and becomes affected by the particular trend of design as well as the modes of usage based on specific consumption patterns and ways of living. In this way, I address a gap in the literature on Masdar City, where much has been written about the city as a critique of ecological modernization and the global-capitalist innovation agenda (Crot, 2013; Cugurullo
2013, 2015; Fox, 2009; Lau, 2012; Reiche, 2010a,b; Vella, 2008; Walsh, 2011; Wellinghoff and Chu, 2009). What is different in this study is that it focuses on the understanding of the technology in this specific project and the shaping of its collectives. It further addresses the residents’ experiences and de-scriptions and how they connect and inform designer intentions and inscriptions through design travel.

3.3 Masdar City and Actor Network Theory

The residential buildings of MIST imply a case that is complex, dynamic, and unpredicted tackling designs as well as their travel. An Ontological focus here is given to a case that is not organised. When it comes to reality, it is less organised and more confused. To embrace rather than simplify such case, a specific lens is used through Actor Network Theory (ANT) (Callon 1980, 1986, 1987, 1991; Law 1987, 1992, 2003, 2007; Law and Callon, 1988; Law and Mol, 2001; Murdoch 1997, 1998). The specificity of ANT as explained in chapter 2.2 lies in the fact that it defies dualism or any sort of division and distinction between the technical and social worlds while forging time and space in the same mold.

The purpose is then to explore the residential designs and how they proceed while affecting and being influenced by the setting that embraces them. It is also to comprehend the specificity of such designs as collectives and gather data about their processes to allow understanding of their travel to use; in other words, from their inscriptions to de-scriptions. This is achieved by slowly and incrementally exploring the residential designs and developing deeper comprehension of the decisions made through the design process as well as the ways of appropriation and adaptation through use. It entails following the designs with their architects at work in the office of Norman
Foster in London and the work of the local design and development team in Masdar City as well as the users within the residential units.

The analysis also aims to understand the variety of social and technical actors involved, including the designers, developers, users and others with each having its own roles and interests. It also entails comprehending the relations and associations that are created or dismantled as a result of agreement and conflicts among the actors. It focuses on the socio-technical collectives or networks that navigate their actions and reactions. In addition to that, there is an exploration of how these connections reshape the designs as well as the technical and social worlds as they are configured and reconfigured in different ways, producing similar or different meanings of sustainability.

This gains further interest when acknowledging that neither technology nor society, in addition to the other actors, are always the same as the ones that were planned and expected at the beginning of the design project. The design or the technology is in itself not static or rigid as it also affects and is affected to a great extent by society. Society, in turn, is not simply the receiver of a sustainable architectural design or a technology. For Latour (1987, p. 259), understanding “what machines are” is complementary to understanding “who the people are” as both shape each other. In this way, technologies and societies take shape in a process of co-evolution and negotiation. That is why it is important to take into account the architect and the user as well as all the actors that contribute to the design or technology and receive similar influence from them. This is important to realise considering the different roles, the change of interests, and maybe the shift in the meaning of sustainability itself and the original aims of the designs while redistributing roles and requirements.
3.4 Actor Network Theory and Grounded Theory

This research is based on a case study methodology that has been inspired and informed by ANT and Grounded theory, where the contribution of both is specific. ANT is not a theory or a defined framework as it describes a way of undertaking inquiries and investigations (Law 2004, 2007; Yaneva, 2013). Rather than providing a rigid path of exploration, ANT suggests an attitude or way of exploration that can be adapted by different people in various ways. In this way, one person’s reading or use of ANT may differ considerably from another’s, resulting in a variety of views and ways of conceiving the same aspect under study (Cressman, 2009; Law, 2004). Glaser and Strauss (1967), Strauss (1987), Strauss and Corbin (1998) provide similar arguments to the Grounded Theory as they imply that it is not a theory, it is a method, an approach, and a strategy. They also show how its utilization depends on the different users, who might adapt it in a variety of ways.

ANT is strongly connected to the Grounded Theory approach and both are complementary approaches, where they are bound to the context as the main source from where the data emerges, informing the case study methodology mainly utilised in this research. Within this context, everything is kept at ground level including the researcher. In this way, they emphasise the closeness to the field from where observations and interactions are obtained as a key characteristic to follow and trace knowledge and practices as collectives that are conceptualised or inscribed and then situated or de-scribed within specific contexts. The researcher is embedded within the subject matter, even if in some other situations he/ she keeps a certain distance.

In this way, the researcher collects data and allows relevant ideas to enrich the overall research content without affecting it by his own input or pre-conceived theories while at the same time not
keeping it loose and open to whatever could emerge that would go beyond the researcher’s interests (Crang, 2003; Laws and McLeod, 2006; McGhee et al., 2007). The aim is not to come up with one self-standing theory to be proven and supported. It is actually to unfold the different mini-theories that could be captured from their native worlds (Glaser and Strauss, 1967; Strauss, 1987; Strauss and Corbin, 1998). In other words, it is to describe the stories and narratives that emerge and happen (Latour 1986, 1987; Yaneva, 2009a,b,c), informing the queries of the case study methodology. Epistemologically, a focus is provided on knowledge developed through experiences and interactions that are produced through diverse modes and arenas. This aims at uncovering and capturing the design and their travel as well as the shaping of the design collective through inscription and de-scription processes.

Furthermore, research inquiry and investigation according to both ANT and Grounded Theory is not a one-directional, simple process. Although the word inductive could imply a specific direction of the research that emerges from the field, the process is rather complex and iterative, embedded with continuous revisiting and revising. This is also done by continuously validating and testing the emerging experiences and interpretations to produce more data that can be further validated and tested.

To extract and validate data in relation to my research aims and questions, I have utilised a variety of methods through different means. Such methods include desk-based study, semi-structured (formal) as well as unstructured (informal) interviews, and site observations. The methods address two parts of the research; the first part relates to the design as collective that it is done or inscribed and the second relates to it as it is contextualised or de-scribed and accordingly reshaped and recreated.
3.5 Following the Designer/ Developer Inscriptions

Through the first period of the research, I analysed articles, books, brochures, media scripts, organizational or institutional reports, public records, and other related documents on Masdar City. I also reviewed drawings, maps, diagrams, charts, photographs and any related images of it. This review has provided a focus on the areas of exploration and interest in line with the main research aims and questions. Such desk research and analysis of available texts and images helped in providing a generic, broad overview of the case study.

This specific moment intersected with seven-month fieldwork in London (UK) as well as Abu Dhabi (UAE) for the period from 10th of February to 15th of September, 2014. Based on a qualitative, inductive methodological approach, I conducted a total of thirty five interviews with designers, developers, professors, and students. Such interviews were formal, of a semi-structured, in-depth nature as well as informal, of unstructured nature. Along with that, I also did a total of twenty four site observations inside MIST, and more particularly the residential units, to follow and trace the different actors in the making and happening of the project. Such actors included humans and non-humans that were involved marginally or significantly in the project. This said, I adapted a middle ground between a rigid, organised approach from the one hand and a spontaneous, free flowing method from the other (Esterberg, 2002), between what I prepared for and what emerged unpredictably from the field.

I was interested in recording such moments of frequent commute by train between Manchester and London that marked the beginning of my fieldwork while I was still in the UK. 22 Hester Road at Riverside was the main location, where Foster + Partners office was located. Impatiently, I could clearly remember how I used to pass through the glass doors, go up the stairs
and move by the elegantly situated employee/guest snack bar that overlooked them.

Approaching the end of the stairs, I used to leave a note at the reception and wait for my participant in the bar. My participant would come afterwards and take me to the main multiuse hall, where we talked and discussed designs, documents, and visualizations. We used to be surrounded by working spaces that were composed of lined offices and rounded tables. The hall was active and extended, where the architects, engineers, designers, specialists, visitors, and clients interacted in different ways while meeting, discussing, chatting, debating, and maybe negotiating. This became of further interest when recognizing their interaction with each other and with the images, diagrams, and documents hijacking office desk space, tables, and covering the surrounding walls. Such crowds and noises, while filling me with astonishment, reminded me how architectural products emerged and happened from and within such multiplicity of human and non-human actors (Latour, 1987; Yaneva, 2009a,b,c), where each contributes in its different way.

Having received some insights and remarks from the designers in London, and acknowledging the need to come back to them at certain points afterwards, I travelled to Abu Dhabi, where I approached more designers from Foster + Partners and other related offices. I had the chance to interview them outside their offices and, in a few cases, to accompany them in joint site observations through the city. I also approached the main designers and developers at Masdar offices, which were situated at a temporary-structure cluster located on the side before reaching Masdar City visitors’ main entrance. I would also recall these moments when I used to pass through the main security kiosk, wait for them at the reception desk, where I called or left a note. They would come afterwards and take me to a meeting room inside one of these structures that, although looked temporary from the outside, could not be distinguished from any other fancy
permanent office from the inside. In this way, the designers from Foster + Partners in the UK and UAE as well as the designers and developers in Masdar offices formed the main actors of design that I followed for the aim of this research.

I introduced myself to the different designers and developers through emails. I presented myself as an insider and outsider, having a background and knowledge in the gulf region culture, education in architectural engineering, and training on architectural research. I always needed to confirm that I was a PhD student and provide the names of my supervisors and the university I was part of. I mentioned in multiple occasions that I got the approval of my university as well as MIST to conduct the research, which guaranteed that I already followed the ethical procedures for approaching participants, dealing with data, safety, security, and other necessary fieldwork aspects such as checked participant information sheets, interview schedules, and consent forms to approach the designers and developers (see Appendix A). I had also managed to meet some of the designers and developers in summits, exhibitions, and lectures, where I had the chance to introduce myself and conduct more informal talks. I found such talks more informative sometimes than formal interviews, where the participants felt tracked and recorded and accordingly were more cautious and maybe conservative. Whether I introduced myself through emails or informal talks, I explained my research purpose of understanding their intentions, decisions, and expectation in regards to the different design strategies and how they were translated in different ways of usage, inhabitation, and adaptation among different users or in other words, the inscriptions and de-scriptions of design strategies. Another target is to find how each of them contributed in shaping and creating the project within a specific collective while tracking all the effects and influences within it. This has led to comprehending how they provided different interpretations and actions in regards to sustainability.
I introduced my research in simple terms to ask questions that were easy to grasp and attempt to observe without raising any concerns or sensitivities. I made it clear through such introduction and background that participation was voluntary. I conducted twelve interviews with designers and developers; six from F+P, four from Masdar City, in addition to two professors from Masdar Institute, to understand their intentions or inscriptions of design strategies. These interviews were conducted at the participants’ offices or in public places and each took around half an hour to two hours. I traced and followed what every actor said and did, where I gave them the space to speak and act. I amended the interview schedule on the basis of what I received and learnt from my participants. As I was open to receiving the surprises and the unpredicted outcomes from them, I still kept my research focus on track, not allowing it to divert from the main emphasis. As they did not allow to share most of the documents and plans, I took lots of sketches and diagrams to connect between what they explain and the drawings they use in some cases to clarify their arguments. In some cases, they would draw tentative sketches for me to explain some design aspects, where I kept a record on such drawings and connected them to the discussion. I used to come back and forth between these designers and developers after conducting further interviews and site observations. I was referred to other participants through a “snow balling effect” when my questions got more specialised in certain areas. Ultimately, this determined the number and nature of the interviewees to include most of who had collaborated in the design and development of the specific stage and, at the same time, who were available and open to be interviewed.

I did one site observation with a designer in addition to the ones that I did on my own or with students. The site observations were connected to what the participants said in the interviews, as they showed and revealed the different actors that contributed to their intentions or inscriptions.
As I accompanied them to the site, I took notes, captured photos, and drew sketches and diagrams. In some cases, I came back to my designers and developers and asked additional questions in regards to the points that were raised. Through such observations, I was caught by a tree that drops shade, a pod that moves from one stop to another, a wind-tower, a courtyard, a façade, and other actors that contributed in telling the stories. As I followed them, I wondered how all of the actors, be they human or non-human, could act and contribute in the emerging stories and scenarios.

I guaranteed anonymity for all participants for privacy reasons, where each of them was given a pseudonym that is clarified in Table-3.1 below. I collected verbal as well as written consent from all participants.

Table-3.1: Interviewees from the design part (Source: author).

<table>
<thead>
<tr>
<th>#</th>
<th>Pseudonym</th>
<th>Category</th>
<th>Designation</th>
<th>Entity</th>
<th>Location</th>
<th>Date</th>
<th>Nature</th>
<th>Length of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS1</td>
<td>George</td>
<td>Designer</td>
<td>Senior Partner</td>
<td>F + P</td>
<td>London Office</td>
<td>18/2/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>DS2</td>
<td>Ralf</td>
<td>Designer</td>
<td>Partner and Architect</td>
<td>F + P</td>
<td>London Office</td>
<td>27/2/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>DS3</td>
<td>John</td>
<td>Designer</td>
<td>Partner and Site Engineer</td>
<td>F + P</td>
<td>Masdar Institute</td>
<td>12/3/14</td>
<td>Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>DS4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GEMs Education – Project Office</td>
<td>30/3/14</td>
<td>Informal</td>
<td>Half an hour</td>
</tr>
<tr>
<td>DS5</td>
<td>Augustine</td>
<td>Designer</td>
<td>Partner and Site Architect</td>
<td>F + P</td>
<td>Masdar Institute</td>
<td>27/5/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>DS6</td>
<td>Hashem</td>
<td>Designer</td>
<td>Architect</td>
<td>F + P</td>
<td>Riyadh</td>
<td>1/2/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>DV1</td>
<td>Isaac</td>
<td>Developer</td>
<td>Development Manager</td>
<td>Masdar City</td>
<td>World Future Energy Summit WFES-2014</td>
<td>20/1/14</td>
<td>Informal</td>
<td>Half an hour</td>
</tr>
<tr>
<td>DV2</td>
<td>Charlie</td>
<td>Developer</td>
<td>Development Manager</td>
<td>Masdar City</td>
<td>Masdar Offices</td>
<td>24/3/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>DV3</td>
<td>Mike</td>
<td>Developer</td>
<td>Efficiency Engineer</td>
<td>Masdar City</td>
<td>Masdar Offices</td>
<td>21/4/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>DV4</td>
<td>Sameeh</td>
<td>Developer</td>
<td>Facility Management</td>
<td>Masdar City</td>
<td>Masdar Institute</td>
<td>19/7/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
</tbody>
</table>
It is worth mentioning that my interaction with such participants was only a part of the story of a long fieldwork, which I uncover gradually through the empirical chapters. I used to believe that, when it came to the designers and developers, I would be exposed to specific interpretations and actions from design and development actors that sat at the top, or in some cases between the top and bottom of the main decisions and intentions made in relation to design strategies. However, when it came to the users and other participants at the bottom, I was exposed to different expectations and experiences through the implementation of the project while being intertwined or in tension with the previous ones. This showed actually how it was complex to go through such processes and actors reflecting “multiple realities” (Mol, 2002). Each of them appeared to contribute differently in the emergence and happening of design strategies.

The argument is that all the processes around the project including the design, development, and implementation are intertwined and stitched together in different ways although each of them could have its specific actors. Accordingly, there is no way to understand one of these processes without tapping into the others, and there is no mean of taking the views of a certain actor without incorporating the others. Through the interaction of such processes and actors, the design strategies emerge within different societies and places. In this way, the design strategy is not a single object that is waiting to be seen and practiced through a one directional, unified, or singular way. Rather, it has a variety of ways through which it could be interpreted and experienced (Healy, 1995; Moore, 1997; Yaneva, 2009a,b). What adds to such complexity is that
it is not static, frozen, or, rigid but changeable and transformable in predicted or unpredicted ways. Through this interaction of the design strategies, societies and places are created and recreated in a variety of ways and this is how reality multiplies among different processes and actors.

3.6 Between the Designer/ Developer Inscriptions and the User’ Descriptions

Through the second part of the research, and acknowledging the necessity to come back and forth to the designers and developers, I decided to approach the users. For the first two months of my fieldwork in Abu Dhabi, I used to go on daily basis to MIST. I had reserved a room at a hotel adjacent to Abu Dhabi airport, which is located five to ten minutes from Masdar City by car. After that, I used to come to Abu Dhabi from Dubai twice to three times a week. I had the chance to walk through, sit around, and explore the different buildings and spaces. The main users of Masdar City were the students of MIST, who were supposed to interact with the design strategies in many different ways through their working and living activities. They were accordingly my main actors of use that I followed for the aim of this research.

At the beginning, I approached them via email, where the institute’s student affairs offered to send out an email to the potential students, although refused to share their contact details. In parallel to that, I decided to approach some of them directly through professional and social media such as Facebook and Linked-in. I also attended some gatherings, meetings, and organised events with students. I used every occasion to introduce myself, whether through other students or casual, informal chats; sharing contacts and inviting to interviews and site observations.

I was amazed by how responsive, helpful, and excited some of the students were, being eager and willing to be part of the research, share some insights, and describe their expectations and
experiences. I believe this was an advantage of doing research in a research-driven facility. I presented myself as a post-grad student, who had her own theoretical and empirical research that made me similar to them and made them willing to facilitate the research; helping a colleague in a way. However, having got an architectural background in practice and research made the nature of my work different than the common areas of the institute, which were mainly related to science and engineering. The approvals that I had already received by that time from my university and MIST paved the way for such a process, which showed me following all the ethical procedures and having all necessary preparations such as checked participant information sheets, interview schedules, and consent forms to approach the users (see Appendix B).

I explained my research purpose and introduced it in simple terms in order to ask questions that were easy to grasp and attempt to observe without raising any concerns or sensitivities. I made it clear through such introduction and background that participation was voluntary. I conducted twenty three interviews with the students; eleven from phase (1-A) and twelve from phase (1-B), to understand their experiences or descriptions of design strategies. These interviews were conducted at public places or in their residential units, along with site observation, where each took two to three hours in total. I traced and followed what every user said or did, where I gave them the space to speak and act. I refined the interview schedule on the basis of what I received and learnt from my participants. I used to come back and forth between them and sometimes to the designers and developers after doing further interviews and site observations to build on and expand.

The site observations were connected to what the participants said in their interviews, so they showed and revealed the different actors that contributed to their experiences or descriptions. I took notes, captured photos, and drew sketches and diagrams. In most of the cases, students
would take me through the site observation in their buildings and units before the interview. As we discuss the different aspects, they would explain to me while showing around the unit to clarify. In the case of male students, and as accessing their buildings and units was forbidden for females as per MIST internal policies, I resorted to a male companion to attend the interviews and then accompany the concerned student to take photos in his unit, particularly focusing on the points that have been raised, which I explained to him. Through such observations, I tried to capture the interactions between the different actors, human and the non-human, and how each of them affects and becomes affected by each other. I was caught by a window that is closed with a shutter, a slot that is shut by a piece of carton, a switch, a card, a sensor, and other actors that seem to contribute to the stories. I observed them, asked questions about them, and followed the different stories and scenarios that uncover such actors that, although could not speak, still act while involving and engaging designers, developers, users, and the different actors in different ways.

I guaranteed anonymity for all participants for privacy reasons, although it looked to me that the students formed a limited and enclosed group of maximum 500 who knew, met, and interacted with each other, making it somehow challenging to keep their anonymity. Still, each of them was given a pseudonym that is clarified in Table-3.2 below. I collected verbal as well as written consents from all participants.

Table-3.2: Interviewees from the user part (Source: author).

<table>
<thead>
<tr>
<th>#</th>
<th>Pseudonym</th>
<th>Category</th>
<th>Designation</th>
<th>Phase/Building</th>
<th>Location</th>
<th>Date</th>
<th>Nature</th>
<th>Length of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Edward</td>
<td>User</td>
<td>2nd Year Master Student– Couple</td>
<td>A/ Bio-Mass building</td>
<td>Third Floor</td>
<td>28/3/14</td>
<td>Formal/Informal</td>
<td>Three hours</td>
</tr>
<tr>
<td>S2</td>
<td>Mahmoud</td>
<td>User</td>
<td>2nd Year Master Student– Couple</td>
<td>A/ Bio-Mass building</td>
<td>First Floor</td>
<td>18/4/14</td>
<td>Formal/Informal</td>
<td>Three hours</td>
</tr>
</tbody>
</table>
Table 3.2 (continued): Interviewees from the user part (Source: author).

<table>
<thead>
<tr>
<th>#</th>
<th>Pseudonym</th>
<th>Category</th>
<th>Designation</th>
<th>Phase/Building</th>
<th>Location</th>
<th>Date</th>
<th>Nature</th>
<th>Length of Interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>S3</td>
<td>Sophie</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Couple</td>
<td>A/ Bio-Mass building</td>
<td>First Floor</td>
<td>18/4/14</td>
<td>Formal/Informal</td>
<td>Three hours</td>
</tr>
<tr>
<td>S4</td>
<td>Eman</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>A/ Wave Building</td>
<td>First Floor</td>
<td>11/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S5</td>
<td>Tiana</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>A/ Wave Building</td>
<td>First Floor</td>
<td>29/4/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S6</td>
<td>Lara</td>
<td>User</td>
<td>Graduate MIST Student (2009)</td>
<td>A/ Wave Building</td>
<td>Third Floor</td>
<td>6/4/14</td>
<td>Formal</td>
<td>One hour</td>
</tr>
<tr>
<td>S7</td>
<td>Yan</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Male</td>
<td>A/ Solar Building</td>
<td>First Floor</td>
<td>8/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S8</td>
<td>Majdi</td>
<td>User</td>
<td>1\textsuperscript{st} Year PhD Student – Male</td>
<td>A/ Solar Building</td>
<td>Third Floor</td>
<td>3/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S9</td>
<td>Abdullah</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Male</td>
<td>A/ Solar Building</td>
<td>Second Floor</td>
<td>7/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S10</td>
<td>Wasim</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Male</td>
<td>A/ Wind Building</td>
<td>Third Floor</td>
<td>8/3/14 - 10/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S11</td>
<td>Hamdi</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Male</td>
<td>A/ Wind Building</td>
<td>Third Floor</td>
<td>21/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S12</td>
<td>Wajd</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>B/ Tidal Building</td>
<td>Second Floor</td>
<td>2/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S13</td>
<td>Nesma</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>B/ Tidal Building</td>
<td>Fourth Floor</td>
<td>16/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S14</td>
<td>Aysha</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>B/ Tidal Building</td>
<td>Second Floor</td>
<td>4/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S15</td>
<td>Maya</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>B/ Tidal Building</td>
<td>Third Floor</td>
<td>20/4/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S16</td>
<td>Maram</td>
<td>User</td>
<td>1\textsuperscript{st} Year Master Student – Female</td>
<td>B/ Tidal Building</td>
<td>Third Floor</td>
<td>25/3/14</td>
<td>Formal/Informal</td>
<td>Two hours</td>
</tr>
<tr>
<td>S17</td>
<td>Mira</td>
<td>User</td>
<td>1\textsuperscript{st} Year Master Student – Female</td>
<td>B/ Bio-Fuel Building</td>
<td>Third Floor</td>
<td>4/3/14</td>
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<td>S18</td>
<td>Larry</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Female</td>
<td>B/ Hydro Building</td>
<td>First Floor</td>
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<td>S19</td>
<td>Ammar</td>
<td>User</td>
<td>1\textsuperscript{st} Year Master Student – Male</td>
<td>B/ Hydro Building</td>
<td>Second Floor</td>
<td>29/3/14 - 4/4/14</td>
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<tr>
<td>S20</td>
<td>Darren</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Male</td>
<td>B/ Hydro Building</td>
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<td>S21</td>
<td>Jonathan</td>
<td>User</td>
<td>1\textsuperscript{st} Year Master Student – Male</td>
<td>B/ Hydro Building</td>
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<td>S22</td>
<td>Allan</td>
<td>User</td>
<td>2\textsuperscript{nd} Year Master Student – Male</td>
<td>B/ Hydro Building</td>
<td>First Floor</td>
<td>28/3/14</td>
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<tr>
<td>S23</td>
<td>Javed</td>
<td>User</td>
<td>1\textsuperscript{st} Year Master Student – Male</td>
<td>B/ Geothermal Building</td>
<td>Second Floor</td>
<td>31/5/15</td>
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Parallel to that, and reflecting on what I was collecting during my fieldwork, I attended lectures, conferences, and workshops and took my stories from MIST to many other events, meetings, and gatherings, where I shared and discussed them with other researchers. I wrote and read some abstracts and articles to share my knowledge and receive some feedback, comprehending the relation between the social and the technical, the subject and the object, and the user and the design. It became clearer to me that society is not out there waiting to receive, adapt, or take up technologies as they are. On the contrary, it supports or resists, adapts or challenges, and re-appropriates or changes them. At the same time, technologies reshape, recreate, and modify it in so many different ways, as both are inherently entangled in everyday life (Latour, 1987; Yaneva, 2009a,b). This gains interest when acknowledging that technology and society change and shift with such relation, and this is how truth multiplies among different places and times. These moments of interaction are not easy or static to capture as they are complex and dynamic. This is why a slow, contingent, and elaborate approach has been adapted while framing the tackled society, technology, place, and time. The idea is not to categorise, explain, or demonstrate certain interactions, but to recognise the huge diversity that emerges from them with different reflections on how sustainability could be defined and redefined.

As doing research and collecting data is accomplished through an iterative, reflexive, and continuous process for the purposes of validating and testing data, other methods of analysis and writing up access such loops and become part of research inquiry and investigation in relation to my research aims and questions. Such methods are thematic analysis and visual presentation and mapping.
3.7 Thematic Analysis

Interview transcripts and other textual data were analysed simultaneously using thematic analysis. According to Braun and Clarke (2006: 6), "Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data." An advantage of this approach is that "thematic analysis is not wed to any pre-existing theoretical framework, and so it can be used within different theoretical frameworks" (Braun and Clarke, 2006: 9), including the Actor Network Theory utilised in this thesis. The analysis was undertaken with the aid of qualitative data analysis software (NVivo 10). Data were coded in pursuit of the research aims of exploring how the collective is shaped and reshaped through inscription and description processes. The analysis process was not linear, but required rethinking and reflection on codes in order to identify over-arching themes and to build a plausible and persuasive argument.

3.8 Visual Presentation and Mapping

Images could say lots of words and provide a variety of presentations. Drawing on my design skills, I have aimed to provide graphic interpretations through a number of diagrams, sketches, and maps. The visuals are a different and complementary way of understanding the setting as they form another part of the analysis through which elements are grouped, themes are pointed out, and arguments are shaped and illustrated. In addition to the illustration that I drew to show different aspects of the designs, I put down the emerging aspects and built their relations in the form of maps, which helped to get a closer and more comprehensive understanding of the collected and analysed data. In this way, visuals become ‘actors’ of the story telling in the thesis, taking further the provided arguments and suggesting ways of analyzing and presenting them.
Such combination of methods, I propose, would potentially help in addressing the issue under scrutiny from different angles while ensuring their validity and reliability at the different stages. The different ways of collecting and analyzing data are highly subjective, which means that one researcher’s way of adapting them is different from other researchers. However, it is important to highlight that the outcomes are highly guided by the research aims and questions.

3.9 The Structure of the Empirical Chapters

As I went through what I collected and started to analyse what related to the two phases of MIST, and the residential units in particular, it appeared to me that there is a multiplicity of designs and technologies that emerge from within the project. Each of which, provide a story that can shed light on the inscription and de-scriptions and the shaping of the resultant collectives. The facades, the wind-tower, the narrow passages, the courtyards, the atria, the air-conditioning, the monitoring and control systems, and much more, were stories that left me overwhelmed and almost puzzled at the beginning on how to keep focus on them while connecting them to different aspects. Another challenge was in how to select the most representative stories in connection to research aims and questions.

The interconnectivity of the narratives made it baffling to maintain a specific focus without abstracting or separating such narratives from their related aspects. For example, the PRT narrative, which emerged as a key aspect of understanding the shaping of the collective through inscriptions and de-scriptions, had a lot of intertwining characteristics with the aspects of walkability that connect to the design of narrow passages, the courtyards, and the wind-tower, which in turn connect to the facades and units and other aspects. Similar to that is the case of lighting strategies, which emerged as another key aspect, where a similar chain evolves
connecting them to air-conditioning, water, windows, slots, facades, and atria that in turn connect to the narrow passages, courtyards, wind-tower, and other aspects. The stories that link the ins and outs, the hidden and the uncovered, and the envisaged and practiced present long chains of interaction between what could contribute marginally or significantly in the process.

I started to study such narratives further through thematic analysis and visual methods. I broke them into fragments, from which themes could emerge, and arguments could be shaped. Figure-3.1 shows a general outline of some of the emerging fragments, the potential relations, and the ways of grouping them together. Figure-3.2 titled “themes that could relate to the drivers and forces”, reflects on a major theme that formed the first empirical chapter tackling the sustainable architecture and the inscription of Masdar City. In other words, the decisions of the designers that could potentially materialise in specific ways. Figure-3.3 and 3.4 show some fragments that have been already connected to each other to produce the major themes from which the rest of the empirical chapters could potentially be shaped. Figure-3.3 titled “commute and walkability”, shows the inscription and de-scription of sustainability in the mobility network in Masdar City. It reflects on the decisions of the designers that have materialised in reality through different ways of adaptation, use, misuse, and resistance within the users. Figure-3.4 titled “controllability and choice”, tackles similar inscription and de-scription of sustainability in the household in Masdar City. The themes of the last three figures have been refined later to provide an emphasis on the aspects of focus and shape the three empirical chapters.

The three empirical chapters were then put together to focus on three examples of sustainability strategies; Masdar City on the master scale, mobility strategies with focus on the PRT, and household management with focus on lighting strategies. The importance of such examples comes from multiple aspects. Firstly, the emerging data in relation to the three examples
presented interest and importance as it reflected on instances that were mostly rich and detailed. Secondly, the three examples presented useful emerging collectives, where the actors involved and the relations between them reflected on the explained complexity of the research. As the collectives changed between different actors, they reflected on the explained dynamism. The three examples then showed interesting cases of shaping the collective and its changeability between inscription and de-scription processes, reflecting on the main research aims and questions.
Chapter 3: The Research Methodology

Ahlam Sharif

Figure 3.1: General outline of potential relations (Source: author).
Figure-3.2: Identified relations shaping the empirical chapters – drivers and forces (Source: author).
Figure 3.3: Identified relations shaping the empirical chapters – commute and walkability (Source: author).
3.10 Conclusion

This chapter has aimed at clarifying the main research method utilised to comprehend the designs and their travel as well as the shaping of the design collective through inscription and description processes. It is interesting here to realise that what emerges from such study is so specific for the time and place when and where it is conducted. Further researches can be done for a similar purpose utilizing the same case. However, with the continuous movement of the designs and technologies, the findings could be different and stand far from what emerges from this study.

It should be acknowledged that this methodology has a number of limitations. Firstly, as the main actors were identified, approaching them proved not to be easy. Some of them could have time or privacy constraints, which made them prefer to keep away from the research. Secondly,
while approaching actors got easier with the snow-balling effect, their number appeared to grow significantly. The network that connects between these actors became more branched and wide-ranging than expected, which necessitated a point where such actors should be framed and bounded. Thirdly, most of the mentioned actors were human, who I could interview and observe. It becomes more interesting and puzzling to regard the non-humans as important as the humans, with their roles and contributions that have specific emphasis. This gains further importance and challenge as most studies and analyses could disregard such actors. What has happened in this study is that those actors have been brought to the front and given specific focus. Although I cannot speak to them and listen to their expectations and experiences similar to other human actors, I still have access to them through the latter and I can extract them from the interviews and site observations. I speak to them my own way, I watch them, touch them, and ask other actors about different stories and narratives to figure how they act, contribute, and have their important roles in the ongoing arguments and debates. Although the main actors that are prominent in the analysis are the designers, developers, and users, it becomes harder to separate their stories and narratives from the non-human actors they interact and react with. The designers again become actors of design and users are actors of use to embrace such mix.

The last aspect of challenge, which is in a way connected to the previous one is that as the target was to study the actors and the focus was on a network of interactions between the human and the non-human, it became harder to study these actors as they were not single but complex. What has added to this complexity is the dynamism of the network within which such aspects are embedded as it becomes not rigid but changeable. Unpredictability adds to this complexity as it becomes harder to capture these aspects through a straight-forward approach.
Chapter 4: Sustainable Architecture and the Inscription of Masdar City

4.1 Introduction

This chapter begins to follow the travel of the architectural design, which is the main focus of the thesis, with the case of Masdar City. It accordingly emphasises its design and development on the master plan scale, including its main factors and key aspects that relate to specific sustainable aims and targets. It shows how the designers and developers imagine, expect, and project usage trends. This paves the way for the following chapters that provide empirical examples of such design and development and the resultant strategies on both neighborhood and building scales and their implementation and use.

This chapter is structured in four parts. The first part presents the contextual aspects within which Masdar City has emerged, which paves the way for the second part that describes the main aims and drivers of Masdar City. The third part explains two main aspects of the city. The first is its utilization of the living lab concept and the second is its adaptation of a blend that puts together the vernacular and the modern. These parts utilise secondary resources together with some of the designer and developer views. The focus is on how the design and development are initiated to be translated in specific ways and how use is imagined accordingly. In other words, how designs and technologies are inscribed with particular expectations to be described in reality. The fourth part shows how such ideas and thoughts of design and development, on the basis of which Masdar City has emerged and evolved, have been translated and materialised on a master plan level for later implementation and use. This chapter establishes the way through which the designs and technologies proceed from design to use and from inscription to de-
scription. The use, or the de-scription of designs and technologies, is expected, which paves the way for the following two chapters targeting the real use or de-scription.

4.2 The Emergence of Masdar City in the Context of Abu Dhabi

The transformation of the United Arab Emirates (UAE) is mainly associated with the discovery of vast oil reserves in the early 1960s, followed by their independence from British rule and the creation of the UAE Federation in 1971 (Crot, 2013; Cugurullo, 2013; Khalaf, 1992, 2006; Reiche, 2010a). The federation consists of the seven emirates of Abu Dhabi, Dubai, Sharjah, Ajman, Ras Al Khaimah, Umm Al Quwain, and Fujairah. These united emirates are originally part of the Arabian Gulf that relied on indigenous ways of living and formed a prominent location for trade since the fifth century BC. They took the form of Trucial States in 1853, alongside other states of the same or surrounding locations (Barnwell, 2011). The emirates share with each other, and with similar other states, the same history, culture, traditions, religion, geography, climate, and activities. Amongst these emirates, Abu Dhabi is rather distinguished for being one of the most fortunate with oil reserves, considering its possession of over approximately 90% of the UAE’s total that represents 8% of the global reserve. The emirate relies on such resources to guarantee its energy supply and provide for its national budgets and citizens’ wellbeing and has one of the highest GDPs per capita in the world. In a way, this emirate represents a state that enjoys an abundance of a single, finite, and natural resource that fuels a high living standard.

This change of fortune is connected to consecutive and rapid urban processes as well as socio-economic formations in Abu Dhabi. Such transformations relate to a number of issues. Firstly, they align with the political changes of the ruling Sheikhs' material support structure as they are
the massive power for authority and governance. They also assume control through being the distributors of the national oil wealth and the builders of modern cities. Secondly, the transformations mark a move of the area from “rags to riches” in less than 30 years, according to Al-Fahim (1995), and a shift of its economy to a new global status. The aim has been always to make Abu Dhabi a global player, with potential to receive recognition and acquire distinction not only on the level of the Gulf but also the world (Al Zubaidi, 2007; MacEacheran, 2011). Thirdly, the transformations relate to changes in demographics as evident in population increase, primarily from the flow of expatriate laborers that come in to support and take advantage of a rising economy. The massive influx of expatriates has made the Emirati nationals minorities in their own country. Fourthly, the transformations result in socio-cultural changes, accompanied with high consumerism. These developments affect the physical shape of the city and the living ways and patterns of its population.

The aforementioned changes turned the emirate into a centre of consumption of naturally-available resources like oil and water, resulting in considerable amounts of emissions and waste. The government of Abu Dhabi has its role in encouraging such sorts of consumption, as it provides energy and water free of charge to nationals (Crot, 2013; Khalaf, 1992, 2006). Similar to other gulf states characterised by oil wealth, it views such sharing as a way to secure public satisfaction and endorsement. These trends of consumption do not only cover nationals (RSB, 2008), as expatriates benefit from energy and water for their significantly low cost in a land where they may lack loyalty and perhaps experience segregation in a sense.

The outcome has been accompanied by a heavy environmental price. According to the World Wildlife Fund (WWF), the UAE has one of the worst ecological footprints in the world, representing a total consumption of natural resources of more than 8.4 global hectares (gha) per
person (WWF, 2012a). This compares to the world average footprint per person of 2.7 gha. The ecological footprint has its association with carbon, which is regarded as one of its main contributors. Carbon represents 5.97 gha out of the total ecological footprint per person in the UAE, indicating the consumption of abundantly available oil resources to produce energy.

This has its own impact on water consumption and waste production. Water forms an important issue that is affected by excessive consumption rates. The UAE is the world’s largest per capita consumer of water, with daily average exceeding 550 litres per person in 2012 compared to a global national daily average of 250 litres per person (ADWEC, 2012; Szabo, 2011). This gains importance when considering water scarcity in the Gulf in general with demand met by desalination and groundwater. With regards to waste, Abu Dhabi’s population is among the world’s major producers, with a current 6 Million tons of waste per year. The waste production of the emirate is almost 30% higher than the average of OECD countries (Abdul Kader, 2013; Khaleej Times, 2010; SCAD, 2009, 2013). This is particularly important given the fact that waste accumulation is an issue in the Gulf.

Another issue is the consumption of land accompanied by the expansion of the city into the desert. This is also encouraged by the government as its land policy gives the right of land ownership to nationals, but not expatriates. Since the 1970s, the government has been distributing thousands of free plots to the nationals and supporting their villas construction (Kakande, 2008). Expatriates, with their huge numbers, contribute to such land expansion because of the need to house them and facilitate their activities. This again results in increasing the waste of land through uncontrolled spread, increasing the urban sprawl, and bringing more issues to the ecological footprint through private cars, which are the main modes of transportation.
With the accelerated expansion and transformation of the city and its population, Abu Dhabi has started to face a series of challenges as there is “no guarantee either of everlasting economic growth as quantitatively measured by gross domestic product (GDP) or qualitatively as economic development in terms of standards of living” (Low, 2012, p. 1). The government is concerned with retaining the strength and position acquired by oil wealth, which has so far secured economic power, urban development, public loyalty, and to some degree global recognition. On the other hand, it is aware of climate change and global sustainability pressures that it believes represent inescapable policy concerns to avoid international criticism and guarantee global engagement (Nader, 2009; Reiche, 2010a; Rosenthal, 2009; Snyder, 2009). As a result, the government has been particularly concerned in responding to such economic and environmental concerns to retain its power and recognition.

In response to such challenges, the Abu Dhabi government has decided to put sustainability onto its agenda. It accordingly initiated a grandiose programme branded as “Abu Dhabi economic Vision 2030” released by the Abu Dhabi Council for Economic Development (ADCED) and “Abu Dhabi Urban Planning Vision 2030” released by the Abu Dhabi Urban Planning Council (UPS) in 2007. This vision represents Abu Dhabi’s first plan and policy influenced by sustainability. It further assumes that the year 2030 is a critical milestone in its development path that would support foreseeing and planning its sustainable future (The Government of Abu Dhabi, 2008a; Low 2012) when the population is expected according to studies to increase to 3.1 Million.

Although the concept of sustainability in that specific context has its roots back in the 1980s or even before, it is the first time to be part of a governmental plan and policy. The vision’s aims and principles are based on those of the late ruler and founder of the UAE Sheikh Zayed Bin...
Sultan Al Nahyan’s approach to sustainability. This approach has long recognised people, heritage, and natural assets of sea and sand that extend beyond focusing on oil as a mere resource (The Government of Abu Dhabi, 2008a,b). This has been evident in one of his familiar quotes, “we must not rely on oil alone as the main source of our national income. We have to diversify the sources of our revenue and construct economic projects that will ensure a free, stable and dignified life for the people” (IEEJ, 2012, p. 2). This quote actually delivers an important message on how Sheikh Zayed interpreted sustainability. Sustainability is not only about how long the resources will last, but how long the government can rely on one source only. This means that the government has to diversify its resources base to sustain the country’s power and development.

Based on this vision, Estidama, which means sustainability in Arabic, was launched as an initiative of UPC in 2008 (Abu Dhabi Urban Planning Council, 2010; The Government of Abu Dhabi, 2008a,b). The main and long term objective of Estidama is to develop plans and policies for sustainable cities and communities that enhance the economic, social, environmental, and cultural well-being of current and future generations.

Parallel to Vision 2030 and guided by a similar approach, the main governmental investment company, Mubadala, has created the Abu Dhabi Future Energy Company (ADFEC). This was officially announced by Sheikh Mohammed Bin Zayed Al Nahyan, the Crown Prince of Abu Dhabi, in 2006 and commonly called Masdar Initiative, or simply Masdar. Right after its birth, Masdar has announced its flagship project that represents its practical application, Masdar City; a new master-planned project in the field of urban sustainability (Masdar City, 2011a,b,c,d,e, 2013). Although Estidama did not exist upon the birth of Masdar City, it gradually came into effect later on while influencing and being affected by its relation to it. With the rise of such a
major development, and knowing the circumstances of Abu Dhabi’s government, exploring the ambitions and motivations behind it can prove to present multiple possibilities and constraints, which I explain in the following section.

4.3 About Masdar City

The word “Masdar” is a derivative of the Arabic word meaning “the source”. According to the official website of the city, it means:

Being a source of many things including knowledge, innovation, and human capital development in the areas of renewable energy and clean technologies. It will be a source for economic diversification and knowledge-economy jobs for Abu Dhabi. It will be a source for expertise in sustainable urban development and design (Masdar City, 2011b, paragraph 5).

With this, Masdar features as a producer of sustainability and a provider of many aspirations and ambitions from its very start, which justifies the choice of its name. The city represents a collaboration between its designer (Foster + Partners, UK) and its developer and main client (Abu Dhabi Government through Mubadala).

George and Ralf are two of the master designers of Masdar City in London, who explain its story from its earliest stages, as both were in charge of formalizing its main conceptions and designs in relation to sustainability. They mention the very beginning, when Abu Dhabi government held a competition in 2006 and F+P won it. George clarifies how they thought and worked on the competition as he emphasises that sustainability is not about a single person or a one-directional
solution as it is more about a multiplicity of people and a series of potential ways of thinking. He adds:

The interesting thing was that, for us, there were lots of people, and there still are around the planet, talking about sustainability and doing bits of sustainability. And one of the difficulties is that there is not one person that you can go to, there still is not, but there are lots of people around with lots of individual pieces of knowledge, which if you connect together become more interesting (George 2014, pers. comm., 18 February).

With this, they envisage that such multiplicity develops and grows from within as well as outside the firm itself. Accordingly, F+P started to invite other teams and individuals from different disciplines to take part in the project and participate with their own interpretations and experiences in regards to how they view and practice sustainability. Such particular interpretation of sustainability and the action connected to it mark a point of agreement between Abu Dhabi government and F+P as designer George further clarifies,

They had themselves been off around the world and looked at projects taking place and they had come to the conclusion that there were lots of sort of dispersed pieces of information that we created that nobody is putting together, which is why they wanted to create Masdar (George 2014, pers. comm., 18 February).

Such implicit agreement has its importance among the key actors of Masdar City as they attempt to explore the different ways to understand and practice sustainability. In this way, the project has focused from its early stages on what is explained in chapter 2.2 as collective of potential actors and networks (Latour, 1987), although it has been specific to particular ones who have interpretations and experiences in the field of sustainability.
Designers George and Ralf explain that they were handed the site allocated to the project by the Abu Dhabi government. It was about 18 Kilometres outside Abu Dhabi, next to its airport, with a triangular shape (Foster + Partners, 2007a; Masdar City, 2011a). With this site, they add that they took inspiration from the historical Arabic cities that were in square shapes. They accordingly formed the city to include one big main square within which the city would be located and around which it would have its services. They have also attached to it another smaller supporting square to host power generation facilities and support the potential expansion of the city. Referring again to the historical Arabian cities, which were dense and mixed in use for cultural and climatic reasons, they chose these characteristics as symbols on the basis of which all the master plan would be designed and developed. At that stage, and on the basis of such main ideas of the city shape and symbol, George and Ralf mention that they gave a presentation to Abu Dhabi government, who awarded the project to F+P to go ahead with its design and development.

Although most of the city design and development work took place in London, through a process that involved George and Ralf in addition to other different design actors. Other design and development work took place on-site in Abu Dhabi through a process that involved other designers like Augustine. Both parties had debates, discussions, and agreements with the developers in Abu Dhabi like Isaac, Charlie, and Mike. In this way, and with reference to the collective or networked nature of technology, the collective of actors and networks of Masdar City, which was originally composed of the designers from the UK, included designers and developers of the UAE, as all contributed in shaping and creating the project and advancing its sustainability aims and targets. The rest of this section goes further in the explanation of the city design to show that the involved collective does not only comprise the designers and developers...
as humans, but also incorporates other actors of design and development, humans and non-humans, where both contribute to the city.

Masdar City is based on the sustainable agenda and vision of Abu Dhabi. It tackles a specific view to urban sustainability that reflects a particular relation to the techno-economic approach, explained by authors like Guy and Farmer (2001), Guy and Marvin (1999), and Moore (1997). Such approach has a dominant orientation centered on top-down, managerial, and hierarchical outlook to direct the materialization of its aims. It also reflects a strong reliance on science and technology to acquire extended effect over time and place. The collective of Masdar City has been informed by a particular perspective on urban development as informed by techno-economic actors, which affect the distribution of agency that seems to be concentrated on specific contributions.

The city’s original concept includes residences, laboratories, factories, movie theatres, cafés, schools, and other utilities similar to any normal city. According to designers George, Ralf, and Augustine as well as developers Isaac and Charlie, its main difference is inspired by its techno-economic targets, which lies in its focus on efficiency and renewable energy. This entails emphasizing technical, environmental, and economic aspects through tackling consumption and production problems. To achieve this, it utilises specific approaches, among which is “building science”, a term that emphasises physical science and its application to buildings. Such application entails gaining more scientific knowledge about buildings and cities and how they physically perform (Guy, 2006; Hutcheon and Handegord, 1983). This includes utilizing adaptive and modern solutions with potential reliance on quantitative analysis, numerical interpretation, and scientific measures.
The city’s development is mainly steered by best practices that provide guides and models in relation to urban sustainability, which is another aspect of its techno-economic aims. According to Guy and Marvin (1999), best practices are individually-conceptualised initiatives that come alongside each other in a wide ranging programme, providing a group of measures with focus on technical, environmental, and economic issues. They write in page 270 that each one suggests a set of “standardised, universal, and transferable guidelines or strategies aimed at directing technologies along a particular, predefined technical development pathway.” Among such best practices that mainly inspired the city is “One Planet Living” (PHA Consult, 2008). It is a global initiative that follows the BedZED eco-village, built in the South of London in 2002, which acquired global attention for providing a learning experience in lowering carbon emissions and enhancing community involvement (BioRegional, 2013; WWF International and BioRegional, 2008; WWF, 2012b). The initiative has taken shape through a collaboration between WWF and BioRegional as two partners in the experiment. It now represents a vision of a world in which “we are living happy, healthy lives, within the natural limits of the planet” (BioRegional, 2013, paragraph 1). According to this vision, the initiative incorporates ten principles of sustainability. Five of them are concerned with techno-economic issues like carbon, material, waste, water, transport. The rest widen such aspects to include food, protection of habitat and wildlife, local values and heritage, social equity, and health and happiness.

As a best practice, One Planet Living provides a model and guide that appears to be exchangeable and universal through its commitment to scientific and technical knowledge. More importantly, it assumes wide acceptance and global appeal. This forms an attractive solution for the designer, and potentially the developers, of Masdar City. By adhering to this guide, the emirate of Abu Dhabi expects to secure a guaranteed path of development, to be recognised and
rewarded for its dedication to such model of urban sustainability and, at the same time, to provide another widely accepted and globally endorsed model to be identified and followed internationally. This entails proceeding with the progressive loop of following technical solutions and producing more of them to be followed. The collective or network that is formed by the designers, developers, and other related human actors has aspects that shape efficiency and renewable energy as well as best practice appear to have their own share of contribution as non-human actors. Designers and developers interact with each other in addition to their drawings, models, and diagrams that are based on such aspects to produce the design and get it into the lived environment.

Based on the specific view of urban sustainability that underpins its design, Masdar City has a number of aims maintained through its design and development. Firstly, they include establishing a research and business base for technology and innovation. Secondly, they rely on integrating “intelligent” designs with traditional Arabic architecture to achieve efficiency. A third aim is to set up renewable energy-based power plants developed inside and outside the city. These plants rely on photovoltaic, solar collectors, and other under-study initiatives such as the beam down project, geothermal testing, and solar thermal cooling. The support of these projects comes from the favorable geographic conditions and, at the same time, the way they integrate and complement each other in supplying the power needs of the city and even some other parts of Abu-Dhabi. A fourth aim is to reduce embedded carbon in material manufacturing and transportation and a fifth one is to manage waste and water through recycling and reuse. The sixth and last aim is to secure a car-free, public transportation, and pedestrian-based environment.
Masdar City targets do not incorporate specific quantifiable standards, but they are aimed to extend in a particular way. They do not concern Abu Dhabi or the UAE as it widens its horizons to become more universal and global. This applies to the defined problems and suggested solutions entailing policy and actions and tackling building, space, carbon, water, waste, and transportation issues on such scales. The extended achievement and effect of Masdar City takes it beyond other sustainable initiatives around the world, which stem mainly from its immense urban scale. Reiche (2010a, p. 380) emphasises this by arguing that “the representatives of the project were aware of the fact that the concept is not new, but the scale of the project is unprecedented.” This echoes the view of designer George, who says that “Masdar made it possible to think city scale” (George 2014, pers. comm., 18 February), which forms an opportunity and a challenge at the same time as discussed next.

Masdar City, according to its initial plan, would house a population of 90,000 people made up of 40,000 residents and 50,000 daily commuters within over seven square kilometers of land. Nader (2009), Rosenthal (2009), and Schuler (2009b) argue that most sustainable initiatives take place on a small scale, providing marginal contributions due to their high cost, where this project would be on a different scale with a cost of USD 22 Billion. Although it has been seen by some authors, like Reiche (2010a) and Snyder (2009), as too optimistic or uneconomic to achieve its targets, such scaling up of sustainability could mean confronting more challenges in the aim of producing an extended outcome. Masdar City is then following the dominant discourse of urban sustainability, but at the same time, aiming for a comprehensive change and global effect.

As part of such extended achievement and effect, Masdar City emphasises its demonstration and boosts its messages and ambitions. These ambitions are encapsulated in a series of catchy phrases. According to its official website, it serves as “a model of what green urban development
should be” (Masdar City, 2011a, paragraph 1) and “a benchmark for future similar projects in the region and around the world” (Masdar City, 2011f, paragraph 8). Furthermore, it features on the official website of Foster + Partners as “a sustainable urban blueprint for the future” (Foster + Partners, 2007b, paragraph 1). Developer Mike contributes to that notion by saying, “Masdar is a prototype, an exemplar that we wish all the other cities would be similar to. We want it simple, acceptable, an example and an inspiration to other cities to be developed in the future” (Mike 2014, pers. comm., 21 April). With this focus, Masdar City appears to present itself as a blueprint, prototype, benchmark, and exemplar while having this as a main driver and a significant direction.

Stemming from and in connection to globalization and demonstration as two main themes, are the uniqueness and particularity of Masdar City. These aspects can be traced by its connection to a series of superlatives. Designer Ralf explains by saying, “the goals were very ambitious, to be one of the most sustainable projects that were ever delivered” (Ralf 2014, pers. comm., 27 February). Augustine agrees by saying, “when you look at the ambition and what it is trying to do, and you put that into a global context, there is nothing else like Masdar” (Augustine 2014, pers. comm., 27 May), where both present and support it.

Masdar City features in its own official website as “the world’s first sustainable city and technology cluster that will be powered entirely by renewable energy” (Masdar City, 2011d, paragraph 6). Also, as “one of the most sustainable cities in the world” (Masdar City, 2011g, paragraph 3). It stars in the WWF official website as “the world’s greenest city” (WWF, 2008, paragraph 1). In that sense, designer George emphasises, “we always knew it had to be different, because it had to be different to do what it was doing.” With this, he stresses its uniqueness while
adding later that “there are lots of people talking about it but nobody else has got it” (George 2014, pers. comm., 18 February), emphasizing it as a main theme.

The previous paragraphs start to show how the collective of Masdar City develops and grows to include a multiplicity of actors and networks. Such a collective supports a techno-economic approach, centered on top-down, managerial, and hierarchical orientation in a specific way through its heavy reliance on efficiency and renewable energy technologies, and gets inspiration by best practices with the aim of providing a model and guide to further initiatives. It bypasses and extends such approach by its specific themes starting with the fact that it is based on comprehensive change and global effect. It also presents its ambitions and goals and boosts its distinction and particularity. Actually, as previously explained, globalization, demonstration, and uniqueness are important connected themes that have accompanied the aims of Masdar since its early stages.

4.4 Masdar City as a Source of Technological Innovation

In order to achieve the challenging and ambitious targets set for Masdar City, there has been a strong focus on technological research and investment starting from the beginning of the project as per what the design office received as a government requirement. Designer Ralf clarifies that their role has been to set up the master plan on that basis and relocate an institute as its first phase and core pillar. Masdar Institute has been accordingly located as a joint academic and research venture between the Government of Abu Dhabi and Massachusetts Institute of Technology (MIT). It is inspired by other universities that have received global recognition and proven workability around the world such as Cambridge, Stanford, and MIT, where the latter is its most prominent stakeholder from which its international outlook and contribution are
reflected. Designer Augustine further adds that “a real driver for this was if there was going to be a globally successful institution that starts from scratch, it does not have the history of all the other ones that were built up over hundreds of years in some cases, how do you do it?” (Augustine 2014, pers. comm., 27 May) The institute has no past and accordingly has relied on other models with a history of success. Such inspiration could represent an appealing and guaranteed solution for Abu Dhabi government to go ahead with MIST by building again on recognised and successful examples.

Masdar City currently houses such institute that aims to provide around ten research-based postgraduate science and engineering programmes in sustainable technologies and renewable energy (Evans and Karvonen, 2011, 2014; Kumetat, 2012; Reiche, 2010a). Augustine comments on that by saying, “I think the whole idea about collecting all of these disciplines together has not been done before purely in sustainability and sustainable research” (Augustine 2014, pers. comm., 27 May). With this, he supports the gathering of knowledge that has accompanied Masdar City from its earlier stages. Designer Ralf adds that such interaction is supported even more by the facilitated collaboration with other universities as well as the private sector. He concludes that this paves the way for the first institution dedicated to providing a connection between student work and industry, which goes beyond the universities that inspire its development and adds to the unique features of Masdar City.

An important part is then represented by Masdar City’s focus on attracting businesses in the field of sustainable technologies. The aim is to encourage circa 1,500 companies to have offices and research centres within its premises. Enjoying the facilities and investment incentives of a free zone, companies would benefit from the possibility of having 100% foreign ownership, no taxes, no import tariffs, and easy access to governmental services (Crampsie, 2008; Lau, 2012; Nader,
2009). In light of that, Masdar City has so far succeeded in bringing in the International Renewable Energy Agency (IRENA), based originally in Germany since 2008, to have its headquarters based in Masdar City. The same has happened with Siemens, also based in Germany since 1966. The city also participates in other multiple global partnerships involving international investments in technology and innovation. In this way, and while being part of it, the designers and developers started to build a collective within the institute that began to include all sustainability disciplines within it in collaboration with other universities. This collective is set to grow and include the private sector.

With such gathering of technology-driven research and business initiatives, developers Isaac and Charlie as well as designers George and Ralf argue that the aim is to develop the needed skill base and intellectual capital in the city. This in turn supports examining the passive strategies and efficient technologies and advancing new ideas in the areas of renewable energy, carbon reduction, waste management, water conservation, and clean-energy-supplied transportation (Crampsie, 2008; Ekblaw et al., 2009; Nader, 2009). In addition to that, the whole city gains the advantage of the overall specific structure that houses it, providing similar technologies prone to research and experience. In other words, the resultant collective includes all that is designed in the institute including the arrangement of the university as well as the buildings and spaces that house them. At the same time it is set to produce further technologies and designs.

Through such arrangements and with its design and development, Masdar City connects itself to the concept of the “living laboratory”. According to a presentation given by Masdar CEO, Dr. Sultan Ahmad Al Jaber, Masdar City resembles a “revolution already under way” and a “living laboratory” (Quoted in Reigeluth, 2009, paragraph 12). Professor John Perkins, MIST provost, agrees with this description by stating that one of the institute's strong points was that “it will be
in Masdar City. It will be a living laboratory” (Quoted in Drummond, 2009, paragraph 13). Such quotes further extend to mark the concept, which is in itself packed with unique ideas that have accompanied the project from its early stages.

Indeed, the utilization of the living lab concept in Masdar City is justified by Designer Ralf, where he says that it is about producing a new sort of science that emerges through interaction. This happens taking into account a number of aspects. Initially, the introduced knowledge is the efficient and renewable technologies that are based on numerical, diagrammatic, and quantitative data, to achieve modern and adaptive designs. What happens through this interaction is to find how it is implemented within the living environment. In this way, beyond the lab where the design is produced and made ready, Masdar City provides the reality within which it is materialised, tested, and refined. A manager of one of the key technology business partners of Masdar states that “Masdar City offers a real life environment... to test new technologies and see how they respond in a concrete urban context” (Quoted in Cugurullo, 2013, p. 30), which implies producing knowledge beyond the lab. It then provides a “high-profile location” (Cugurullo, 2013, p. 29) or a “unique metropolitan-scale test bed” (CTBR, 2009, paragraph 7), where such location or test bed is distinguished by its prominent location and extended scale.

Another aspect of the living lab concept in Masdar City is that initially the knowledge produced is universal, global, and standardised following models and best practices, but what happens through such interaction is the revelation of knowledge within a particular society and place. In this way, design does not only connect to the users, who adapt it, but also to the locality in which it is implemented.
A third aspect of the living lab concept in Masdar City is that, initially the incorporated stakeholders in producing knowledge adapt a top-down, managerial, and hierarchical approach with restricted actors, but the living lab interaction mandates that other actors from the lower end of the hierarchy get involved. In this way, they do not only include the involvement of the universities with the private companies, but also the public sector, where innovations are developed through a public-private partnerships. In other words, the collective or network of Masdar that has started from its early stages and extended to form a base for knowledge and skills is supposed to extend to include practical and empirical actors.

Among such incorporated actors, users have particular emphasis, highlighting a fourth aspect of the living lab in Masdar City. Initially users have specific roles to play and particular responsibilities to act upon, the living lab interaction entails that users have more extended and interactive contributions. In other words, the collective is supposed to further grow and widen to include such actors.

Within the living lab concept in Masdar City, the resultant technologies are supposedly not only controlled but also authentic, highly visible, and useful. Hence, these technologies would have a greater possibility of successful adoption on local and potentially global levels while promising commercial rewards and academic merits in producing new knowledge.

It is worth highlighting here that although Masdar City supposedly adopts a living lab approach, which reflects a specific learning process, the city has indeed become aligned with it in terms of particular aspects while still going beyond it, changing it, and appropriating it to its own vision. Within Masdar City’s adopted techno-economic orientation, it still maintains to a certain extent a top-down, managerial, and hierarchical approach with actors that are restricted to a specific
domain. Such an orientation aims to achieve efficient and renewable designs and somehow guarantee user satisfaction. It is accordingly steered to feed into the models where technologies are designed to achieve these aims but not to the lived environment where technologies are really experienced. Users are expected to follow what is modeled through their lived experience and produce specific results that take designs and technologies further. In this way, and within the collective evident in Masdar City from its early stages, most of the agency seems to be attributed by the designers to technologies, while being limited in regards to the users. Although the collective include many actors, it excludes the users, or includes them in specific ways. Although more roles are given to some actors, who dominate actions within the collective or network, users are given specific roles as they are directed and steered to achieve particular outcomes in alignment to the main actor’s aims. In this way, and within such a collective, the designers dismantle most of the relations with them and only keep particular ones on the basis of its goals to translate through a steered direction. According to this explanation, the created collective is relatively rigid. This contrasts the ideas of De Laet and Mol (2000) of fluidity explained in chapter 2.2 as the boundary of the designs and technologies is fixed and confined. Examples of such a concept adapted in Masdar City is the transportation and mobility strategies as well as the lighting and household management strategies, which I explain in the following two chapters.

With such potential of the living lab concept, Masdar tends to extend its specific learning process to reflect on notions like technological advancement and production as well as knowledge gathering and circulation to produce sustainable innovation. This supports transforming Abu Dhabi “from a technology consumer to a technology producer” as stated by a Masdar press release (The International Resource Journal, 2009, p. 5). In other words, Masdar City potentially connects back to its Arabic meaning highlighted in the earlier section; the “Source”. It would be
a source of innovation, where designs and technologies are tested and refined and then implemented inside and outside the walls of Masdar City to sprawl into Abu Dhabi and embrace the world. This includes feeding back to where technologies originally started, as their designers and developers would use such feedback to enlighten further projects. In addition, this includes a further spread in different directions and distances. This said, they produce efficiency and renewable energy in specific ways. Also and while inspired by best practices, they form examples, prototypes, and blueprints that produce further best practices. In this way, the living lab concept again extends the narrative of globalization, demonstration and uniqueness adapted by Masdar City.

In other words, the concept situates Masdar City in a different place that surpasses other cities following the same approach with the utilization of such widely-known concept and authentic learning process to raise its impact and influence beyond its boundaries and support its own recognition, presentation, and appeal. This emphasises what is clarified by Evans and Karvonen (2011, p.1), who write that “a wide variety of organizations, notably universities, government bodies, and private companies are using the term in an unapologetically boosterish manner to develop and market their own approaches to sustainability,” supporting such aims and targets.

This could arguably make the living lab concept fall under what is described by Evans and Karvonen (2011) as “hugely powerful yet poorly defined” as a concept that has been brought by the designers and developers for its power, impact, and potential to support specific aspirations. Actually, Masdar's collaboration with a renowned international university, like MIT, in addition to attracting internationally-recognised organizations like IRENA and Siemens can be part of that strategy of bringing in powerful and effective aspects. This also is traceable through the
early stages of the project in connecting the city to a star firm, like Foster + Partners, which potentially has its role in supporting and delivering Masdar's message and ambitions.

4.5 Technological Orientation within a Specific Context

The aforementioned drivers in relation to Masdar City have indeed informed the design and development of the city's master plan. While the previous paragraphs emphasise the global context of the project, the following ones ground the project in its physical and cultural context. According to designer George, there are three key aspects about the context within which Masdar City has arisen that, for him, could form opportunities or challenges at the same time. Such aspects represent, firstly, the people who have gone through the Bedouin living style in the desert to the modern world in a span of only 30-40 years, which is less than an individual’s lifetime. He argues, “there is an incredible knowledge of the environment, which is hidden and one of the things that would be a sad thing is if now, as it develops, it is forgotten” (George 2014, pers. comm., 18 February). This first point actually presents a tension between the past and the future. While sustainability means to the designers and developers the advancement of technologies, they still go back to the old utilised ones. A second important aspect for him is the economy that has gone from pearl fishing to the pearls being taken over and lost. The single, finite, and natural source of economy has gradually died and been replaced by another single, finite, and natural source upon which the whole economy has been based, represented by oil. This second point indeed brings back the idea that the history of Abu Dhabi has always had its connections to a sole resource, where the designers and developers support the idea of diversifying resources that represents a sustainable future. The third contextual aspect is the extremity of the heat, humidity, and dust, where this point reflects the different and particular climate to be taken into account by the designers and developers. With this, designer George
concludes, “so you have got the people, you have got the economy, and then you have got the climate” (George 2014, pers. comm., 18 February), as he wraps-up the inspiring, yet challenging aspects in Abu Dhabi. In other words, George defines the collective from his own perspective, while including human actors such as designers, developers, and potentially people who inform the design process in addition to the non-human actors such as oil reserves, heat, and dust.

With such background, designers George, Ralf, Augustine, and John as well as developers Isaac and Charlie agree that the city takes inspiration from vernacular treatments. These strategies are evident in different cities like Shibam in Yemen, Aleppo in Syria, and Marrakesh in Morocco as well as traditional districts within Abu Dhabi, Dubai, and other cities in the UAE and the Gulf region, reflecting the particularity of its context. Designer Ralf emphasises that “Norman [Foster] uses this phrase; sometimes to look forward you have to look back, to learn from the past essentially” (Ralf 2014, pers. comm., 27 February). This view is shared by Augustine, who argues that “the most successful elements of the design have been learnt from what has happened in the past” (Augustine 2014, pers. comm., 27 May). John agrees by saying, “like in the good old days, in the original cities that were built in Arabia” (John 2014, pers. comm., 12 March). In this way, they justify and rationalise such tension that appears between the past and future. To be able to proceed in the city’s future sustainably, they need to look at its past.

According to Guy and Farmer (2001) as well as Moore and Karvonen (2008), vernacular treatments evolved naturally and were amended incrementally by trial and error throughout the past. They emerged from and became bound to the constraints and possibilities of the contextual forces of nature and human knowledge and needs. Designer Augustine explained that they are about getting the building and spaces in the size, shape, and relation to the context through channeling the climatic conditions and respecting the cultural aspects. He adds, “it is all about
being aware of the context and trying to work with it rather than ignore it and work against it...

it's about trying to work in harmony with rather than in opposition to” (Augustine 2014, pers. comm., 27 May). This is extended by developers Isaac, Charlie, and Mike, who said that they are all about orienting and shading buildings and spaces. They described them as solutions that if accomplished in the right way in relation to people and place, they would not save lots of cost, time, and effort.

Masdar City utilises a combination of vernacular and technological approaches. Developer Mike agrees with Schuler (2009a,b) by describing a hierarchy of strategies, during the design and development stage, through which the incorporation of vernacular treatments with other modern technologies has been achieved. Both of them explain that focus in the first step has been on load reduction through passive design strategies inspired by such treatments, such as the courtyards and narrow passages. Designer George emphasises that by saying, “that is the most important thing. That is before you start talking about can I get an efficient air conditioning system? Can I get solar collection?” (George 2014, pers. comm., 18 February). Developers Isaac and Charlie agree with him and believe that passive strategies, most of which are inspired by vernacular architecture, are the best way to start. Accordingly, they consider other strategies as marginal in comparison to orientating and shading the buildings and spaces. Having said this, the second step of the hierarchy of the strategies is in going ahead with achieving efficient envelopes while utilizing efficient systems through active strategies, like air conditioning and lighting as well as smart building management through controls, sensors, and monitors.

The mix between vernacular treatments and more advanced technologies aims to provide “a full picture of what sustainable urban development will encompass” (Masdar City, 2011b, paragraph 4), where “vernacular architecture meets innovation” (Gysin, 2011, p. 1). Designer Augustine
emphasises such blend by saying, “the first thing we did was to look back and try to understand how things worked in the past, what was successful, why they were successful, and how we could use that in a modern context” (Augustine 2014, pers. comm., 27 May). Developer Charlie agrees by emphasizing, “all we do today really is trying to find our way back to where we started, but embracing with whatever is available as a modern technology” (Charlie 2014, pers. comm., 24 March). Designer Hashem supports this aspect by arguing that “the solution was already there in the old architecture. We just developed this old architecture using technology to make it more efficient” (Hashem 2014, pers. comm., 1 February), where all agree on such mixture as one of the design and development drivers. An example of this mix is the wind-tower, which is a form of wind-catcher inspired by vernacular architectural treatments in the UAE for the aim of providing natural cool air movement from upper levels to cool lower interior spaces. The wind-tower has taken a reinvented form in Masdar City with a modern structure and components mixing between the natural ventilation and mechanical air movement to cool the lower courtyard underneath it (Figure 4.1). Another example is the re-interpretation of the Arabic Mashrabeyya, which is the shell that covers the windows to provide private views and cooling effect. The Mashrabeyyas took a new shape in Masdar City to cover the created balconies, where they had more modernistic styles and elements to provide similar or even more advanced effects and complement the provided cooling system (Figure 4.2).
The first two described steps show the role of the mix between the vernacular and the modern in providing a strong focus on the efficiency and consumption-related issues, where these issues

Figure 4.1: The wind-tower as an example of the mix between the vernacular and the modern (Source: to the left: http://www.greenprophet.com/2011/05/foxter-partners-architect-dubai/bastakiya-wind-tower/, to the right: author).

Figure 4.2: The Mashrabeiya as an example of the mix between the vernacular and the modern (Source: to the left: http://aestheticsjr.blogspot.co.uk/2012/01/turned-wood-mashrabiya-window.html, to the right: author).
feature as primary and essential. This can be traced in Designer George’s argument, as he says that “at the moment, if you are going to be sustainable as a city, then we need to reduce the consumption” (George 2014, pers. comm., 18 February). Developer Isaac adds, “minimise the use, where you really make a difference” (Isaac 2014, pers. comm., 20 January). Designer Augustine emphasises, “so everything you see has a response to trying to make the buildings as sustainable as possible by limiting the demand they place on the utility requirements of the city” (Augustine 2014, pers. comm., 27 May). Such a focus on consumption implies shifting the continuous and available supply of energy resources to be more limited and controlled. This assumes clear emphasis at the early stages of the project to form a differentiator that inspires other examples around the world.

After the two steps described earlier and as part of the mix, focusing on reducing energy demands, a third step concerns energy supply, which is mainly through renewable energy sources and active renewable strategies like photovoltaic cells and solar collectors in addition to others that are being tested. Although renewable energy and relevant production issues have been quite emphasised through Masdar City’s first stages, they are described by designer George as utilities that come at the end as there are still limitations in them for the time being. With this, the project is embedded with high aspirations and ambitions connected not only to reducing energy consumption, but also energy generation and technology production that appear to form another differentiator of the project to provide examples for the world that further emphasise globalization, demonstrations, and uniqueness as main themes that accompany such differentiators.

The preceding paragraphs take a closer look on how the collective of Masdar City combines a multiplicity of actors and networks. Being part of the collective, the designers and developers
create it while being informed by a techno-economic approach centered on a top-down, managerial, and hierarchical orientation, which affects the distribution of agency that seems to be concentrated on specific contributions. This approach is taken forward within the living lab concept that includes researching and experiencing the newly-produced technologies and the already available structure that Masdar City houses. Among these technologies are the mix between the vernacular and the modern, where the idea of the collective seems to align such different logics behind the design of the built environment. Designers George, Ralf, and Augustine argue that such mix has not been done before in that specific context, that although has specific history of sustainability, lacks all the measures and interpretations to produce it.

The vernacular and modern are put together to achieve efficiency and renewable energy and fulfil user satisfaction through focus on building science. Designer Ralf mentions that the importance of such a focus lies in “its ability to do these very complex analyses” (Ralf 2014, pers. comm., 27 February). In other words, building science eases and reduces the sophisticated or intricate aspects that emerge from the previously-explained stages to specific interpretations that are more manageable and readable. According to designers Ralf and Augustine, this includes models, diagrams, and quantitative data in relation to airflow, sun light, and heat, while taking into account different typologies, user profiles, and detailed weather data, where all are part of the actors and networks. It also composes the cooling and lighting as well as the monitors and controls in these studies and analysis, while extending the actors and networks. The results and outcomes of such mix are based on best practices that are aimed to achieve and even go beyond its aims and targets, further stretching the actors and networks. In this way, the vernacular treatments appears to be appropriated to fit into the adapted techno-economic approach. This results in a hybrid approach that is quantitatively based and expressed in numerical reduction in
consumption through efficient resource use and increased productivity through renewables. The outcomes are themselves subject to research and experience through specific ways and strategies and accordingly provide knowledge on how such blend produces sustainability.

In addition to the three stages that are taken into account during the design and development stage, a fourth aspect receives consideration at the implementation stage. Stemming from the techno-economic approach and as part of the living lab concept, the utilised strategies are monitored, followed, and verified by the designers and developers to compare the expected models, diagrams, and measures with the real ones that have been achieved by users and to make sure that the intended design has been fulfilled by them. Such verified data goes back through the learning loop to regenerate a modified, amended, and developed design on the basis of what has been achieved, incorporating all related actors and networks.

As explained earlier, and within the created collective, most of the agency has been initially attributed by the designers to technologies, and little to the users. Although the previous stage implies not limiting the collective to specific actors, users appear to be excluded or included in a specific, pre-defined, and restricted ways. Users are only combined as actors that play specific roles, but not as actors that have their own contributions through their interpretations and experience in the lived environment. They are expected to follow the intended models, diagrams, and measures in specific ways and use such designs in particular modes arranged by the main stakeholders. Within such a collective, the designers dismantle most of the relations with them and only keep specific ones on the basis of particular goals to translate in a specific way. Accordingly, the created collective is relatively rigid, contrasting with the ideas of fluidity explained in chapter 2.2 as the boundary of designs and technologies are fixed and confined.
With the utilised approaches and concepts, design and development is initiated to be translated in specific ways and use is imagined through a particular lens accordingly. In other words, the designers and developers inscribe their vision in certain ways to be de-scribed later on by the users. The result is a complex collective and hybrid mix of actors and networks that include the humans and non-humans. The collective, although configured by the designers and developers in a relatively rigid way, is set to change and transform in particular way on the basis of the received feedback from monitoring equipment. The results and outcomes appear to fit within a predicted window of expectations that they arrange. As users are included in particular ways with specific relations, this restricts their contribution as they do not form part of the complexity, dynamism, or predictability of the created designs and technologies.

4.6 Masdar City and its Master Plan

The ideas and thoughts of design and development on the basis of which Masdar City has emerged and evolved have been translated and materialised on a master planning level to be implemented and used later on. According to designers George and Ralf, and in alignment with the city and Foster + Partners official websites, the master plan rises over a 23 foot-high concrete base with a diagonal orientation to capture and channel the north-west prevailing breeze and allow sunlight while blocking accompanying heat (Foster + Partners, 2007a, Masdar City, 2011a,b,c,d,e, 2013). Two green park bands expand through the whole city and head towards the sea breeze and the cool night winds. The parks form the main arteries of the city that hierarchically branch into narrower spaces within its mixed use, low rise, and dense fabric. Such an arrangement reflects on the specific relation and adjacency between buildings, creating particular spaces between them, where both are designed in a specific way to include narrow passages, internal and external courtyards, wind-towers, roof coverage, canopies, and
colonnades. (Abbasi et al., 2012; Crampsie, 2008; Ekblaw et al., 2009). Through this arrangement, designers and developers aim to stimulate air movement and provide shading. They further integrate such strategies that target producing natural cooling and lighting sources at all levels of the city, building, and unit with other sources incorporating air-conditioning and artificial lighting, where all are supplied from the available photovoltaic and solar collectors.

The city design extends to incorporate carbon, water, wastewater, and general waste as well as transportation in alignment with the main city aims (Foster + Partners, 2007a; Masdar City, 2011a,b,c,d,e, 2013). The designers and developers have decreased carbon within the city through the reliance on clean energy. In addition to that, they have reduced the embodied carbon through the materials that are provided locally and internationally. Water usage is planned by the designers and developers to be reduced and managed within the city to optimise its demand and reduce the need for desalination. This would happen through the utilization of technologies, such as highly-efficient fittings, fixtures, appliances, and smart water meters that inform consumers of their consumption as well as identify leakage across the system. Wastewater optimization occurs through recycling and reuse for landscaping. Waste is also planned by the designers and developers to be reduced and sorted for recycling, composting, or utilization for energy recovery.

Another central aspect of the design and development of the city is the transportation that is planned by the designers and developers through a network of personal and public options within the city and beyond it. This includes Personal Rapid Transports (PRTs) that are electric powered, automated, and single-cabin vehicles. The system is supposed to be complemented by an extensive public transport network that links the city to Abu Dhabi utilizing light rail and metro lines. In addition to that, designers and developers plan to provide parking lots for personal vehicles provided at the edge of the city as they are not allowed inside (Abbasi et al., 2012;
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The integrated system would provide a specific separation between cars and people, with a maximum walking distance of 150 meters presumed, beyond which transportation means are available. Such separation has its impact in providing firstly, an efficient transport system that eliminates congestion, parking, and space problems. Secondly, it allows cool and clean air that is free from heat and emissions produced. Thirdly, it paves the way for safe spaces to encourage pedestrian activity and social interaction (Nader, 2009; Schuler, 2009b) as the traffic is “far away” or “under the deck”, according to designer George. Such spaces designed for traffic would further provide spaces for services and utilities to support the liveable city.

4.7 Conclusion

The chapter has focused on how the design and development of Masdar City is initiated to be translated and how use is imagined accordingly. In other words, how designs and technologies are inscribed to be de-scribed in specific ways. The chapter has started by introducing the way through which the collective was formed since the earliest stages of the project. This started when the designers put together all the parties that could provide relevant experience in sustainability. However, the collective does not stop there as the developers form part of it as they negotiate the project and contribute to it in different ways. Being part of the collective, designers and developers configure the collective to include other actors and networks. They have formed the project as efficient and renewable with best practices that are represented mainly by One Planet Living international that guides Masdar City as an emerging model. Adhering to such a scheme and setting up their own standards according to designers George and developers Isaac and Charlie, Masdar City has been already in alignment with its localised sustainability standard; Estidama. There has actually been a mutual influence between the two,
where Estidama is a system and Masdar City is a practical example that has a system of its own. The resulting framework aims, arguably, to embrace what is addressed by the other more internationalised standards such as LEED and BREAM. However, the main difference between them lies in how the former views the specific solutions and problems of Abu Dhabi and the UAE, reflecting the conditions, needs, and circumstances of this particular locality.

The designers and developers, while focusing on a techno-economic approach, have formed the collective through an experimental approach, where the project adopts the living lab concept. One of the aspects of such approach and concept is that although the context is supported by vernacular treatments that are regarded as sustainable from multiple facets, this for the designers and developers does not substitute for technological means such as the codes, standards, and rating systems as well as examples, models, and best practices important to produce sustainability, as Estidama, for example, was still at its early stages. This is explained by designer George as he says, “a lot of times there was not information there” (George 2014, pers. comm., 18 February). This view is also supported by developer Charlie, who says that “we still do not have much experience in this area and we are still learning” (Charlie 2014, pers. comm., 24 March), where both emphasise such lack of information and shortage of experience that challenge the designers and developers and embed the project with ambiguity and vagueness. Another aspect is that the designers and developers aim to achieve a specific blend between the vernacular and the modern strategies, which for them is unprecedented at that specific scale and in that specific context, which further underlies the project with further ambiguity and vagueness.

It is worth mentioning here that the conducted experimentation has heavily relied on technological advancement that could potentially reveal the ambiguity that could emerge from
the process of sustainability production. Learning is informed by monitoring and data collection. This reflects a particular kind of urban laboratory, rather than what they claim to be a living lab, because it includes users as data generators rather than co-producers. In other words, there is a difference between an urban lab that is created to advance technologies while including users to generate them and another living lab that is created to include the daily living and experiences of the users in shaping technologies.

These processes focusing on efficiency and emphasizing technological, environmental, and economic aspects downplay the complexities of social and cultural aspects that such particular orientation targets in specific ways. The approach relies on building science through numerical interpretations, quantitative measures, and scientific data, while following adaptive and modern solutions.

Such relations imply a one direction and a single path of development determined through rational decisions made by specific contributors and directly implemented among others. This reflects on the static image of the building and cities with no influence or effect from or over its surrounding. It also hints that the way through which buildings and cities proceed is predictable and expected in terms of results and reactions (Farmer and Guy, 2002; Guy, 2006). In another way, this reflects on a collective that although looks complex, still limits its actors to specific ones. Although it appears to be dynamic to change in accordance with the feedback data, it has specific relations that do not allow changeability or transformability to go further. The collective also appears to provide predicted outcomes. Such remarks showing this particular approach to buildings and cities raise concern on how the resultant interpretations of particular contributors could align with lived environments, tackling other contributors on the ground (Frampton and Moore, 2001; Guy and Marvin, 1999; Healy, 1995; Moore, 2001; El-Sheshtawy and Abul
Nagga, 2000; El-Sheshtawy, 2010). In other words, how such a collective based in modeled data would translate through the lived experience.

The notion of standardization or universal rules in the name of science and technology with reliance on models and practices tends to further underestimate and overcome the variety of societies and places. This implies an image of the building that is homogenous, replicable, or one size fits all (Farmer and Guy, 2002; Guy, 2006). It is further based on direct implementation through a one-directional perspective pointing towards specific-end solutions. Coming back to the collective, this implies that it is shaped in a specific way that is not to be changed while going through a predicted path. It raises concern on how such image could adapt to or take into account different circumstances and particularities. In other words, how the collective would translate within the different contexts.

This chapter has established the way through which the designs and technologies proceed from design to use and from inscription to de-scription through a focus on shaping of the collective. The use, or the de-scription of designs and technologies is still expected. In other words, it is excluded, or included in the collective in a specific way. This paves the way to the following two chapters targeting real use or de-scription.
Chapter 5: Inscribing and De-scribing Sustainability in the Mobility Network in Masdar City

5.1 Introduction

This chapter explains the travel of designs and technologies in Masdar City by examining the Personal Rapid Transit (PRT) as a central strategy and a departure point from which the transportation and mobility in Masdar City can be tackled.

Focus on transportation strategies is driven by two reasons. The first reason is that they show how the relations within a specific collective between human and non-human actors are shaped and reshaped among what is proposed by the designers and what is interpreted and experienced by the user. They accordingly provide an apparent example of inscription and de-scription processes. The second reason is that, as designers and developers are interested in sustainability in alignment with Masdar agenda, they focus on transportation as a contributor to the ecological footprint in the UAE, being one of the highest in the world (WWF, 2012). According to the Environmental Agency report of Abu Dhabi produced in 2012, a total Green House Gas (GHG) emission of 18,547.28 Gg CO2 eq has been produced from transport means in Abu Dhabi alone, out of which 18,321.59 Gg are direct CO2 emissions. Road transport is the highest producer, being responsible for a total of 11,735.60 Gg CO2 eq of GHG emission, of which 11,549.38 are direct CO2 emissions (Environmental Agency – Abu Dhabi, 2012). In this way, transportation strategies can be a highly-influential aspects in relation to meeting the sustainable agenda set by Masdar City in targeting environmental and economic concerns. It is accordingly important to trace their design that meets such ambitions and follow how it aligns to the different forms of use.
With this emphasis, I bring back the research questions through an empirical example of the sustainable transportation strategies utilised at MIST, with focus on the PRT. The questions are then firstly, how to understand the functionality of the PRT as a sustainable technology? A second question is how does the PRT proceed between the design and use in phase (1-A) and then between phase (1-A) and phase (1-B); in other words, from what is inscribed to what is described and beyond? The aim of these questions is to comprehend the PRT and its travel as a central element and departure point that reveals the shaping of its collective through its inscription and de-scription in Masdar City. It is also to utilise the emerging stories to reach a specific understanding on how the concept of sustainability transforms with such travel of the designs and technologies.

Through the techno-economic approach adapted in Masdar City and described in chapter 4.2 (Guy and Farmer, 2001; Guy and Marvin, 1999; Moore, 1997), the research questions gain further importance and specificity. Within such approach, both the designers and the developers are located on top of the process, enjoying more managerial, decision-making influence, while the users are at the bottom. At the same time, the developers and users share the same context, which is different than the designers’. This does not mean that they are separated as each of these actors has a specific role through the interlinked processes, among which the designs and technologies proceed.

This becomes further particular as it links to the living lab concept, which I have described in chapter 4.3 as envisaged by the designers and developers to be applied within Masdar City, including MIST (Cugurullo, 2013; Evans and Karvonen 2011, 2014; Karvonen and Bas Van Heur, 2014). With such a concept, designers and developers utilise Masdar City as a test bed for sustainable technologies that hosts new ideas, including the structure within which MIST has
emerged. Students, presenting the first users of MIST, are supposed to research technologies through facilitated interaction with other universities and companies. At the same time, they are expected to experience what has been implemented through their living and working activities. In other words, their role is to receive, adapt, and potentially improve technologies. On the basis of what works and what does not work, the designers and developers reshape and recreate the sustainable technologies in the current and upcoming stages. This potentially reflects on a specific learning process that is based on technological advancement and production as well as knowledge collection and circulation. This chapter further explains that concept through the lens of the transportation strategy and the extent to which it is aligned with the initiated living lab.

MIST assigns a job to each student as a research assistant in addition to his/her post graduate scholarship. Further to that, it gives each student a free accommodation with no charges for water and electricity. All these costs are supposed to be covered in part by the Abu Dhabi government, where another part comes from other companies and residents, who would rent spaces inside the city later on. The aim of such student financial support is to give them the incentive to work for and produce sustainability in that specific context in collaboration with the designers and developers.

This chapter is structured in three parts. The first part describes a site observation in Masdar City with one of the designers for a detailed and elaborate look into the PRT. I also bring back some of the designer and developer views, revealing their intentions or inscriptions regarding the transportation strategy. The second part provides a closer look to understand it as a technology and how it is shaped through designer, developer, and user interactions. In other words, how it proceed from design and development to use and back or from inscription to de-scription and beyond. The last part concludes with an analysis on how such transportation strategy produces
sustainability in Masdar City in a different way or, in other words, offers a different meaning of what sustainable transportation could be.

5.2 MIST in Focus

As explained in chapter 4.3, the designers and developers have decided that the first part of Masdar City is its institute. MIST has been divided into four phases from which only the first phase (1-A) and second phase (1-B) have been concluded at the time of the research. The first was built between the years 2007 and 2010 and paved the way for the second that was built between 2010 and 2013. According to designers George and Ralf, part of MIST design team, the entire neighborhood follows the main principles of Masdar City master plan described in chapter 4.5. In alignment with such principles, designers and developers have raised MIST on a concrete base, oriented it diagonally, and located it around one of the main green fingers of Masdar City that forms one of the major pedestrian areas and migrating routes. Phase (1-A) is located on its Northern corner (Figure-5.1 and 5.2), and phase (1-B) is to its South-East. The green finger forms a main park around which the key buildings of the phases are arranged, such as the knowledge centre, the multi-use hall, the mosque, and the conference hall for the four phases, respectively. The central park then branches to narrower spaces that extend into the phases of mixed use, low rise, and dense fabric that mainly comprise residential and laboratory buildings.
While in the taxi on my way to Masdar City, I received John's call telling me that he arrived at our agreed meeting point. John is one of the master designers of MIST, who has had his involvement in the design and development from its early stages through to the conclusion of the second phase. There are two ways to reach MIST; the first is through the newly-introduced main parking lot, which faces the two iconic buildings of phase (1-A) and (1-B); the knowledge centre and the multi-use hall, respectively. According to John, the lot occupies what is meant to be part of the green finger, or the central park of MIST’s four phases.
This fact actually surprised me at the beginning as I was under the impression that all parking lots were supposed to be at the edge of the city not within it, as cars and other transportation means were not allowed inside (Foster + Partners, 2007a; Masdar City, 2010). This comes in alignment with what designers George and Ralf and developers Isaac and Charlie say, as the aim is to support a car-free community, where the main transport method is the more efficient and renewable PRT located at the lower level of MIST. The access point from the parking is a main staircase and a ramp that guide to the key buildings. Although this way is quick, direct, and partly covered by a shading structure above the parking lots, it does not stop the fact that it is still open to the hot and humid weather. The second way to approach MIST is through the PRT parking, where the main entrance is located.

The PRT is an automated system that originates back to the 1950s. One of its earliest versions has been sketched and presented by Fichter (1964), who called it Veyar and suggested it as a solution for cities and transportation needs. He provided it as an alternative that could go beyond the public and private transport modes after stressing the difficulty of using the former, comprising “flat fare, slowness, radial routing, and schedule malaise” (p. 21) and the latter with its “restrictions, parking troubles, and tensions” (p. 22). Fichter (1964, p. 36) adds, “in principle, an obvious remedy is a fleet of driverless vehicles. Unfortunately, these could not expect to share the streets with the motor vehicles”. With this, he indicates two main features of the system, its independence and separation from other modes in addition to combining public and private transport advantages.

Between 1966 and 1999, a number of different PRT systems went under examination through full-size test tracks and vehicles supported by governmental funds. Examples of such initiatives are Cabtrack - UK 1966-1972, Aramis - France 1967-1988, Cabinen Taxi - Germany 1969-1974,
CVS - Japan 1970-1979, Aerial Transit System 1970-1974, and Raytheon PRT 2000 1990-1999 in the US. According to Carnegie and colleagues (2007) and Lowson (2002), most of these initiatives have not been successful. Lowson (2002, p. 2) considers the reason for failure “that the three main components – vehicle, structure and control system – had inadequate design integration,” which for him results in inadequate systems. Another reason for him is that they “attempted to mimic existing capabilities of public transport rather than meet the basic requirements.” Carnegie and colleagues (2007) argue that besides the technical issues that limit the capacity of the systems and increase costs, the lack of political support has contributed to their failure.

In recent years, a few small-scale PRT projects have been operational around the world (Schweiser and Meggs, 2013; Gustaffson et al., 2013). Examples of such projects are ULTra at London’s Heathrow airport - UK, Vectus PRT with a full-scale test track in Uppsala - Sweden, and an additional system under construction in Suncheon - South Korea. In addition to these, a fourth one is 2GetThere with a circuit in public operation at Masdar City. This has also gone under implementation on a small scale with the intention to be tested and applied later on a larger scale. The PRT is one of the radical, urban automated public transport options among others like Cyber Cars, High-Tech Buses, Advanced City Vehicles, and Dual Mode Vehicles (Wynn and Hill, 2010). These transport options come along with other automated systems like innovative urban automated freight transport and the self-driving cars, where each has its specific characteristics for testing and application on future transport.

I asked the taxi to drop me at the PRT parking of Masdar City and went through a pair of glass doors, where I met designer John. It was actually one of my first times to enter through the PRT hall or main station. I turned to my left to find the PRT parking slots. The slots are the central
element of the PRT station that breaks the uniformity of the rectangular extended hall with their oblique cubical shapes (Figure-5.3). Each of them is comprised of three glass sides that marks a space that is big enough to accommodate the standard size of the PRT pod. None of the PRT pods was available at the time of our visit, so I kept gazing upon the hall that was prepared to resemble the beginning of Masdar City experience for students, staff members as well as tourists and visitors. John was busy introducing me, along with a companion of his, to the technological gadgets, the stands, and the model that featured prominently within the hall. According to him, the model itself was not like the current MIST as there were a few changes after the time when it was first made. Still, it kept a high level of detail and elaboration.

![Figure 5.3: The PRT main hall (Source: author).](image)

My preoccupation with the design of the hall and the parking slots was interrupted by a pod that was approaching the parking, swiftly getting inside its specific slot. The pod has a simplistic, yet modern design, where its curved edges draw the boundaries that link between its identical front and back sides. The security officer was apparently accustomed to welcoming the arriving people and trained to guide the ones who were not used to the PRT. He walked towards the slot, where the pod had parked, moving closer towards two glass doors that were in perfect alignment with
its own doors. He pressed a blue button that was mounted on a short column beside the parking slot, where both doors of the parking and the pod opened. The security guard invited us to get in and asked us to press the green arrow on the user control screen at the opposite side of the pod (Figure-5.4).

According to Masdar City website, “the vehicle’s user control panel consists of an information screen and interfaces for the vehicle activation, intercom, doors, medical assistance and emergency stop” (Masdar Institute, 2015, paragraph.7). These components, as agreed with John, are supposed to support the independence of the system from drivers. The only interaction with the system is managed by the rider, whose job is limited to only inform the pod of his readiness through a single click. Upon tapping on the control screen, a welcoming voice message announced the beginning of movement of that “zero-carbon transportation vehicle”. The pod moved smoothly with us on board, leaving the parking slot as its glass walls reflected the scene of the waterfall and vegetation adjacent to the PRT path. Although it was driverless, the pod independently moved on its preset route in a similar manner to any driven car, slowing down at
intersections, giving the required signals prior to taking any turns, and passing by multiple advertisements on the walls adjacent to its path.

According to Masdar City Brief, the pod’s programme guides it to proceed without stopping through predefined paths with a specific speed of up to 40km/h, and at 25km/h on curves (Foster + Partners, 2008). Designer John explained that this is the pod’s working principle comprising continuous and consistent movement. This is further clarified in Masdar City’s official website, where the driverless vehicles are controlled by an advanced navigation system that uses magnets embedded in the corridor ceiling and floor to know their position (Masdar Institute, 2015). In addition to that, onboard sensors detect any obstacles in their path. A wireless connection keeps them linked to the central computer, which guides them on their journey and ensures smooth operation among all vehicles. Pointing at the ceiling and the floor, John explained this point by showing me that “there are magnets and you can just see this line up here [at the ceiling]. There are also magnets underneath here [at the floor],” where all for him with the detecting sensors and the operating computer connect to each other (John 2014, pers. comm., 30 March). This said, the functionality of the PRT depends on a complex system or a multiplicity of elements that appear to go beyond a number of stations, a fleet of automated vehicles, and a network of dedicated guide ways. Such description suggests strong reliance on technology that supports itself without seemingly any reliance on other contributors who potentially function, maintain, or participate by any means in its workability. This appears to reflect in specific way the designers’ inscriptions of the transportation strategies in Masdar City.

Although the level at which the pods moved indeed felt like a basement, because of the mounted walls around and the ceilings that spread over their path, actually it is not (Foster + Partners, 2007a; Masdar City, 2010). Pointing at the ceiling John explained, “this building is actually
down with what we call slab” (John 2014, pers. comm., 30 March). He adds that it is actually situated on the ground level that goes under the platform base of the city as a result of its elevation one floor above. The city is raised on the platform not only for allowing light and breeze through, but also for accommodating an extra lower level, “the undercroft level”. The undercroft is itself protected from the sun while allowing natural lighting and cooling from the upper level supported with artificial ones.

The idea of creating such vertical layout is to separate two modes of mobility, transportation and walkability, where cars run one floor under the pedestrians (Masdar City, 2010). This arrangement aims to provide an efficient transport system that eliminates congestion, parking, and space problems to achieve user satisfaction. Designer George says, “if you continue building cities where people and cars are mixed up, the cars will become very inefficient, because you can control cars, you can give cars collision controls, but you cannot control people” (George 2014, pers. comm., 18 February), which necessitates separating them from each other. A second aim is to create cool and clean air that is free from heat and emissions. George adds, “because you have not got all the heat of the traffic of the cars, because the cars are underneath the deck and they are electric, and they are shaded anyway” (George 2014, pers. comm., 18 February), which means that both levels benefit from this advantage. A third aim is to pave the way for a safe space to encourage pedestrian activity and social interaction. This is supported by Developer Charlie, who says that it is likely to be aware of the surrounding and interact with people if you are in such space. In other spaces, you might probably be distracted with the cars. Designer Ralf adds that it allows all kinds of people and activities, like kids, wheelchairs, push chairs, and bikes. Through the scenarios imagined by Charlie and Ralf, it is safer for the upper level to be free of cars.
Another idea of the vertical layout is to separate the city from its utility infrastructure, including power and sewage lines, pipes for potable, grey, and black water, cables for the city’s information and communication system, waste and recycling networks along with other systems and equipment (Masdar City, 2010). Designer Augustine adds that “you have got this kind of service world that happens beneath the public realm” (Augustine 2014, pers. comm., 27 May). This potentially provides a quick, separate, and easy access to them. This means that the aim is not only to provide efficient transportation, but also efficient operation through providing building service, particularly maintenance, from the start (Masdar City, 2010). Dr. Patrick emphasises:

So we see in our old cities that there are a lot of underground services that are under the streets, and there is a constant disruption. Something is always breaking and somebody has to dig here or there. But if you dedicate that whole level from the outset to services, then, it is not underground (Patrick 2014, pers. comm., 10 April).

Through the previous description, it seems that there is this apparent notion of separation between people and cars, between lived city and services, or between human networks and technological networks. The suggestion appears to support that fact that what relates to cars, services, and technologies is more controllable than people, lived city, and human networks, which represents a specific orientation in inscribing transportation in Masdar City.

According to Retting and colleagues (2003), there are many interventions that are aimed to separate pedestrians from vehicles by space through underpasses or overpasses. However, their high cost mandates implementing them on very limited scales (as small as a single bridge that separates the two modes, for example). It appears accordingly that Masdar City design attempts
to bypass such interventions with its scale and extended benefits, marking specific uniqueness and distinction that come along with applying a radical and different transport system represented by the PRT.

The PRT pod arrived at its end stop and we went out to the main hall, which looked to me similar to the first one. The main exception is a staircase that leads to the upper level; “the podium level”, which represents life above the deck and the walk-able realm. Designer John used that opportunity to mention that stairs feature prominently to be welcoming and inviting, while elevators are pushed aside in a hidden area to be only used if really needed, which is the reverse of the case in the conventional buildings (Figure-5.5). Designers and developers have prioritised stairs as a more sustainable technology as compared to the less sustainable elevators. In this way, they inscribe their visions of sustainability into specific technologies, where they design “scripts” or imagine scenarios for the users to de-scribe (Akrich, 1992). With the envisaged scenarios, designers and developers expect the users to use the stairs more frequently rather than other means that should be only used when necessary by the handicapped or for transferring heavy equipment. Designer Augustine emphasises this by saying, “there is kind of simple nudges to try and get people… to make it easy for people to adopt a more sustainable way of living” (Augustine 2014, pers. comm., 27 May). In this way, such strategies conform to designers’ specific ways of inscribing strategies in Masdar City while saving energy and encouraging people to get involved. Indeed, this strategy is an extension of other explained intentions through which the designers and developers envisage raising efficiency and increasing walkability through the city. This raises the question of whether or not users play their roles or define different roles on their own through their ways of de-scription, suggested earlier in chapter 2.3
through user typologies, while supporting, tinkering, reconfiguring, and resisting designers’ inscriptions.

![The prominently featured staircase and hidden elevators (Source: author).](image)

At the end of the stairs, we reached an enclosed space that accommodates the main reception. That particular space is described by designer Ralf as the circulation zone, located at the middle of phase (1-A) buildings and combining two of them together. It mainly comprises the reception desk and security inlets to get inside, which we decided to leave behind and proceed.

### 5.3 The PRT Inscribed by its Designers and Developers

The first question I tackle is how can the PRT be understood as a sustainable technology in relation to Masdar vision? According to this description, I discuss the second question in regards how to unpack the way it proceeds. Such understanding of the PRT and its travel would potentially allow comprehending the shaping of its collective through its inscription and description in Masdar City. This could be utilised ultimately to reach a specific understanding of the concept of sustainability as it transforms through the applied strategies.
According to Masdar City brief, “in developing all the mobility and transportation elements, the primary target is to embody the vision of Masdar project” (Foster + Partners, 2008, p. 43). Based on a top-down managerial approach, the main sustainable aims of Masdar City transport remain inspired by a techno-economic focus on efficiency, renewable energy, and no carbon emissions while maintaining specific user consideration in providing safe, clean, and cool areas or, in other words, convenient, satisfactory, and comfortable spaces to walk and commute. Such design aspects reflect a specific design philosophy and show how the designers and developers aim to cater for transportation in Masdar City through a dominant perspective that focuses the agency within specific contributions. The PRT gains its importance in being the key transport mean to achieve this, resulting in its development as a revolutionary and advanced mean of transport. It is also concurrent with a number of strategies like banning other vehicles and encouraging walkability. In this way, the vision is explicit and ambitious, reflecting on the clarity and straightforwardness of the PRT.

According to Masdar City brief and 2GetThere official website, the PRT as a sustainable technology supports the vision of sustainability through particular characteristics that position it as an efficient and renewable transport system and at the same time secure user satisfaction, convenience, and comfort (Foster + Partners, 2008; 2GetThere, 2015). These features include its directness, being on demand, privacy, non-stop mobility, safety, independence, decreased noise, less demand on parking, and reduced congestion. Such characteristics are in line with the ones discussed by Fichter (1964) as they combine the advantages of the personal automobile (like privacy and on-demand service) with the ones of public transportation (like less demand on parking and reduced congestion). At the same time, the PRT aims to be different and unique by itself.
In addition to these features, the PRT, similar to other sustainable strategies applied in MIST, aims to provide a living lab where learning occurs through experimenting the system, tracking its consequences and implications, and other sorts of scientific inquiry. It also aims to offer a pilot project that produces it as a model, example, or best practice that enlightens other projects on broad, global, universal scales for sustainable transportation that departs from Abu Dhabi and inspires the world. It accordingly delivers the vision of sustainability while globalizing and demonstrating it in a specific, unprecedented way. According to MIST concept design transportation report, “the MIST PRT system is the first in the world to be deployed at a campus scale” (Systematica, 2008, p. 9). Also, according to Masdar City brief, “it is introducing a new age of public transport provision that offers a safe and clean way of reaching your destination,” (Foster + Partners, 2008, p. 26) stressing the fact that it is revolutionary and futuristic.

The preceding paragraphs reflect on the PRT as a sustainable technology that results from the contributions of the designers from Foster + Partners, the developers from Masdar City, and the suppliers from 2GetThere, its support company. In addition to those, other involved actors contribute to its delivery, construction, and maintenance. Those form the contributors, who shape their designs to be materialised in reality, or inscribe their visions to be de-scribed amongst the users. Forming a collective in themselves and being part of it, they configure it in relation to use. Having done that, they decide to include or exclude the potentially involved actors from the side of use in the design, creating specific relations between both. In other words, they ease and facilitate a particular way of translation of design intentions to use experiences.

In addition to the previous description, the PRT comprises a number of technical elements that work with each other to provide sustainable transport in Masdar City. Part of these elements is visible, such as the station, the pod, the network of roads, as well as the user interface. The other
part is hidden, representing the magnets, the sensors, and the computer that controls the pods movement. In this way, the collective or network the designer configures in relation to users is not limited to human subjects, but to non-human objects with their relations, as both are involved in the translation processes.

In this way, understanding the PRT as a sustainable technology connects to the idea of the collective that combines human and non-human actors and networks that work together to provide the PRT with its efficient and renewable qualities. The actors and networks grow to accommodate the features and uses that the PRT delivers. In other words, the boundary of the PRT extends and widens to include many actors that initiate it and keep it going. Such an arrangement produces sustainability in a specific way envisaged through Masdar vision. Figure-5.6 shows a map that reflects on such relations, where focus is provided on the PRT as a main transport mean in a system that does not have any associations with other means. The PRT has its relations with its most influential actors such as the designers, developers, and other human and non-human contributors, but it does not include users. It also has its relations with the features that it fulfils such as privacy, directness, and reduced congestion. This said, the map presents part of an extended collective, but what it focuses on are the actors and features that potentially affect its design and use. The rest of this chapter utilises similar ideas; the collective or networked nature of technology brought by Latour (1987), as well as its fluid and flexible nature of De Laet and Mol (2000), and goes ahead with such explanatory figures to explain the PRT and its travel as a technology.
The question of how the PRT travels is inherently concurrent to such way of defining what the PRT is and how it is put in place as a sustainable technology. This entails comprehending how the designers and developers envisage the ways of use and the different features of the PRT that support its sustainability, and how they in reality come in line or contradict the intended ones. To do this, I present a dialogue between the most influential actors; designers, developers, and users. I focus on the main aims as well as the features and uses of the PRT service to capture “the world inscribed in the object and the world de-scribed by its displacement” (Akrich, 1992, p. 209). In other words, to find how the PRT collective or network that has been constructed by the designers and developers works with its specific relations to cater for sustainability and how the introduction and involvement of other actors occurs. This includes users that keep or change its relations and translate it in different ways, resulting in another meaning of sustainability.
It is worth mentioning that the only residents of MIST are the students, where their major part lives there. The other part resides in Khalifa city, which is a residential suburb that is 6 km or 10 minutes far by car from Masdar City. It is not related to it in terms of the sustainable vision and agenda, nor is it connected to it by the PRT. The villas accommodating the students there are rented by Masdar City until it is able to host all of them on campus. Phase (1-A) has hosted a limited number of students since its start, mainly second-year post-graduate students that have been given priority for their research requirements. This has left the rest of the students, mainly in their first year at that time, waiting for the conclusion of phase (1-B) to move to MIST.

In this way I classify the students, in relation to transportation, into a number of main categories; students residing in MIST (S1-S23, referring to chapter 3.7, Table-3.2), who need transportation, comprising the PRT mainly at that time, whenever they need to go out of MIST for facilities and services not available inside it. Another category comprises the students residing, or have resided for a specific period of time, in Khalifa city (S1-S7, S9-S15, S18, S20, S22), who need such transportation daily to go to MIST and use its services and facilities. A third category comprises some of the students, who live at MIST, but have their families in other parts of the UAE (S13, S15-S17), where they need transportation during weekends to go back for visits. A fourth category includes staff members (DR1, DR2), who do not reside in MIST, but need the transportation for their daily trip to campus. Within this variety of users, a multiplicity of interpretations and experiences emerge in regards to the adaptability and diffusion of the different design strategies.
5.4 De-scribing the PRT through User Interactions

The PRT currently includes only two stations with around 10 pods that run from the main entrance of Masdar City to phase (1-A). Despite its limited reach compared to its ambitions, creating an efficient transport system that is based on renewable energy as its main feature starts to prove challenging from the early stages of design and development through to implementation. One of the reasons is that Masdar vision views it as a singular system with determined aims and targets in relation to sustainable transport. Developer Isaac explains that this results in a system that is rigid, uncompromising, and at the same time complex and delicate. The system cannot be intersected with or crossed by other facilities, utilities, vehicles, or people, where all need to be accommodated differently. This reflects on the accumulated cost to create another separate path for them. In this way, the collective of the PRT has been created or inscribed by the designers and developers, including specific actors and network as well as their relations to translate in a specific way. This is further rigid, where the boundary around it, although widens at certain times, still bounds it within specific limits. Such rigidity is dominated with the idea of separation between people and cars, between lived city and services, and between human networks and technological networks, stemming from the notion that technical and technological aspects are more controllable and can operate independently. These dominant notions result in unpredicted implications and consequences that are tackled later in this section.

Another reason for the PRT challenges is that Masdar vision views it as an advanced, huge, and ambitious mean of sustainable transport. This results in what is argued by developers Isaac and Charlie as expensive and accordingly hard to extend and incorporate a larger number of PRT stations and pods. For them, this would include the cost of elevating the remaining part of the city, the cost of the additional pods as well as the general setting, and the cost of maintenance.
Isaac adds that, at the time of the design and development of the first phase of the PRT, the government was in full support of the project. However, at the time of its implementation, the financial crisis happened, which made it challenging to go further with it. In other words, the financial market appears to be an actor that has shaped the PRT collective and de-scripted the intentions of the designers. The financial market was probably not considered to be a central actor in the original collective originally inscribed by the designers.

The stage of implementation reveals more challenges and embeds the whole system with another layer of complication, which I present in the following paragraphs. When one attempts to follow the users through their daily lives and routine activities, their interactions are not as direct or straightforward as originally expected by the designers and developers as they are much more complex and changeable. As the designers introduce the design through their performed analysis, predefined measures, or followed examples, users tap into other different parameters and dimensions that contest it and change it in ways that could not be introduced or predicted at the onset of the design. In other words, users de-scribe what the designers have inscribed to them in different ways.

Akrich and colleagues (2002a, p. 202) stress users’ influence on these dynamics by arguing that “the evaluation of the disadvantages and advantages of an innovation is entirely in the hands of the users: it depends on their expectations, their interests, on the problems which they raise.” According to Rohracher and Ornetzeder (2002), such aspects include how users adapt or resist handling them, integrate them into their daily routines, and make sense of them in different ways. Users themselves are not homogenous in their interactions with technology. On the contrary, they provide a variety of scenarios that reflect on how they affect and get affected by these technologies. Through such interpretations and experiences, they redefine the functionality of the
PRT and contest its sustainable meaning. Coming back to the collective of the PRT, it needs to integrate itself and build relations with other actors who take, adapt, and support it. Otherwise, it stands a higher chance of being ignored, resisted, or even rejected by them. In other words, it does not translate as intended by the designers. In case the design is more flexible to accommodate them, such actors extend it limits, exceeding its borders and blending it with their aspects of use. In case it is not, they disturb the design and cause its failure. Following, I show how the users interact with the PRT through tackling its intended features and uses that facilitate its materialization.

One of the important features of the PRT system is being direct to destination, which is discussed on both Masdar City and 2GetThere official websites supporting its vision of sustainability in ensuring efficient and renewable transport and user satisfaction (Masdar Institute, 2015; 2GetThere, 2015). According to this feature, passengers do not need to change vehicles to travel between any two stations on the network. As long as the PRT system is composed of only two stops, it provides a direct transfer carrying passengers from the entrance of the city to phase (1-A).

As developer Isaac describes in an informal discussion how he would experience the PRT if he was a user. He provides an example, where his daughter could fall asleep on his way back home in the car. He explains the imagined difficulty of parking his car at the PRT parking at the entrance of the city, as cars cannot go beyond that point. He accordingly needs to carry his daughter from there to one of the PRT pods that is supposed to take them inside the city. From there, he needs to leave the PRT pod and walk to his residence. He provides a similar example in case he is coming back from shopping with many bags that he needs to carry all through the PRT. This is to him more exhausting and less comfortable than taking his car all the way to his
residence, although this is not based on efficient and renewable technologies. He adds that “changing means of transport is much less sustainable than arriving directly” (Isaac 2014, pers. comm., 20 January). With such reference to sustainability, he addresses the directness feature that is not fulfilled by the PRT but actually supported through other means. In case he needs to leave the city, he would experience a similar scenario. Dr. Patrick agrees with that by saying, “the point is to be able to get from point A in the city to point B using the PRT, and if you have to get on a PRT to get from point A to point C and then you get in a car that will go from point C to point B. It’s worse, right?” (Patrick 2014, pers. comm., 10 April) With this, he indicates the same spatial logic of the PRT that does not fit the designer intentions with potential user expectations in terms of directness.

Apparently, such scenarios that have been conceived by the developers as they put themselves in the shoes of the users are not far from the ones experienced by the users. Tiana, shares a similar scenario as she says, “I would like to drive directly to my home where I live, not stop somewhere and then change to another vehicle” (Tiana 2014, pers. comm., 29 April). Maram, Maya, Mira, and Nesma agree with that, as they need to travel every week from MIST, where they stay, back to their families in other emirates of the UAE to eventually come back with lots of bags. With this, they express the difficulty to manage such movement all the way. The difficulty of movement is also applicable in the cases of ordering food or a taxi, taking a car, or waiting for the bus at the PRT station.

In this way, the intention of the designers and developers regarding the directness of the PRT does not materialise as they have envisaged, as in reality students do not find the PRT as direct as expected. The limitation of the PRT to two stops could be part of the reason, as its original purpose is to extend within and beyond Masdar City, where the students might not need to
change the mean of transportation at the entrance to go anywhere else. This route represented at some point the only access to the city, which made its location more visible and important for the users to pass through. The designers and developers mandated the users to enter Masdar City and leave through it. In this way, they inscribed their vision of sustainability into the technology, where they designed scripts for the users to de-scribe. With these envisaged scenarios, designers and developers expected the users to use the PRT as the only way to approach the city. As they play their roles, users such as Maya, Wajd, and Abdullah, who lived inside the city and at some point beyond it, found them hard and restrictive.

Another characteristic is the on-demand service, where the PRT should be always available upon request. According to Masdar City Brief, “even during peak hour, the waiting time for a PRT car will be normally less than 2 minutes, and the cars will be able to run at an interval of less than 3 seconds one from another, guaranteeing the capacity required” (Foster + Partners, 2008, p. 50). With this, the on-demand service is central to the PRT to guarantee minimal waiting times at most of the cases, including day and night.

Dr. Zaher diffuses this feature by saying, “when we come to the PRT station, we need to wait for 20 minutes until we are able to get in” (Zaher 2014, pers. comm., 20 January). Wajd, Sophie, and Aysha agree that they wait 15-20 minutes sometimes before a single pod is available, with more delay when it is more crowded at early morning or during events. Although the PRT is supposedly available for most of the time, Dr. Patrick highlights that it does not work after midnight. In this way, the PRT appears not to be as on demand as the designers and developers expect in light of the waiting time endured by the users as well as the limited working hours.
A third feature of the PRT is privacy, where passengers travel either alone or within a small, private group. According to Masdar City Brief, “every group of passengers will use one vehicle exclusively for the whole trip and every passenger will travel seated, as in a car” (Foster + Partners, 2008, p. 50). Such characteristic appears to reflect contextual needs and requirements of Abu Dhabi, as privacy is a central aspect. Mahmoud comments that although the maximum capacity for the pods is six passengers, couples including himself and his partner, both living at MIST, would not prefer to share the same pod with other people. In this way, although most of the users appear to be supportive or adaptive to the previous features according to the typologies described in chapter 2.3, as they do not contribute to any changes, Mohammad and other couples could fall under the category of tinkering users in regards to the privacy feature. The reason is that they do not comply with design inscriptions as they provide minor changes through their description when they reject sharing the pods with others. In this case, regardless of whether privacy is more or less achieved, it limits the capacity of the pods adds to the waiting time described earlier.

The fourth feature of the PRT is the non-stop nature of its operation. According to Masdar City Brief, “once a person or group of people have boarded and planned the route, the vehicle will not stop until the chosen destination has been reached” (Foster + Partners, 2008, p. 50). The magnets and computers that control them, mentioned by designer John and developer Isaac, guarantee such a feature. Upon stopping at the destination, the pods recharge their batteries, if needed, preparing for the next trip. What happens, however, is that pods occasionally stop on the way. Edward comments, “there was a time I was in the PRT and it just stopped in the middle” (Edward 2014, pers. comm., 28 March). Allan, similarly says, “I am just stuck in the middle here and someone might have to come out and reset everything manually” (Allan 2014, pers. comm.,
28 March). It could be that the delicate system of magnets and the control computer are the reason behind such moments of failure of the system. In other words, such aspects did not work as inscribed by the designers as they diverted them and de-scripted their intentions.

The fact that the PRT could stop actually causes further delay and adds again to the waiting time to stop, to call for help, and to wait for another pod. This gains importance when realizing that there is no other way to leave the pod and continue the trip for safety purposes, which is another feature of the PRT. Edward for example mentions that he tried opening the door of the pod as it stopped to continue the trip walking, but it simply did not open until the maintenance team arrived and allowed him to exit. Even Jonathan once mentioned that he wanted to walk the route of the PRT without the pod as it would be easier for him than taking a pod that could stop and trap him inside. However, he found out that this was forbidden by the security guards. In other words and in regards to this feature, there seems to be less opportunity for users to tinker, re-configure, and resist a system that seems apparently dominant. In this way, the non-stop feature of the PRT does not materialise as the designers and developers expect, as in reality it is accompanied with some complications. With the pods that stop for charging on the station, another challenge appears. Larry, emphasises, “the PRTs have to charge and you will often find there is one or two PRTs stopped charging, so they are not even running” (Larry 2014, pers. comm., 9 March). This means that the system would not run at its full capacity of pods, which potentially causes further delay.

The potential collapse of the non-stop feature of the PRT affects another feature, which is being driverless or independent. Allan for example argues,
The fact that they need to have people come reset the cars is interesting to me, because I thought the whole idea was that it would just kind of do its thing and it would figure out where to go and do the thing right. The whole idea is that it is an autonomous system (Allan 2014, pers. comm., 28 March).

In this way, the reliance on those people makes the PRT not fully independent as its designers and developers initially intended. The more concerning issue to Allan is that such failures or complications happen in a system that is still in its simplest version or early stages, which could mean further complications if it goes beyond that.

In this way, the collective of the PRT that has been intended by the designers, who delegate most agency to the technology but not the user, is not experienced as intended. This can be traced through following the features and uses that have been inscribed by the designers such as the non-stop, on-demand, privacy, and independence that have not aligned with users and were described in different ways accordingly. Here again, the collective, in addition to the users it is supposed to include, embraces other non-human actors like the bags they carry and the taxies they call. As the users have such relation with the loads they have and the taxies they need, they do not align with the other relations that they have with the PRT, where it does not translate in the expected way. In some cases, the magnets and controls that have been inscribed in specific ways as part of the collective appear to fail and further de-script the intentions, creating more responses among the different users and their introduced elements. In other words, the PRT is a relatively rigid and single system that only allows the users and other aspects within its boundaries in specific ways.
On the top of the complications that face the PRT implementation, mainly the waiting time and the increased congestion connected to it, the number of its potential users gets higher with accepting more students and opening the Siemens building and other facilities directly beside MIST, which host additional users. This implies a collective that keeps growing and actions and reaction that further exacerbate. According to developers Isaac and Charlie, it is unrealistic for the students, as well as the newly-introduced company employees, to continue using the PRT in the same way. Although the issue of the PRT might not affect students’ decisions in enrolling into MIST, such issues might actually discourage companies from renting offices in Masdar City, putting down one of its main targets of bringing universities and companies together and developing a skill and research base that supports MIST. This triggers the question that, as the features supporting the vision of sustainability in Masdar City are not materialised, does that mean that the PRT is no longer sustainable or contributes to sustainability in any way?

As an outcome of the mentioned challenges through the design, development, and implementation stages, including the financial constraints that appear in the former and the performance issues that occur in the latter, the developers have decided to scale down the whole PRT system. In other words, what has been intended during the design and development stages has not aligned with the lived environment through the different processes and this is why the intentions have changed. The system has been accordingly limited to around 10 pods covering two stops between the entrance of the city and phase (1-A), which has further restricted its usage. There has previously been another PRT parking at the city ready to accommodate further PRT pods but has accordingly, temporarily or permanently, been abandoned. This actually changes one of the main design intentions of the PRT as expressed in Masdar City brief, where “a large number of internal stations (76) will guarantee that more than 50% of users will not need to walk
more than 100m to reach a station to board a vehicle or, on arrival, at their final destination. The longest walking distance will be 150m” (Foster + Partners, 2008, p. 50). The plan has been to stretch the PRT much further from its current phase and knit the foreseen neighborhoods of the city at the time with each other, with eventual connectivity to Abu Dhabi.

In addition, and as a result of the financial constraints and user complaints and as part of a second phase of transport in Masdar City, the developers have decided not to solely rely on the PRT anymore and to introduce other potential options. This actually changes another main intention of the PRT, which is being the main sustainable transport mean in Masdar City. They have accordingly suggested three new transportation technologies in line with Masdar vision and driven by efficiency and renewable energy aims and user satisfaction measures with specific features and uses that contribute to the sustainable targets, to be tested. Those comprise the electric vehicles, the driverless cars, and intelligent management. Furthermore, other regular technologies came into effect, such as the shuttle buses and public transport. Although they are not as efficient or renewable as the PRT to contribute to it as a sustainable technology and to the sustainable transport system in Masdar City, they contribute to them by enhancing user satisfaction as part of its sustainable targets through other features and uses like directness, on-demand, the non-stop that could or could not materialise to certain levels and stages. In this way, in addition to the main efficient and renewable aims, other targets such as the mentioned features and uses trigger the change in the mobility strategies at Masdar City to potentially achieve a more satisfactory usage.

In this way, the collective of the PRT once formed the only transport system in Masdar City. As a result of the financial constraints and user interaction, the PRT was not anymore the mere transport system as other means have come to effect as part of it. Although the PRT is
uncompromising and unwilling to relate to other actors and means, the transport system started to build new relations in the aim that it translates differently within the constraints and interactions. In other words, although the PRT is supposed to be a relatively rigid and single collective with apparently narrow and restricted boundaries, the transport system is not, as it reflects more fluidity with boundaries that widen and extend around the PRT to include other actors and means.

When the PRT as transport system travels, the involvement of different actors and networks could change and suggest ways of shifting the relations within its collective originally constructed by the designers and developers to deliver a different sustainable system of transport or particular technology. Such change entails reshaping the system or technology itself in different ways while creating different arrangements and contributions within and around it, including actors and networks that keep growing around it and boundaries that continue widening. Sustainability is embedded with these collectives, reflecting its contestation and transformability.

Introducing the PRT as a mere transport system by the designers and developers to produce sustainability in a specific way has raised lots of debates among the different users. Aysha mentions that the PRT as a sustainable technology is highly focused on efficiency and renewable energy and other designers’ targets in a way that could disregard users. Wajd adds that, when thinking of sustainability through the PRT, there is a question of comfort that should be tackled. This has ultimately led the developers to introducing different options to the transport system, adapting to different potential meaning of sustainability. In other words, and in result of such interactions, sustainability as a concept transforms to reflect a completely different meaning, where aspects like efficiency and renewable energy, comfort, suitability, and convenience are
negotiated between the design and use in different ways. It is important here to realise that these conflicts over sustainability do not only happen amongst social groups as can be followed from the arguments of authors like Adams (2001), Pepper (1996), and Redclift (1992), but it also involves material aspects that contribute to it.

5.5 The Newly-emerging Options of Transport

At the beginning, the developers did not allow any transportation means inside Masdar City other than the PRT as part of its zero-carbon strategy. This, however, had only one exception, which was the shuttle buses. Shuttle buses are regular small buses roaming Masdar City to support two aspects of the PRT. The first aspect is that they go through the same route of the PRT to compensate for its waiting durations and limited operational times. Such shuttle buses were ultimately cancelled with the limitation of the PRT and the alternative introduced options.

The second aspect of the shuttle buses is that they go from Masdar City to different destinations beyond it, compensating for one of the main intentions of the PRT, which has not materialised as a result of its mentioned limitations and alternatives. According to the students and faculty members, the idea of these shuttle buses is to provide transportation to specific places at particular times, including Khalifa city, where some of the students reside, in addition to the main shopping malls and markets of Abu Dhabi. Wasim describes the shuttle buses schedule by saying, “they go through two trips a day, which are usually around 5:00 pm coming back at 8:00 pm and 8:00 pm coming back at 11:00 pm” (Wasim 2014, pers. comm., 8 March). The shuttle buses going to Khalifa city commute more frequently as a result of more reliance on them on daily basis. Although they do not contribute to the PRT as a sustainable technology nor sustainable transport in Masdar City through any efficient or renewable aspects, they still
contribute to user satisfaction that is also part of the sustainable targets through their characteristics that differ, overlap, or supersede the features and uses of the PRT like directness, on-demand, and non-stop that could or could not materialise to a certain extent.

In terms of the directness feature, for example, Allan, Wasim, and Ammar argue that shuttle buses take them from the front of the main building of phase (1-A) and drop them at their targeted destinations without needing to switch to other means of transportation. Maya, Yan, Hamdi, Abdullah, and Eman do not agree as they argue that they need to switch to other means of transport when the bus does not take them where they want directly. This potentially makes the shuttle buses less direct for some students than expected by the developers.

In terms of being on demand as a second feature, Javed and Mira find the schedule of the buses convenient to fit their times. Tiana and Maya, however, argue against the time of waiting for the buses to go to or come back from Masdar City to their destinations as they cannot go on other times beyond their schedules. This indicates that shuttle buses might not be really on demand for lots of students as expected by the developers.

In terms of non-stop as a third feature, many students, such as Lara and Nesma, argue that shuttle buses are straight on their route without needing to stop on the way and they go back the same way. In some cases, however, the pre-set destination of the shuttle buses might be far, which accumulates more time during the trips as argued by Allan and Darren. In this way, although shuttle buses do not stop on the way, they still consume time during the trips depending on the adjacency of their destination.

Through the features that partly intersect with the PRT, shuttle busses contribute to user satisfaction as part of the sustainable aims of the transport at Masdar City. They might extend
such characteristics to go beyond the PRT with the reduced congestion and the parking spaces that they need. Meanwhile, they might not include some of the PRT such as privacy, safety, and independence.

Shuttle buses extend the collective of the PRT and, at the same time, represent another collective or network on their own. Each of these collectives provide features and uses that intersect or disconnect with the other. Shuttle buses accordingly become part of the collective of the sustainable transport system in Masdar City. The transport system collective is not anymore limited to the PRT. Rather, it builds relations with the shuttle buses that could be less sustainable in terms of providing efficient and renewable aims but still contribute to user satisfaction as part of other sustainable aims that translate differently. In other words, beyond the relative rigidity that has marked the earlier stages of the transport system at the design and development stages with focus on a specific mean, it has started to cater to some fluidity welcoming other aspects. This recreates the transport system boundaries that are not narrow or restricted but wide and extended to include questions of convenience, comfort, and suitability that become important through the implementation stage.

Among the other limited options available in Masdar City is public transportation. Such mean has been newly introduced by the Abu Dhabi transport authority and located outside the PRT parking. As explained earlier, and similar to shuttle buses, although public transport does not contribute to the PRT as a sustainable technology, it still contributes to user satisfaction through its features and uses that could intersect, go beyond, or contradict it.

To start with, and as a mean of transportation, public transport is less direct. Lara, who is accustomed to using it, emphasises that the stops are off the way, where she needs to go to a
specific station to take and drop her far from her target. Ultimately, she needs to switch to another mean of transport to continue her trip. She further adds that the route itself is less straightforward. In addition to that, public transport is less on demand, as Lara explains that the provided public buses are limited with inaccurate and less frequent intervals. Added to that, it keeps stopping throughout its route, as emphasised by Edward and Lara.

Public transport still extends the collective or network of the PRT and, at the same time, represents another network on its own. Each of these collectives provide features and uses that intersect or disconnect with the other. It becomes part of the sustainable collective of the sustainable transport system in Masdar City. The transport system collective continuously and progressively includes other aspects while being no more limited to one supposedly-sustainable option which collective is set by its designers and developers in a specific way. It builds relations with other options that could be less sustainable in terms of providing efficient and renewable aims but suggested by the developers to contribute to user satisfaction as other sustainable targets to enable their different translation. Sustainability is reproduced through the redistribution of such options so that the users have a choice of their usage.

It is important here to emphasise that, as Masdar City is not complete as a full-fledge city at the time of the research, the facilities and services inside MIST are still lacking according to designers Augustine and John. Students accordingly need to leave on repetitive bases to fulfill a number of basic and auxiliary needs. What exacerbates the challenge is that Masdar City is far away from the external facilities and services in Abu Dhabi, where the nearest ones are by no means within a walking distance from it. This in turn adds to the reliance on transportation to overcome such challenges.
With the need for transportation, the PRT, shuttle buses, and public transport provide some options for going within and beyond Masdar City. Beyond this flexibility in options, students like Lara, Eman, Jonathan, Darren, Ammar, and Sophie still express their restriction in movement that they characterise as limited, difficult, and bound to specific conditions. Students rely on other means that further change the PRT and recreate the transport system, as a response to such challenges.

5.6 The Re-appearance of the Car as a Transport Option

As a result of the financial constraints and the user complaints that accompanied the PRT, and as part of the second phase of Masdar City, many options were introduced by the developers. Part of such options were the shuttle buses and the public transport as mentioned earlier. Other options extend to include opening a new parking lot beside the knowledge centre. This new parking opens the door to all students, faculty members as well as tourists, visitors, and other segments of the public to enter the city without restriction. It, however, partly replaces the green belt, changing a main intention of Masdar City master plan. It appears that the developers, like Isaac, Charlie, and Mike have aimed at resolving the challenges that have started facing the users of the PRT by compromising such intention. In other words, although the new parking area adjusts part of the green belt and might not be aligned with the efficient and renewable aims, it still contributes to sustainability in providing quicker and more direct, private, and convenient transport as part of the sustainable aims through the features and uses that cars and other vehicles contribute to as they complement other means.

Developers Charlie and Mike argue on keeping, to a certain extent, efficient and renewable ways of vehicle usage. For them, what is specific in Masdar City is its cluster-based design with
maximum walking distance of 150 meters from the parking. Charlie argues that the city would
grow in the same way with more facilities and services being provided, which would mean
potentially maintaining the walkability to a large extent within the city and having less reliance
on vehicles to go beyond it. According to that, he provides an example, where a husband would
need a car to go to work outside the city, but the wife would not need it to bring groceries within
the city. With this, he thinks that this might go one step beyond having two or three cars for one
family to rely on a single car for the whole family. He adds, “so we are doing things to
encourage people to have a life without or with less cars” (Charlie 2014, pers. comm., 24
March). He further provides a suggestion that might go even further, which is through car-
pooling or car-sharing as he believes that, with less reliance on cars, more than one family would
be more likely to share them. As a result of the suggested solutions, Charlie concludes by saying:

There are always ways to let people choose not to have a car. We are not saying that if
you live in Masdar City you have to give up your car, but if you live in Masdar City, you
say that, ‘hey it is more sensible for me not to have a car’ (Charlie 2014, pers. comm., 24
March).

Isaac agrees by saying, “the trick is two-fold, one thing is not owning a car and that may be
tricky, but the next step is… well you have it but you do not use it” (Isaac 2014, pers. comm., 20
January).

Although the developers do not have any previous intention to allow cars inside Masdar City,
they appear to rethink and decide to make them part of the transport options with some
amendments and shifts. Regardless of the fact that the introduction of such cars might have come
as a result of the financial constraints of the PRT and user complaints, it also could be that the
developers have rethought sustainability in a different way, where issues like efficiency, renewable energy, comfort, and convenience are negotiated between the design and use. Another reason is that the developers have realised that sustainability is not about the introduction of one sole transport mean, but negotiating a multiplicity of means through which multiple features and uses can be provided; giving the user further choice and flexibility.

In this way, the car as a collective in its self has its place in the collective of sustainable transport in Masdar City. Developers are not able to eliminate it entirely, but they aim to shrink it as means that do not contribute to efficiency and renewable energy but still provide user satisfaction as another sustainable aim through their features and uses. At the same time, they work to extend the influence of other means that could contribute to that in different ways. In other words, sustainability is not how to get rid of specific collectives as it has been the case at the beginning of the project, but how to connect them together in particular ways as it starts to unravel later.

Sustainability as a concept transforms with the movement of the designs and technologies, bringing a completely different meaning than the one originally intended.

In this way, the travel of the PRT as a transport system reshapes it as what has been intended by the designers and developers has not worked as expected within the lived environment or, in other words, the collective has not translated in the intended way. This has resulted in involving other actors and networks and shifting its relations to reshape the original collective and produce a specific sustainable system of transport or particular technology that translates in different way. Such change means reshaping the system or technology itself while creating different arrangements and contributions around it with actors and networks that keep growing around it and fuzzy boundaries that continue widening. Through these changes, sustainability is
reproduced and negotiated differently, exerting more focus on certain aspects and less focus on others.

Figure-5.7 shows a map that reflects on such relations, where focus is provided not only on the PRT as a main mode of transport, but also on its associations with other modes such as electric cars, shuttle buses, public transport, and cars. Each has its relations with its most influential actors such as the designers, developers, and other human and non-human contributors. They also include users as part of the contributors. Each of them has relations with specific features that they fulfill, where they start to overlap and enhance the achievement of such features. This said, the map presents part of an extended collective, but what it focuses on are the actors and features that potentially affect its design and use. What is important here is that the map shows how the transport system includes and builds relations with actors such as users that are initially not there as illustrated in figure-5.6. It also grows its sustainable means through the other relations it builds with them, where figure 5.6 shows that such relations are not intended originally.
Introducing the new parking and allowing cars as well as other means mentioned earlier as an intention of developers to produce sustainability in a specific way has raised debates between the different users, who disagree or agree with these strategies. Aysha on one hand says that “in terms of sustainability, such strategies might be questionable” (Aysha 2014, pers. comm., 4 March). In other words, they might compromise one of the sustainable aims of Masdar that are focused on efficient and renewable energy as the city is not anymore zero carbon or even carbon neutral. On the other hand, the strategies align with other students and faculty members as they provide more user satisfaction. Darren emphasises, “now you have the parking lot opened. It is easier to walk there and take your car than go to the PRT then go to your car” (Darren 2014, pers. comm., 11 April). Wajd agrees by saying, “the opening of the new parking has made our life easier” (Wajd 2014, pers. comm., 2 March). The opening of the parking has also reflected on other students and faculty members, who want deliveries, order taxies, or have private cars, where such matters become easier and more approachable. This further has an impact on the
users that come back with shopping bags or heavy loads and want to access or leave the city directly. The opening of the parking aligns with students and faculty members who know that, although the city is no longer zero carbon or carbon neutral with the introduction of such strategies, they provide more flexibility and convenience in terms of transport. This could actually be seen as another version of sustainability that aspects such as efficiency and renewable energy as well as user satisfaction are tackled differently.

5.7 Re-shaping the PRT through the New Means of Transportation

With the introduction of the new parking and further reliance on cars and other transport means, the usefulness of the PRT has become more limited compared to its original scope set by the designers and developers, while allowing other means to take charge. Sophie agrees to that, amongst many students, as she says, “we stopped using the PRT when the new parking lot was opened” (Sophie 2014, pers. comm., 18 April). Javed further adds, “in the period of the last four months, since they opened the nearby parking, I have not used the PRT very much” (Javed 2014, pers. comm., 31 May). Students accordingly have limited their use of the PRT parking to the cases when they need to reach the original entrance of Masdar City, finding no other place to park their cars, or using public transportation that is only accessible from there. Other students, such as Majdi and Larry, still try the PRT for entertainment and exploration and encourage their friends to try it from time to time. In other words, most of these users, when they found the opportunity to use other means, simply showed all forms of elimination and resistance to the PRT.

The PRT, as a transport technology, has a limited role in reality in moving users from one point to another within Masdar City as initially intended by its designers and developers. However,
according to developer Issac, it attracts a specific, yet narrower audience. Rather than being of
benefit to the local users, who need transportation on a more repetitive basis, its current users
include mainly visitors and tourists, who would rather experience and enjoy new, futuristic
concepts from time to time. In this case, and for its new audience, issues like waiting time and
delay as well as convenience, suitability, and comfort connected to them are understandably less
important and influential to the functionality of the PRT. Other features become more important
to present it and potentially provide it as a ground for testing and refinement. In this way,
although the PRT falls short of designers’ and developers’ expectations to deliver its role in
transport, it still aligns with them in terms of other purposes pertaining to demonstration and
experimentation. In other words, it still serves an essential aim of Masdar City in terms of its
vision in relation to sustainability.

According to De Laet and Mol (2000, p. 225), “there are many grades and shades of ‘working’;
there are adaptations and variants.” In that sense, although the functionality of the PRT as a mean
of transport has been restricted, when one looks at it through another identity or angle of
workability, it might look different. As the functionality of the PRT might be relatively limited
and rigid in relation to providing transport in Masdar City, in terms of other demonstrative and
experimental roles, the PRT in itself might appear to be more fluid, flexible, and changing over
time. Such differing identities and levels of workability can be traced through its alignment with
some users while disregarding others, prioritizing some features and uses over others, achieving
some of the predicted goals but not all.

The travel of the PRT as a transport system recreates the collective of involved actors and
networks, connecting to some and disregarding others as it translates in different ways. This
shapes the system or technology itself and leads to new settings and contributions surrounding it
with actors and networks that keep changing around its differing boundaries. Depending on these changes, certain grades of sustainability are assumed. There is no clear cut-off point that marks when sustainability is delivered as a concept, and accordingly, it remains changeable and unstable with the dynamics and transformations of the project.

5.8 Conclusion

Thinking about the travel of the PRT as a transport system and how its collective has started to take shape reveals how it has actually commenced from the moment when the developers resorted to Foster + Partners to design Masdar City, resulting in multiple sustainable strategies that include transportation. Through the design and development process, the circle of collective of the PRT has widened to include the support, manufacturing, delivery, and maintenance teams. All have worked in alignment with Foster + Partners as well as Masdar City developers to design and develop the main technical elements of the PRT, embedding within them specific features and uses.

Although the collective of the PRT as a transport system has been initially arranged by the designers and developers in specific ways during the design and development stages, it has changed and extended as a result of the challenges faced. The implementation stage has added another layer of complication as it has been received, experienced, and contested by the users, which has further changed and widened the collective itself. This raises the question on how are such processes traced and adjusted and how do their actors interact and relate to each other?

The involvement of the developers in the PRT takes a specific form as they started getting closer to the users’ stance. In some cases, the developers wore the hats of the users, exploring the different scenarios of functionality of the applied transportation technologies. Developer Isaac,
for example, says, “I have never taken my car from here to MIST. I could do it, nobody stops me... Either I go and take an electric vehicle, or I walk to this parking lot and take the PRT” (Isaac 2014, pers. comm., 20 January). Others would go watch the experiences of the users and hear their interpretations of the PRT. Developer Charlie says, “I just come back from there, I watch them… and you just get to become more aware of what is going around you” (Charlie 2014, pers. comm., 24 March). In this way, although the project has initially been based on a top-down, managerial approach, determined by the strong and solid design and development authority, there have been some moments when the developers dissolved within the project; experiencing, observing, and involving the users. In other words, they have allowed other actors to contribute to the project.

Through such a process, developers demonstrate similarities to what is described by De Laet and Mol (2000, pp. 252 - 253) when they explain that a “specific kind of people is required: non-modern subjects, willing to serve and observe, able to listen, not seeking control, but rather daring to give themselves over to circumstances.” This potentially emphasises the developers as less rigid and restricted and more flexible and serviceable in creating, implementing, and reshaping fluid technologies through the travel process.

In regards to the designers, however, Foster + Partners have not had similar involvement in Masdar City after the implementation of the second phase, as advised by the designers themselves as well as the developers. However, this has not stopped their follow up from time to time through the photographs that they take, the visits they conduct, and the events they attend according to designers Georgre, Ralf, and Augustine.
As the designers and developers initiated the earlier conceptions of Masdar City, assuming that it delivers a living lab within that particular context in a particular way to approach sustainability, the developers and users take it on later, realizing that it might not align within the lived environment as predicted earlier. One of the reasons is that Masdar City is not yet finished, where another reason is that the assumptions of the designers and developers did not fit with the actual living conditions.

The top-down approach, when seen from the ground, is different in prioritizing other issues that have been taken into account differently at the beginning. The vision that has been relatively rigid and restricted accordingly is changed and manipulated, reflecting a certain level of flexibility and embracing the actors on the ground. Developers change and improve the design and development of the current or upcoming stages. They shift the original inscriptions of technologies on the basis of what they watch, try, and collect as they follow and trace the users and put themselves in their shoes. Users are no longer mere receivers of technologies, they have rather active roles in shaping, recreating, and modifying them with their use, adaptation, and inhabitation, through their different ways of de-scription that support, tinker, and resist the PRT. Technologies reflect transformability and changeability through such a recursive loop of learning between the designers, developers, and users, where they are manipulated on the basis of how the developers align user needs with the physical design of the city.

As the developers realised the difficulties that users faced carrying their bags through the PRT path, ordering taxis or food, waiting for the next pod to arrive, being stopped in the middle of the way, and faced by other scenarios, they decided not to solely rely anymore on the PRT and introduce other means. Financial constraints were part of such learning loop that has contributed as an aspect to design revision and shaping.
This said, a different meaning of the living lab concept and a learning process emerge in the context of Masdar City, showing how it evolves over time with the transformation between the design, development, and use. In other words, the living lab that used to focus on a specific learning process that emphasises technical issues and break-through technologies with collaboration between the designers, developers, and users has changed to a different learning within which users’ responses are incorporated and aspects such as comfort and choice come into the spotlight to be tackled differently.

The transformation that the PRT as a transport system in the first phase marks the outbreak of other options that appear with the later phase such as the electric cars, shuttle buses, public transport, and private cars. Not all these options are inherently in line with the original designers’ and developers’ sustainable intentions, but they provide more features and uses that complement the PRT and offer more convenience and suitability in Masdar City transport. This widens and redefines the collective of the PRT as a sustainable transport system to reflect a complex matrix of interactions, where each mean within it represents a collective that has its own place and role to produce and re-produce sustainability.

The transport system comprised of the PRT that the designers and developers have meant to be revolutionary, powerful, and universal as a sustainable strategy, unexpectedly does not work on its own in a presumed rigid way through a single path or solution. On the contrary, it proves to be more fluid to include means that provide sustainability in different ways that complement the PRT and work with each other, providing an array of paths or solutions in relation to what sustainable transport could mean. Sustainable transport can only be understood through such contestation and flexibility that emerge through a variety of intended or unpredicted ways.
Chapter 6: Inscribing and De-scribing Sustainability in the Household in Masdar City

6.1 Introduction

This chapter explains the travel of designs and technologies in Masdar City by examining lighting as a main strategy and departure point from which household management can be tackled.

Focus on lighting strategies is driven by two motives. The first is that they show how the relations within a specific collective between human and non-human actors are shaped and reshaped among what is proposed by the designers and what is interpreted and experienced by the users. They accordingly provide another apparent example of inscription and de-scription processes, in addition to the one demonstrated in the previous chapter. The second reason is that, as designers and developers are interested in sustainability in alignment with Masdar agenda, they focus on energy as a contributor to the ecological footprint in the UAE, being one of the highest in the world (WWF, 2012a). Electricity forms a major part of energy demand, with lighting contributing with around 940,000 ton of carbon emissions (Trade Arabia, 2014). The residential sector assumes specific emphasis in this regard as it is, according to the EWS-WWF-RTI report issued in 2012, responsible for 57% of the energy consumption in the UAE (RTI, 2012). Within that sector, lighting is the largest electricity consumer after cooling, comprising 20% of electricity consumption and affecting the cooling load in result of the heat it emits. In this way, lighting strategies in the residential sector can be a highly-influential contributor to the sustainability agenda set by Masdar City in targeting environmental and economic concerns. This said, it is important to trace their design that meets such ambitions and follow how it aligns with the living experiences and allows to manage light on daily basis.
With such interest, I bring back the research questions through an empirical example of the sustainable lighting strategies utilised at the residential part of MIST. The questions are then firstly, how to understand lighting as a sustainable technology? A second question is how does it proceeds between design and use in phase (1-A) and then between phase (1-A) and phase (1-B) or from what is inscribed to what is de-scribed and beyond? The aim of these questions is to comprehend the lighting strategies and their travel as central elements and departure points that reveal the shaping of its collective through its inscription and de-scription in Masdar City. It is also to utilise the emerging stories to reach a specific understanding of how the concept of sustainability transforms with such travel of the designs and technologies.

The research questions gain importance and specificity through a project that adapts a techno-economic approach with what appears to be restricted actors and rigid aims, as described in chapter 4.2, where users have a limited contribution (Guy and Farmer, 2001; Guy and Marvin, 1999; Moore, 1997). In chapter 5, I show that, through the travel of the designs and technologies, those actors that have concentrated the agency at the top decided later to distribute it over the ones at the bottom, adapting a more flexible stance. This chapter tackles the movement of lighting strategies in the same manner, while providing another empirical example.

The research also relates to the living lab concept, explained in chapter 4.3 and envisaged by the designers and developers to be applied at Masdar City, including MIST (Cugurullo, 2013; Evans and Karvonen, 2011; Karvonen and Bas Van Heur, 2014). I have shown how the living lab emerges in chapter 4.3 and gains a different meaning with the travel of designs and technologies as explained in chapter 5. This chapter builds on such development of the living lab concept to unpack the initially-introduced and implemented lighting strategies through the designer, the
developer, and the user and clarify how the learning process takes place in the different buildings and units.

This chapter is structured in three parts. The first part focuses on phase (1-A) and explains some of the designer and developer views, revealing their intentions or inscriptions of lighting strategies. It further applies a closer look on lighting as a technology and its shifts and changes through designer, developer, and user interactions. In other words, how it proceeds from design and development to use and back to design and development or from inscription to de-scription and back to inscription. The second part of the chapter emphasises phase (1-B) and the changes that it has gone through in response to phase (1-A) extending designer, developer, and user interactions. The last part concludes with an analysis on how such lighting strategy produces sustainability in Masdar City in a specific way or, in other words, offers different meanings on what sustainable lighting could be.

6.2 Phase (1-A) in Focus

Phase (1-A) is the first phase implemented in MIST (between 2007 and 2010). It comprises residential and laboratory buildings, facilities and services, as well as a knowledge centre as its iconic building within a mixed-use, low-rise, and dense fabric (highlighted in Figure-6.1 as 1, 2, and 3, respectively). Family and female residences are separate from the ones dedicated for males, which comes in compliance with the local social and cultural requirements supporting privacy as a main contextual aspect. Buildings are four floors high, or three residential floors above podium level. The family building comprises three prototypes, which vary in size and number of bedrooms. The other three buildings, however, comprise a single one-bedroom prototype with little variation in its design.
6.3 Lighting Strategies and Designer/Developer Inscriptions

The applied lighting strategies relate to two contextual issues in the UAE. The first issue is the fact that the population of the UAE pays insignificant amounts for electricity compared to other countries as all is supported by oil-driven governmental subsidies. Developer Isaac gives a comparison to illustrate this fact mentioning that, in the UAE, the payment is around 2.75 pence per kilowatt, whereas, in the UK, it is around 19 pence. Such low payment results in high consumption and less awareness of the usage of electricity, including artificial lighting (Crot, 2013; Khalaf, 1992, 2006). This is summarised by Dr. Patrick, who argues that as long as people do not pay in full for their consumed electricity, they would not really be concerned with the light switch. The second contextual issue driving the lighting strategies in the UAE is the climatic conditions that raise a concern in utilizing natural light as a requirement. Such desirable aspect that is available in the UAE is usually accompanied by two undesirable aspects that are considered problematic for their excessive rates and volumes in that particular context, which are heat and glare. This is emphasised by designer John, who says that in this part of the world, there are lots of concerns over the solar gain and the angle of the sun that cause heat and glare. This
opens the question on how to balance between bringing in the needed aspects and keeping out the problematic ones.

With such contextual background, the main sustainable aims of the lighting strategies, similar to other strategies applied in Masdar City, are focused on three hierarchical steps that are considered during the building design and development stage (as described in chapter 4.4). The first is centred on passive design strategies inspired by vernacular treatments that result in load reduction, like shading and orientation. The second step is focused on active strategies to further achieve optimised envelopes and utilise effective systems, like efficient lighting technologies. This integrates with control systems, like sensors and dimmers. Where the first two steps focus on reducing energy demands, the third relates to energy supply by utilizing renewable energy sources, like photovoltaic cells. In this way, the passive and active, vernacular and modern, and past and present blend together.

In addition to such aspects taken into account during the building design, other aspects are considered when it becomes operational. Developer Mike accordingly adds a fourth step, which emphasises the final implementation of the initiated design strategy and the assessment of what is intended by the designers and developers to ensure that users follow such intentions. He explains that through these aspects, the building is monitored by measurement and verification as well as a team that takes charge of the buildings operation and their relation to the target.

This blend of strategies comes in line with Masdar vision to produce efficient and renewable strategies considering the stages from the intentions of the designers and developers to the implementation that delivers it to the users. This aligns with multiple authors, who have studied light in architecture and urbanism. For example, Tregenza and Wilson (2011, p. 111) argue that
“the key to a sustainable use of energy in buildings is the control of electric lighting and of window transmittance,” or in other words, “finding a balance between daylight and electric lighting.” Philips (2004) emphasises that such balance needs to account for the change from day to night and from the bright sunny days to dark, cloudy, rainy ones. Less supply of one of the sources entails further reliance on the other.

Apart from the consideration of efficient and renewable strategies, user satisfaction gains importance as designer Ralf clarifies:

> You have got two components, the social side and then the sort of technical side, which is meeting low energy requirements and all the rest of it, which actually is in many ways simpler. I think that the challenge is to make these things work as places of innovation (Ralf 2014, pers. comm., 27 February).

In other words, he argues that both mesh together to create places that make this possible and facilitate activities and liveliness. In this case, and as the residential places are dedicated for students who live and study, designers John and Ralf argue that lighting, with its type, nature, and level done by its designers should be satisfactory, comfortable, and convenient for its users to provide this potential. Designer Augustine adds that the design should provide superior, healthy, and natural places compared to Abu Dhabi regular buildings, where lighting for example is more artificial, preset, and standardised. On the basis of such explanation, I describe the passive and active strategies in phase (1-A) of MIST. This summarises the inscription of sustainability principles in the collective by the design team.
Passive Strategies and Natural Light

A typical unit in phase (1-A) comprises a living part in addition to a sleeping part. The former includes an entrance, a kitchen, a sitting area, a dining table, and a desk; all shared within an open space. The latter forms a compact bedroom that can be closed-off by a sliding door and a bathroom that can be shut by a regular door (Figure-6.2, 6.3, and 6.4). The unit has further an external balcony that either overlooks adjacent buildings or an inter-building courtyard.

Figure-6.2: A residential unit in phase (1-A) and its arrangement in relation to facades, atria, and other units (Source: author).

Figure-6.3: The internal open space within a residential unit in phase (1-A). To the left is the view from the dining area and to the right is the view from the sitting area (Source: author).
As part of the unit design, the light penetrates into the unit through a specific window distribution. Lined up windows are located at the upper level of the exterior wall with an angle at the high ceiling to direct the light and reduce its glare. Two additional operable, vertical windows (shown as number 1 in Figure-6.2) take their places at each end of the wall to light-wash the interior white walls, which further reflect light internally. Two operable, oblique windows (shown as number 2 in Figure-6.2) provide different angles of light. The overall arrangement comes in addition to further openings, including the balcony door (shown as number 3 in Figure-6.2) that allow different portions of additional light that vary among different units.

Such windows integrate with the design of the façade, as they not only contribute to day-lighting of interior space, but also reducing issues of heat and glare. Designer John emphasises that “in this part of the world, we have a problem with glare, we have a problem with solar gain, but we still want to maximise the daylight into the space” (John 2014, pers. comm., 30 March), raising the concern on how to achieve a balance between the desired and the undesired. In this way, the façade is based on orientation strategies with maximised external shading by adjacent buildings.
and self-shading through its three layers (Palmer, 2011). The first layer is a balcony that contributes to shading the facade in addition to creating a usable place and providing privacy through the ornamental wavy shell that covers it (Figure-6.5). The second layer is a combination of solid aluminum-glazed panels and timber-framed windows, which allows for a specific ratio of glass depending on its location within the façade and the extent of its shading. Units on lower floors receive less light, because it is reflected many times on the façade. Thus, they require larger windows to receive equivalent levels of daylight. The third and final layer utilises a highly-insulated and sealed inner façade as part of the interior finishing.

This arrangement aims to reduce glare and heat. Developer Charlie explains, “none of the units have direct sunlight going inside, that is deliberate, or if it does, it is really very limited.” Instead, light indirectly bounces through the units and reflects within them. He continues, “the idea was that even with the shading, there is adequate lighting for reading and writing” (Charlie 2014, pers. comm., 24 March), reflecting on the expected suitability of the provided lighting levels.

Another source of natural light comes through the slots at the opposite side of the facades overlooking the atria (shown as number 4 in Figure-6.2). Such slots are high horizontal of
normal or frosted glass within the walls of the bathroom and the bedroom as well as low horizontal and partially obstructed within the wall of the kitchen to allow more light in while ensuring privacy. The atria, according to Philips (2004), act as internal streets to light the interiors of the buildings, while blocking heat and glare, where the uppermost floors benefit from such effect that reduces gradually as light goes down the floors. The residential unit atrium design reflects the same manner, where the ceiling includes oblique north-facing windows that allow the reflection of the light to bounce downward across voids within all floors while preventing heat and glare (Figure 6.6). Further to this natural lighting source, each floor has sensor-operated LED lights as complementary artificial sources.

Figure 6.6: The atria (Source: author).

Designer Ralf clarifies that most of the design relates to physical and computational models with an artificial sky as well as simulations including heat and light that start from the level of the master plan to the level of the institute and then to the building and unit level. He adds, “they were absolutely too inferring between these kinds of analysis and ideas and then going back into the computer and then analyzing these things again, making sure it is going to work at every level” (Ralf 2014, pers. comm., 27 February). According to PHA Consult, designers used
Transolar analysis for the modeling of the master plan as well as IES Virtual Environment [IESVE] thermal modelling software to integrate the generic analysis of the master plan with the more detailed ones of the phases. The former utilises tools such as Computational Fluid Dynamics (CFD). The latter is “an integrated environment containing a variety of building simulation modules, including thermal, artificial lighting and day lighting, solar and computational fluid dynamics (CFD)” (PHA Consult, 2008, p. 100), reflecting on their detailed and elaborate processes.

Such models go through multiple stages that start by utilizing sun path diagrams and shading analysis to study light within the available weather conditions. Another stage is to analyse light in relation to external elements like streets and courtyards as well as the internal elements like facades, rooms, and passages. The result is a matrix that specifies light in relation to the differing variables. A final stage to reproduce such studies in relation to different building typologies and conditions with specific recommendations to locations and levels of buildings and units, street and courtyard dimensions, and glazing percentages.

According to PHA report, to achieve light quality and visual comfort, these scientific studies and analyses are done in relation to specific indicators that come from the modeling and simulations. They are represented by the illuminance, for example, which is the “total luminous flux incident on a surface, per unit area measured in lux (lx)” (Foster + Partners, 2007a, p. 60). The target illuminance in the residential buildings and units is approximately 150-200 lx. Another indicator is the day-light factor, which describes “the subjective daylight quality in a room and is the ratio of external horizontal diffuse illuminance (Ea) over internal horizontal diffuse illuminance at a specific point (Ep), expressed in per cent” (Foster + Partners, 2007a, p. 60), which is targeted at 2.7% in general. A third indicator is the light autonomy, which is “the time at a specific point
when there is enough daylight and thus no artificial light has to be switched on” (Foster + Partners, 2007a, p. 60). The targeted daylight autonomy of the residential buildings and units is 60% from 8am to 5pm. Such value could change depending on the activities that are done in each space of the building and the unit and the duration of stay. It is to be achieved during the day and compensated during the night with the artificial light sources. Targets that run in parallel of the previous aspects are the glare and heat protection.

Such indicators of natural lighting as part of other natural strategies aim to contribute with 40% of energy saving compared to the usage in Abu Dhabi while keeping an optimum visual level (Foster + Partners, 2007a). According to Schuler (2009a,b), this was part of an overall strategy to reach 80% saving without compromising the quality of the provided services. The total energy consumption target per meter squared is set between 92 – 97 KWH/ m2/ year (PHA Consult, 2008). The conducted studies and analysis contribute to finding how these targets can be achieved and investigating further opportunities of fulfilling the required lighting level and the anticipated energy saving.

In this way, such design aspects reflect on a specific design philosophy and way and show how the designers and developers aim to achieve the lighting designs in MIST through a dominant perspective that focuses the agency within specific contributions. Here I refer to Masdar vision that is based on a top-down, managerial approach and inspired by the techno-economic focus discussed in chapter 4.2. Firstly, there is a strong emphasis on efficiency and renewable energy as a main direction to sustainability in addition to user satisfaction, which is achieved through a blend between modern and vernacular strategies that allow a sufficient and controlled amount of light. Those are represented by the sophisticated and detailed models and simulations the designers and developers use in addition to the paths, analysis, and diagrams they follow within a
specific window of targets and references. Secondly, with such a focus on efficient and renewable lighting and user consideration, emphasis is on blocking heat and glare while allowing light to bounce through. With light that is allowed, privacy is kept through the provided balconies that block the outsider views. Thirdly, other aspects are provided to contribute to light, such as open space, high ceilings, and further balcony area.

_active strategies and artificial light_

By maximizing natural lighting in the residential units, artificial light sources are accordingly minimised. The utilization of LED lights supports in achieving this, which are considered more energy efficient than other common types in the UAE. They are fixed on the ceiling of the unit entrance, the kitchen, the bathroom, as well as the living room, where available. Although the provided lights can be switched on and off manually by the user, either by a master switch or separate switches, the added sensors manage them based on occupancy as well as time. Designer Mike clarifies the combination between the lights and sensors by saying, “we placed the switch for turning the light on, because some people might not want to turn it on if there is enough daylight or even if they want to stay in the dark.” He continues, “if you leave the room either you shut the light by yourself or it shuts by its own if you forget to” (Mike 2014, pers. comm., 21 April). In this way, the arrangement allows the unit to enter a sleep mode when it is not needed upon leaving or going to sleep, where ceiling lights switch off after a limited period of time should no occupancy or motion be detected. In such a case, part of the management of light is handled by the system. Although switches provide the user with the ability to switch the lights on, sensors do not leave him space to fully master them as he wants. This actually comes in line with what is argued by developer Charlie, who questions whether “you give control to the
machine or to the human” (Charlie 2014, pers. comm., 24 March), reflecting a potential tension in the matter.

In the spaces that are not provided with dedicated fixed ceiling lights, which are mainly the open space comprising the sitting area, the dining table, and the desk, as well as the bedroom space, a limited number of portable lamps is provided. Such lamps are of regular type, not necessarily efficient, that limit the usage to a specific time and area of activity. In addition to that, they are completely managed by the users and could be dimmed if needed as long as they are plugged to the socket.

Such design strategies have gone through selection and testing via computational models and simulations that do not only cover the natural lighting sources, but also the artificial ones as they are incorporated into the models to guarantee the required balance between both. Designer Ralf confirms that the studies and analyses were detailed and included both natural and artificial lighting.

In terms of the references relied upon to produce light, designer John clarifies that they set their own numerical targets of energy saving, comparing them to more global guidelines like ASHRAE 90.1. He adds, “we are always trying to make better baseline and improve the performance of the system” (John 2014, pers. comm., 30 March). Through such baseline and after maximizing the natural light and incorporating it with the artificial light, the suggested target of the artificial light was estimated. He clarifies, “in the residential part, we set our target of basically 10 watts per meter squared of lighting, so again we were trying to reduce it down to as small amount as possible. It was how much light do you need to function basically?” (John 2014, pers. comm., 30 March), indicating the optimization criteria in place.
According to the PHA report, these lighting targets in addition to other strategies and targets would contribute to 30% reduction of energy compared to the usage of Abu Dhabi (Foster + Partners, 2007a). This is also part of the total of 80% saving that is done without compromising the quality of the service (Schuler, 2009a,b). It is important here to realise that all the mentioned targets remain tentative and vague according to developers Issac and Charlie. The reason for that is that Masdar City was experimental and based on a living lab. Through these experiments that are based on assumptions and global references, it was ambitious to set its own targets.

John adds that they have connected the lighting to other systems to monitor and track the achievement of these targets. He clarifies, “from an energy perspective, we can tell you, any one of these lamps what it was doing at any time” (John 2014, pers. comm., 30 March), where such strategies allow them to base and follow their designs. According to Mike and John, all the energy usage inside each building and unit in Masdar City is recorded and stored in a facility based in the undercroft. They aim later to analyse data and compare it to the targets. They are also ambitious to utilise such data in the future through specific ways that further encourage users to save energy when they know their consumption. This, for them, could ultimately enhance the experimentation with their living lab on how targets could be achieved or reproduced in different ways to exceed the original aims. Learning here occurs through such specific ways of monitoring, data collection, analysis, and other forms of scientific inquiry that feed in and back within similar loops.

In this way, I come back to the main aspects of the designs that align with Masdar vision based on the top-down, managerial approach and inspired by the techno-economic focus. There is a strong emphasis on efficiency, renewable energy, and user satisfaction as a main direction to sustainability, which are addressed through the combination of natural and artificial lighting.
This materialises through the sophisticated and detailed models and simulations they use, the paths, analysis, and diagrams they follow, the best practices they learn from, and the standards and targets they assume. It is accompanied by orienting the behavior of the user and delegating part of the agency to the system.

The preceding description shows how lighting strategies have been inscribed by the designers, developers, and others that could support their supply, delivery, construction, and maintenance. Each of such contributors participate as an actor that has its place and role within a collective or network of interaction, which they align with Masdar vision in creating efficient and renewable lighting and achieving user satisfaction. This is done through, firstly, achieving a specific quality or sufficiency of natural light in relation to heat, glare, and privacy, where the designers and developers configure such aspects in relation to slots, windows, facades, atria, distribution of spaces, and height of ceiling, each as an actor that has its role and place in the collective. The second way is through limiting and managing artificial light by delegating part of the agency to technology. Although switches provide the user with the ability to switch the light on, sensors do not give him the space to fully master these lights as he desires. In this way, the contributors arrange their relations to LEDs, switches, sensors, and portable lamps, where the actors grow and the collective extends to produce a balance between the natural and artificial sources to translate in a specific way. Light itself, as a result of natural and artificial sources, is located somewhere within the collective; affecting and being affected by such contributions.

In this way, light is not single, separated, or isolated, but connected to and dependent on so many aspects or actors within their collectives. It is accordingly produced through the relations between the allowed and the blocked, the managed and the unmanaged, and the limited and the infinite as all are involved in its translation. Light is flexible with boundaries that extend and
widen to include many actors that initiate and spread it. This arrangement produces sustainability in a specific way envisaged through Masdar vision.

Figure-6.7 shows a map that reflects on such relations, where focus is provided on lighting strategies that include the main aspects of natural and artificial light. Light has its relations with its most influential actors such as the designers, developers, and other human and non-human contributors. For example, natural light has its relation with atria, windows, and facades as main aspects as well as heat, glare, privacy as features they address. Artificial light has its relation with natural light as it affects and is affected by it. It also has its relations with sensors, LED lights, and other non-human contributors that do not involve user interference. This said, the map presents part of an extended collective, but what it focuses on are the actors that potentially affect lighting strategies design and use.

![Diagram showing the relations of the network shaped by the designers in phase (1-A)](image)

*Figure-6.7: The relations of the network shaped by the designers in phase (1-A) (Source: author).*

The question of how the lighting travels is inherently linked to such way of defining what lighting strategies are and how they are made as sustainable technologies. Additionally, how designers and developers consider users in their intentions and how they inscribe use in their
designs. Designers George and Ralf comment that users have not been involved at the first stage as they were not present. The relation between design and use has been suggested and identified by the designers and developers, where George argues, “you have to make it so easy and so much better that people do it anyway” (George 2014, pers. comm., 18 February). Ralf adds, “it was never designed to say you must do this to live in a sustainable way. It was to try and design something that would be naturally used in a sustainable way” (Ralf 2014, pers. comm., 27 February). In other words, the designers’ and developers’ intention to delegate part of the agency to technology aims to make it easier and natural for the user to adapt to sustainable living. With such easiness and natural impact of the sustainable strategies, users receive and follow them without any major role or contribution from their end. In other words, and referring back to user typologies explained in chapter 2.3, they are expected to be supportive users, adapting and conforming to the suggested strategies without any form of change or resistance.

This raises the question that, with the ways designers and developers envisage or inscribe use, how does it come in reality or get de-scribed to align or contradict such intentions? In other words, with the way the designers and developers construct their lighting collective to work and cater for sustainability, how could the introduction and involvement of other actors, including users, keep or change its relations and translate it in different ways resulting in similar or different meanings of sustainability? Following the fact that the only residents of MIST currently are the students, and with emphasis on the lighting strategies materialised in phase (1-A), focus is provided on the students residing in that part (S1-S11 in Table-3.2, chapter 3.7).
6.4 User Descriptions and Light Quality

The first intention of the designers to create efficient and renewable lighting strategies and to fulfil user satisfaction is to achieve sufficient natural light in relation to three aspects; heat, glare, and privacy. Although the designers and developers expect users to receive and follow lighting strategies, the argument here is that they interact with them in different ways that go beyond these expectations. In other words, although designers and developers inscribe their visions to be described in specific ways, users could go beyond such inscriptions through the variety of descriptions they provide.

Referring to what was explained in chapter 2.3, the concept of use, when one attempts to follow it through the daily lives and routine activities of the users, is not as simple and direct as originally expected by the designers and developers as it is much more complex and changeable. It is not only about studied analysis, predefined measures, or followed examples, as it taps into other different parameters and dimensions that contest it and shift it in a way that could not be predicted in the design. Through such interpretations and experiences, users describe the lighting strategies and contest their sustainable meaning. Referring back to the collective, use combines a multiplicity of actors who, when enrolled in the design collective, contributes in its reconfiguration while translating it differently. Depending on the flexibility of the design, use changes its limits, exceeding its borders and blending with other aspects. Following I show how the users interpret the lighting strategies by focusing on heat, glare, and privacy.

Heat is a first aspect that designers and developers tackle through their studies and analysis. This is addressed through the specific arrangement of the building within the urban fabric and units within the building with orientation and shading strategies. Such strategies block light and allow
only a reflection that varies among the buildings and units. In response to that, some users like Tiana argue that the natural lighting level is acceptable during the day but becomes a concern towards the afternoon. Others, such as Sophie and Eman, go further to state that light is a concern even during the day. As a result, and as tinkering users according to the user typologies, they confirm the reliance on the artificial light to substitute for the lack of the natural. It appears then that the fact that only a reflection of light is allowed and that it could vary among the units affect user responses in accordance to the amount they receive.

The second aspect that is also incorporated in the designers’ and developers’ studies and analysis of lighting is the glare or excessive light. In case of windows, this is addressed through the orientation and shading strategies of the facades, not allowing extra light to come through. Although many users like Wasim and Ammar, being supportive users through their de-scriptions, keep their windows open as they do not face excessive light concerns, others like Hamdi, being resisting users, close them for the same issue. For them, extra unwanted light could come from any other sources such as ornamental lights or wind-tower light. Eman and Maya add that light reflects on their TVs or computer screens causing further disturbance.

In case of the slots, glare is reduced through frosting and partially blocking them, where in both cases no direct light is allowed from the atria. Although many users like Wasim, Abdulla, and Ammar are supportive to keep their slots open as they do not face such concerns, others like Hamdi and Yan perform scenarios of resistance through closing the slots for similar reasons. Sensor-operated lights in the atria turn on frequently with students coming back to their apartments, which allows further light in the units, causing disturbance for the users. Glare then, as an aspect considered by the designers and developers in their lighting design, does not align with the users in the same way expected.
The third aspect that is also incorporated in the designers’ and developers’ studies and analysis of lighting is privacy, where a balcony is particularly designed to cover the windows with a shell to keep such aspect while allowing sufficient light in. Although many users like Abdullah, Yan, and Tiana are able to support such aspect and keep their windows open when they want to, others like Eman, Edward, and Hamdi resist it as they regard privacy as a main reason to shut the windows off (Figure-6.8 and 6.9). Eman for example says, “I am concerned that windows expose me during day and night, especially when I go out of the bathroom after showering” (Eman 2014, pers. comm., 11 March). Hamdi emphasises that by saying, “I am worried that I am exposed to other people and buildings, because they are directly in front of me” (Hamdi 2014, pers. comm., 21 March) According to the users, privacy is an important social and cultural aspect connected to the specific context of the UAE, where such issues are supposed to be given extra care and attention. In this way, despite what the designers and developers do to cater for privacy, users still experience it as lacking in many cases. This is confirmed later by developer Charlie, who argues that the side effect of the unit design is that its users can potentially see or be seen by others in facing or nearby residential or laboratory buildings.

Similar scenarios emerge from the slots overlooking the atria that are made high, obstructing views to keep privacy while allowing light. Although many users, such as Yan and Wasim, adapt to such aspect and keep the slots open as a source of natural light, others like Tiana consider privacy a main reason to counter such aspect and cover the slots with cardboard or paper. This is mainly for people not to peek or for the cameras installed in the atria not to expose them (Figure-6.9). This emphasises the earlier point that privacy, as an aspect considered by the designers and developers in their lighting design, does not align with the users in the same way expected.
The preceding discussion shows how the designers and developers inscribe their design strategies while aligning them with Masdar vision of sustainability to produce efficient and renewable lighting strategies and achieve user satisfaction. In other words, they develop a specific collective to support their intentions in regards to the natural sources through providing the expected light quality. Within such a collective, they align light with other actors like heat, glare, and privacy through configuration of windows, slots, facades, atria, and other connected actors. These intentions in regards to lighting strategies, however, do not work in the way
originally envisaged, where in reality they change as they are confronted with other expectations and experiences. Users, as they de-scribe the design strategies, reconfigure the collective and introduced different relations as they negotiate aspects like heat, glare, and privacy in different ways conflicting over efficiency and renewable energy, comfort, convenience, and satisfaction through their lived experiences. Windows do not allow light all the time as their relation to light is not the same with the users that closed them. Slots do not contribute to light in the way intended either as their relation has changed with users who shut them off. The translation of natural light sources affects light quality that is diffused with these changes as an actor in the collective. Light is no more a single or rigid aspect that is studied and analysed by the designers or developers in quantitative ways, as it is a result of user interactions through which it transforms and changes in different ways. Such light diffusion potentially leads the users to reconfigure the collective again and develop more relations with artificial light to enhance its quality, further changing the main intended lighting strategies.

This said, although designers and developers have introduced such a collective through their models and assumptions in a specific way inspired by the vision to produce sustainability, users have suggested modifications in these relations through their living experience and direct interaction with the introduced strategies. They tackle this aspect in a different way while viewing sustainability from completely different angles. For example, privacy as an issue was not underestimated by the designers. On the contrary, it was taken into account through their models and diagrams. When the users come, and through their lived experience, they show different aspects of privacy that were not expected by the designers.
6.5 User De-scriptions and Technology Delegation

Following the intention of designers and developers to create efficient and renewable lighting strategies and to fulfil user satisfaction through achieving sufficient natural light in relation to heat, glare, and privacy, the second way is through limiting and managing artificial light by delegating part of the agency to technology. As technology assumes a specific intention or inscription that users receive and follow, the argument here is that technology modification or de-scription implies users that go beyond the assumed scenarios.

This is pursuant to the discussion that the concept of use is not simple or direct but complex and changeable, defining sustainability in a different manner. Coming back to the collective, the use enrolls different actors in it that contribute to its configuration and translates it in a specific way. The system is diffused with such a collective as an actor that contributes to the relation between technology delegation of the designers and developers to management retrieval by the users in different ways and to a variety of levels, translating it differently. I uncover that through clarifying the two aspects of limitation and management of artificial light. This is important while considering the fact that natural light has not fully aligned with the users in the way intended, which exerts more reliance on the artificial sources, which are in themselves limited and managed.

With light limitation as a first aspect, the designers and developers minimise artificial light sources that they have made of efficient LEDs. In response to that, and although some users such as Edward say that light is enough being supportive to design intentions, many others like Tiana, Eman, Sophie, Abdullah, and Wasim share different views and actions. Being reconfiguring users, they express that the lack of ceiling lights at their apartments drives them to rely on
portable lights that, to them, are still not enough. Tiana comments, “I do not think being sustainable means you have to stay in the dark, so the lighting level is not enough” (Tiana 2014, pers. comm., 29 April). Hamdi adds, “sustainability is much more than restricting the number of lights” (Hamdi 2014, pers. comm., 21 March), as agreed by many other users. In this way, the designers and developers intentions in regard to light limitations do not align with the users as expected.

In regard to light management as a second aspect, the designers and developers have provided sensors that act upon and restrict the artificial light to the needed level. Beyond many interpretations and actions of different users that support them for their potential efficiency, effectiveness, and responsiveness in some cases, other users such as Tiana, Hamdi, Edward, Sophie, and Eman express different reactions. As Tiana and Hamdi prepare their food, the kitchen light keeps turning off although they are still there. They accordingly need to switch it on again continuously, which causes them disturbance and disrupts their activities. Such scenarios are exacerbated by the fact that some users like Sophie and Tiana rely on the kitchen light to substitute for the lack of light in the adjacent open space used for living and studying activities. In addition to that and as Mahmoud watches TV, the living room light goes off as if the sensor does not detect his presence and movement. Similar stories emerge amongst users like Hamdi, Yan, Abdullah, and Wasim, where light goes off while showering or using the washbasin in the bathroom due to the sensor’s inability to detect them.

In this way, the designers and developers intention in regards to light management through sensors does not align with the users as expected. Part of the reason is the type of utilised sensors that the designers and developers select to be less sensitive as other types could detect slighter movements and cause disturbance as argued by developer Mike. Another reason is the ceiling
height in the units, reaching to 4.5m, which further affects the sensors ability to detect movement from such height. This means that a combination of actors that comes together through inscribing the light strategies appears to result in unintended consequences. A third reason is that sensors themselves are not aligned with user choice, which means that their inscriptions are originally restricted and constrained, where de-scriptions were directed in specific ways.

As a result of that, the de-scriptions by the users at MIST take different shapes between the ones who support, tinker, reconfigure, or disrupt the system. The first category, or typology, of users, like Edward and Yan, supports the lights and sensors or conform to them by accommodating them and utilizing their available capacities. Abdullah and Mahmoud, being tinkering users as part of a second category, consider leaving their apartments and working at their labs, where light is arguably more manageable. Eman and Tiana repeatedly call, complain, and ask the facility management company to adjust the sensors in their units. Their request is to provide a longer time delay before lights go off automatically, as the current time set for the sensor lights to go off is not sufficient to conclude an activity. According to developer Sameeh, lighting occupies second place amongst the top complaints received by the facility management company from the apartment users after air-conditioning. In some cases, they need to raise the time delay in line with their needs although resulting in less alignment with the original designer intentions.

A third category of users reconfigures the system through more reliance on portable lamps. Yan shows more dependence on the provided portable lamps, disregarding the ones on the ceiling. Sophie brings additional portable lamps and places them all around the apartment. She emphasises that having more ceiling lights would have compensated for such excessive amount of extra lights that are arguably not as sustainable as the former ones. Hamdi raises one of them on a large suitcase, arguing that this could enhance the lighting that is otherwise concentrated on
the floor. Portable lamps are accordingly used to their maximum levels with major disregard to their dimming features in order to compensate for ceiling lights.

A fourth category of users resists and disrupts the system going further beyond. Sophie argues, “we have disabled the sensors. Now they are un-operational” (Sophie 2014, pers. comm., 18 April). She further says that lights are left on all the time, unless she switches the sensors back on from the control panel. This actually allows her to master technology that has been intended to be less manageable by the users. Such techniques of bypassing the system have spread amongst different users, teaching each other how the utilised technology could be adapted, adjusted, or potentially neutralised in a way that bypasses the initial intention.

Drawing on the preceding discussion, the designers and developers inscribe their design strategies while aligning them with Masdar vision of sustainability to produce efficient and renewable lighting and cater for user satisfaction. In other words, they develop a specific collective to achieve their intentions in regards to the artificial sources through limiting and managing light. Within this collective, they delegate action to technology or distribute part of the agency within the technological collective through arranging its relations with LEDs, switches, sensors, and portable lamps in specific ways. With such a focus on non-human actors, users are excluded from the system or included in a specific way. In other words, more roles are given to some actors, who dominate actions within the collective, as they have more agency in relation to others. Users, however, are left without any role as they are free to navigate the building and units but trapped within the lighting system, provided limited capacity to act upon or modify it, as the suggested way of use is simple and direct according to the designers. With the ceiling light that is lacking and the sensors that keep switching off while they cook, watch TV, or take a
shower, such an arrangement proves to be disturbing and disruptive to the users’ activities and daily lives.

It is imminent to realise how a sustainable design or technology, as it proceeds from design to use, could go beyond the sustainable intentions envisaged by its designers and developers. The reality of use could uncover a multiplicity of scenarios that could or could not be aligned with such intentions and might or might not be predicted by them. Users accordingly, and as they describe the designs and technologies, reconfigure the collective from which they are excluded, or included in a specific way, and introduce different relations negotiating issues like efficiency, renewable energy, comfort, convenience, and satisfaction through their living experience and direct interaction with the introduced strategies. They amend the system, trick it, or do something different that is not supposed to happen according to the initial script or the original scenario. The usage of portable lamps is not anymore limited as their relation to light changes with users, who exert more reliance on them to substitute for the lack of light and its management. Relations between the control boards and light are amended as well by users who want to bypass the system and align it with their needs. Through such translations, light is diffused and changed as an actor that is affected within the collective as it is not anymore similar to the one originally introduced.

In this way, sustainability in the models of designers and developers could mean something different compared to the lived experience of the users. Eman clarifies, “there is a contradiction in a sustainable concept with big image of sustainability for its designers and developers that has flaws in being convenient for the user” (Eman 2014, pers. comm., 11 March). This particularly shows how users are supposed to adapt to a sustainable setting according to Masdar vision.
However, such a concept has gone through modifications and amendments in different ways on the ground.

In light of foreseen differences, MIST conducted a meeting after the inhabitation of phase (1-A). According to designer John, the meeting included part of the designers, developers, staff members, and student representatives, where the latter expressed their interpretations and experiences in regards to different design strategies inside their buildings and units, including lighting itself. The maintenance company, whose role is to check the buildings and units, revealed further students’ interactions. Furthermore, designers and developers, who directly contacted some students, uncovered more stories and scenarios. In the living lab context, and as these interactions are uncovered and revealed, designers and developers have resorted to change the design of phase (1-B) on the basis of what was learnt from the implementation of phase (1-A), which is what I trace and follow in the next part.

Such learning process with the transformations and changes on the basis of what is learnt are potentially the aspects that differentiate Masdar City as a living lab rather than other previously-considered aspects that Masdar itself called and advertised for. The learning loop that happened with the lighting strategies is different than the one that occurred to feed back to the PRT. The first, mainly formal one, relied on the meeting, the maintenance company, as well as the direct interaction facilitated by the designers and developers, which allowed various ways of tackling students’ experiences. The methods that were used in the PRT, however, were more informal as they relied on the developers’ own experiences and direct interactions with the students. Both of the cases of the lighting strategies and the PRT hold within them different learning than the one intended by Masdar City at the beginning. While the former relied on users interactions, the
latter had more dependence on scientific inquiry and technological achievements. The following discussion about phase (1-B) reveals such learning process further.

### 6.6 Phase (1-B) and Designer/Developer Inscriptions

Phase (1-B) is the second phase implemented in MIST between 2010 and 2013. It comprises residential and laboratory buildings, facilities and services, as well as a multi-use hall as its iconic building within a mixed-use, law-rise, and dense fabric. Also, similar to phase (1-A), female residences are separate from the ones dedicated for males, which comes in compliance with the local social and cultural requirements. This phase is slightly different from phase (1-A) though, with an additional floor that is added to the buildings, where they are five floors high, or four residential floors above podium level. Also, all its buildings comprise a single one-bedroom prototype with little variation in apartment design. According to developers Isaac and Charlie, those changes are introduced for the financial constraints that started to face Masdar City after the delivery of phase (1-A) and the initiation of phase (1-B), where one of the introduced solutions was through providing more simplified and standardised designs. In this way, financial constraints appear again as an actor that de-scripted the original designs, in addition to the users’ expectations and experiences explained earlier that further de-scribed them and changed their initial inscriptions.

#### Passive Strategies and Natural Light

A typical unit in phase (1-B) is smaller in size than phase (1-A). According to Isaac and Charlie, phase (1-B) unit could reach 40m² compared to phase (1-A), which is around 60m². It is composed of an open space that includes the entrance and the kitchen together with the sitting area. The sleeping area is part of the open space, but with a partition separating both. The desk
area is adjacent and open to the same space. The unit further includes a bathroom and an external balcony (Figure-6.10, 6.11, and 6.12).

Figure-6.10: A residential unit in phase (1-B) and its arrangement in relation to facades, atria, and other units (Source: author).

Figure-6.11: The internal open space and general arrangements in a residential apartment in phase (1-B). To the left is the view from the sleeping area and to the right is the view from the sitting area (Source: author).
Similar to phase (1-A), phase (1-B) units include vertical open-able windows at each end of the wall (shown as number 1 in Figure-6.10) to light-wash the white interiors, which further reflect light internally. This comes in addition to other openings, including the balcony door (shown as number 3 in Figure-6.10), that allow different portions of additional light that vary among different units. However, unlike the window setup in phase (1-A), no lined up windows are at the upper level of the exterior wall and no oblique windows exist. According to designer John and developer Charlie, such windows are actually introduced within a specific design of the façade that is developed in phase (1-B) to include similar principles of the ones of phase (1-A), permitting more light and blocking the accompanying heat and glare. However, the difference is that the façade is more standard and simple as part of the new strategies in phase (1-B) as a result of the financial constraints that faced phase (1-A). Such standardization and simplification of facade disallow oblique windows. These also compress the façade in height to permit an additional floor, leaving no space for the lined-up windows at the upper level.

Another source of natural light comes through the slots at the opposite side of the facade overlooking the atria (shown as number 4 in Figure-6.10). The slots differ from the ones
provided in phase (1-A) including high horizontal frosted slots at the wall of the bathroom and the entrance door as well as a vertical or horizontal frosted one at the desk area, while potentially keeping privacy. The atrium design is similar to the one of phase (1-A), with ceiling windows at the utmost floor to allow natural light in and block heat and glare. Further to such natural lighting source, each floor is provided with sensor-operated LED lights as complementary artificial sources.

*Active Strategies and Artificial Light*

Similar to phase (1-A), with the emphasised reliance on natural light sources in the residential units, artificial light sources are minimised. Such sources comprise mainly LED lights that are fixed on the ceiling of the unit entrance/ kitchen, the sitting area, the sleeping area, the desk area, and the bathroom. The sitting and sleeping areas have the two LED lights that work with the same switch and the desk area has a separate switch. Those lights are supplied with dimmers that manage the light intensity depending on user needs. The entrance/ kitchen area has a sensor-operated LED that switches on upon occupancy or movement and off after a specific time should neither be detected. Also, the bathroom has a sensor-operated light that can be switched on by the user but turns off by a sensor after a specific time should no occupancy or movement be also detected. In this way, phase (1-B) is meant to be different from phase (1-A) in terms of lighting. According to developer Sameeh, three types of lights are available; one controlled by users through switches and dimmers, one partly controlled by sensors, and one completely controlled by sensors. The designers and developers realised the scenarios of interaction between the user and technology into which action was delegated and decided to shift it back to the users. Developer Charlie emphasises, “in phase (1-B), the overarching decision is that they want to give control back to the occupier” (Charlie 2014, pers. comm., 24 March). Here the user is able to
switch part of the lights on without sensors management and adjust them with dimmers depending on his own need. Only two lights are still operated partly or completely by sensors.

One of the users of phase (1-B), Allan, turns a plain plastic card over and over in his hands. It does not have any printing or images on it that could potentially reflect any sort of specificity or relation to the way it is supposed to work and the utilities it connects to. The card is operationally associated with a plastic holder, where it is supposedly inserted or removed. The holder is located on the wall to the left of the door at a height similar to the normal switches.

When Allan inserts his card in its holder, he sends a signal to the apartment to come into life. All lights turn on, regardless whether he has switched them on or off last time when he removed the card. He accordingly starts to switch off the unneeded lights manually. The entrance/kitchen light and the bathroom light cannot be switched off manually. He comments, “I wait when the sensor does not detect my occupancy or movement at those spaces to shut them off” (Allan 2014, pers. comm., 28 March). The card, however, is not only connected to the lighting system that switches on when it is inserted. According to designer John and developer Sameeh, it is also connected to the air-conditioning system of the unit that restarts and resets its temperature and the water sensor at the bathroom that becomes ready for use.

When Allan removes his card as he leaves his apartment or maybe sleeps, he sends a similar signal to the apartment to enter sleep mode. This is aligned with what John says, “when you take the card out, the system should then say, ‘Okay, you are now leaving’” (John 2014, pers. comm., 30 March). This means that all the lights are switched off regardless of the ones that were kept open manually. The air-conditioning turns off gradually and the water sensor stops operating. Allan comments, “now, if you try to switch one of the lights, the air-conditioning, or the water
sensor, nothing works” (Allan 2014, pers. comm., 28 March). The card then does not work on its own as it depends on its association to the holder, where it is inserted or removed. Through such association, it mediates between the user and the different utilities upon his entry to or exit from the apartment through specific relations that work in particular ways and through certain protocols.

The card forms another response of designers and developers in phase (1-B) as they learn from the users’ interaction in phase (1-A). It presents an alternative relationship that they recreate between the unit and the user. John clarifies, “it was thought as the easiest way to do it” (John 2014, pers. comm., 30 March), explaining that its idea comes from the hotels. In other words, they have decided to utilise a system that is already tested and configured elsewhere. The user utilises a card given at the hotel to make the facilities work or stop working as this depends on his own convenience and commitment. This scenario is believed to be better applied for the user as he contributes to the workability of the facilities through the card as he enters or leaves, which goes beyond the previous scenarios where the user navigates the spaces without any ability to contribute to the available facilities. In other words, the new system is more open and flexible to the user compared to the previous one, which is more closed and rigid trapping him inside. In the hotel room, more priority is given to the convenience and comfort of the user, who could or could not be mindful or committed to resource consumption in the way assigned by the designers and developers. Similarly, the lighting in phase (1-B) becomes more free and in the hands of the users rather than being limited or machine-managed.

Although all spaces are supported by dedicated fixed ceiling lights, portable lamps are also provided in phase (1-B) similar to phase (1-A). Such lamps are of regular types, not necessarily efficient, that limit the usage to a specific time and area of activity. In addition to that, they are
completely managed by the users and could be dimmed if needed as long as they are plugged to the socket.

In this way, the lighting strategies in this particular phase have been inscribed by the designer, developers and other facilitators. Each of such contributors participates as an actor that has its place and role within a collective or network of interaction. As actors of the collective, they further configure it in specific ways to manage sustainability in phase (1-B), not only in alignment to Masdar vision but also through the negotiations over such vision in phase (1-A) including the financial constraints and user responses. This is done through, firstly and similar to phase (1-A), achieving a specific quality or sufficiency of natural light in relation to heat, glare, and privacy aspects. The designers and developers configure these aspects in relation to slots, windows, facades, atria, distribution of spaces, and height of ceiling, each as an actor that has its role and place in the collective. The second way, and in contrast with phase (1-A), is through providing more available and manageable artificial light by shifting the agency from technology to the user. In this case, the contributors rearrange the relations to include the users and allow them to utilise more available lighting sources through the switches and dimmers and manage devices through the cards that are in turn connected to other facilities in relation to cooling and water, where all are parts of the reshaped collective. Light is then produced through such interactions that are aligned with Masdar vision and, at the same time, negotiated with the user. This arrangement produces sustainability in a specific way envisaged through this combination.

Figure-6.13 shows a map that reflects on such relations, where focus is provided on lighting strategies that include the main aspects of natural and artificial light. Light has its relations with its most influential actors such as the designers, developers, and other human and non-human contributors. Again, natural light has its relation with atria, windows, and facades as main
aspects as well as heat, glare, privacy as features they address. Artificial light has its relation with natural light as it affects and is affected by it. This time, it has its relations with sensors, LED lights, and other non-human contributors that could involve user interference. This said, the map presents part of an extended collective, but what it focuses on are the actors that potentially affect lighting strategies design and use. What is important here is that the map shows how lighting strategies include and build relations with actors such as users that are initially not there as realised in figure-6.7. It also grows its non-human actors that could be steered by users through other relations it builds with them, where figure-6.7 shows that those relations are not intended originally.

![Diagram of lighting strategies](image)

*Figure-6.13: The relations of the network re-shaped by the designers in phase (1-B) (Source: author).*

The question of how lighting travels is linked to such way of defining what the lighting strategies are and how they are transformed and recreated in phase (1-B) as sustainable technologies in a way that is different from phase (1-A). Additionally, how designers and developers consider users in their intentions and how they inscribe use in their designs. Contrary to the assumption of use that has been adopted in phase (1-A), when no users are actually present and accordingly designers and developers assume the relation between design and use, phase (1-B) takes shape
on the basis of available users that the designers and developers have followed and traced within a learning loop that feeds back from use into design. John emphasises, “lessons were learnt from that side and applied onto the other” (John 2014, pers. comm., 30 March). With this, he refers to the meeting conducted by MIST, the input from the maintenance company, and the personal views of the users, inspiring reconfigurations and recreation of the design. Accordingly, the designers and developers have reshaped lighting strategies not to be limited or machine-managed anymore as they delegate the agency to the users. The user is not a mere follower of technology as he is expected to interact and contribute in sustainability by limiting and managing light through switches and dimmers while inside the apartment and through the card as he enters or leaves it, where sensors would contribute marginally.

As long as such interactions would be dependent on the convenience and commitment of the users, designer John argues that the ways of use would differ among the different users with different levels of limitation and management of sources. What he means is that some users might be more cautious to switching the unneeded lights or dimming them and taking the card out if they leave. Others would just leave the card in and the lights on to their maximum capacity. In other words, use is not as easy and direct as might be expected as it is complex with the different user interactions. It provides various ways of negotiating what is initially intended and shaping it in a different way. In other words, and referring back to user typologies, the user is expected to be not only supportive and adaptive, but he also might show other scenarios of interaction such as tinkering, re-configuring, and resisting the suggested strategies.

In this way, sustainability re-emerges differently, giving more space and flexibility to the users to adapt or not to adapt to sustainable living rather than the limited space and relative rigidity that appears to be part of the concept at the beginning. In other words, it starts to adapt to user needs
and requirements through their living experience rather than sticking to what the designers model or assume. Designer George comments, “you have to think about how we give people the choice to be sustainable and how we help people control consumption and actually get a better life” (George 2014, pers. comm., 18 February). With such difference, designer John and developer Mike still agree that there is lots of energy saving in using efficient lighting and supplying them from renewable energy sources even if the users do not conform with the design assumptions and expectations. George, although agrees with them, still emphasises that “it is not just about energy use, it is about personal quality and choice” (George 2014, pers. comm., 18 February), where he stresses what has been found in phase (1-A) and emphasises applying it on phase (1-B).

This raises the question that, with the ways designers and developers envisage or inscribe use, how does it come in reality or get de-scribed to align or contradict these intentions? In other words, how does the collective change among such different actors, resulting in a similar or different meaning of sustainability? Focus is provided on the students residing in that part of MIST (S12-S23, referring to Table-3.2 in chapter 3.7).

### 6.7 User De-scriptions and Light Quality

The first intention of the designers to create efficient and renewable lighting strategies and to achieve user satisfaction in phase (1-B) is similar to phase (1-A) in fulfilling sufficient natural light in relation to three aspects; heat, glare, and privacy. Although designers and developers have made a few design adjustments between phase (1-A) and (1-B) in terms of the arrangements of buildings and units and their openings, user interactions have been similar. In case of heat, and according to users like Maya, Nesma, Aysha, and Wajd, the response depends on the fact that they receive a reflection of light and that it could vary among the units. In regards
to privacy and glare, users like Larry, Alan, Javed, and Aysha act and react with the windows and slots in similar ways, keeping them open or closing them permanently or temporarily as a result of such interactions.

The three aspects, then, considered by the designers and developers in their lighting design in phase (1-B) reflect among the users in the same way as they do in phase (1-A), going in some cases beyond expectations.

### 6.8 User Descriptions and Household Management

In addition to the designers and developers’ intention in alignment with phase (1-A) of achieving sufficient natural light, their second approach contrasts it in providing more available and manageable artificial light by shifting the agency from technology to the user. The designers and developers intend or inscribe the technology as a result of the negotiation of users in phase (1-A), where they are given more space and flexibility to interact. The argument then is that design or technology modification or de-scription proceeds, where users go much beyond the assumed scenarios. Such relation continues to be dynamic and progressive, producing different meanings of sustainability. I uncover that through clarifying the two aspects of availability and management of artificial light.

Regarding light availability as a first aspect, the designers and developers have increased artificial light in phase (1-B) compared to phase (1-A), where they have relied on efficient LEDs as well. This is supported by the fact that phase (1-B) has lower ceilings and smaller spaces than phase (1-A) to help in light distribution. In response to that, Wajd, Aysha, and Maya state that the lighting is excessive with the fixed sources and the additional portable ones still provided. Aysha emphasises, “here, the ceiling is low, not very spacious, but the lights are bright. You can
feel there is light at day and night” (Aysha 2014, pers. comm., 4 March), which for her makes it lively and comfortable. Such aspect allows more room for the user to manage the light as it is freely given and unlimited.

Concerning light management as a second aspect, the designers and developers have provided switches for the user to master the lights, which are more controllable in phase (1-B) compared to (1-A). Although most of the rooms have independent switches, allowing users to deal with them separately, Mira, Aysha, and Wajd state that the lights at the sitting and the sleeping parts turn on together by the same switch. This makes it hard for them to switch one off if they only need the other, leaving less space for the user to deal with such aspect.

Another facet of light management is that the designers and developers have provided sensors that are more aligned with user requirements in phase (1-B) compared to the ones available in phase (1-A). In addition to that, the maintenance company has responded to user requirements in regards to extending their time delay, where lights are programmed to switch off after longer periods of time allowing users to finish their activities. In response to that, although many users support such modification that makes it easier for them, others express different reactions. Users like Maram and Maya state that they finish their activity in the bathroom without having lights turned off, as the lights stay on for a while even when they go out. This becomes annoying at night, according to Maya, especially that the bathroom is located directly beside the sleeping part, where she waits for the light to go off in order to be able to sleep.

The same case applies to the kitchen as its light remains on after conducting the activity. Allan needs to wait for it in case he watches a movie in the sitting area, which happens to be beside it. Maya also waits for it in case she wants to sleep, as it happens to be in front of the sleeping area.
The issue of the kitchen light exacerbates with the fact that it turns on by the sensor and not through a switch like the case of the bathroom, which means that even if the user wants to conduct the activity without turning it on, or even if the user passes by the kitchen without aiming to do anything inside it, its sensor can recognise his movement or occupancy and turn the light on by itself. In this way, the designers and developers’ intention in regards to light management through the switches and sensors does not align with the users as expected. This means in some way that sustainability is not produced in phase (1-B) in the same way intended by the designers and developers through the switches and sensors.

In parallel to the switches and sensors provided in phase (1-B), the original intention of the introduced card is to offer more openness and flexibility to the system beyond the more restriction and rigidity assumed in phase (1-A). The main contribution of the card is to switch all lights on and bring the apartment into life as soon as the user inserts it. Although many users find it helpful, others such as Larry and Maya find it strange that they need to switch the unneeded lights off after inserting the card and wait for sensor lights to turn off by themselves. Card removal switches all the lights off, which is found to be helpful by many users like Maya, especially if she in a hurry and does not have time. This is how the card contributes in bringing the apartment into life or turning it to sleep mode as expected by the designers and developers. However, the card contribution does not stop there as it goes beyond such expectations.

As a result of the light management scenarios through switches and sensors, users have started to utilise the openness and flexibility introduced by the designers and developers through the card to extend its usage from mere entry and leave of the apartment to usage inside. As switches and sensors are supported by the card, users acquire more management over light and align it with
their choice. The card acts like an alternative switch for the lights, where the user switches the normal and the sensor-operated lights depending of what he wants.

Maram states that one of the problems that complicates the card functionality in managing light is that it connects to all the lights together, which means that if she decides to switch one of them on or off, others follow. The card however, does not only associate all the lights together, but also includes other utilities. When the card is inserted, it activates the air-conditioning and the water sensor with it. In other words, and according to Mira, Maram, and Aysha, if they remove the card for any reason in relation to light, they cannot set the air-conditioning or activate the water sensor. Maram accordingly cannot take her card off during the night as it is not only a problem of light, which she can replace by portable lights, but she is not able to switch the air-conditioning if it is hot or have water if she needs the bathroom. This also applies to the opposite case, where Aysha removes the card to stop the water sensor, for example, but then cannot switch on the lights or the air-conditioning.

With such interactions, a variety of de-scriptions to the card system emerge among the different users, who support, tinker, reconfigure, or disrupt the system. To start with, a first category, or typology of users like Mira, Wajd, and Aysha have chosen to support the system and deal with it as it is, although it might not deliver the desired management over their utilities. Another category has tinkered with the system like Maya, who believes that she has still no management over the kitchen light that switches on at undesirable times. She states that there is no switch to turn it off and the removal of the card to turn it off would be associated with other undesirable changes. Accordingly, she moves her couch at her sitting area far from the sensor of the kitchen so that it will not detect her movement. She also passes to the interior part of the unit through the arch beside the windows that is farther away from the sensor, so that it does not detect her
movement before she sleeps. A third category has chosen to reconfigure the system. Larry, for example, has decided to cover part of the kitchen sensor, so that it does not turn the light on until he passes by a specific area where the sensor is not blocked to detect his movement. A fourth category has resisted the system and disrupted it. Allan covers the sensor entirely as he does not prefer to keep the light on at all. Maram has chosen not to fix the light when it stopped working, as she feels it is disturbing. Such scenarios allow the users to use their cards while limiting the undesired changes that could accompany their usage.

With the inherent connection of the card to their daily lives and routine activities, users are cautious not to lose it. Maya mentions that even if she takes her card out of its holder, she leaves it inside her apartment so that she would not forget it out. Larry goes further and tapes the card above its holder so that he does not lose it inside or outside the apartment (Figure-6.14). Javed and Maya state that the card itself is not specific to any apartment, which means that any card of any other apartment can be used. This includes student cards, or any piece of paper or cardboard as Javed and Ammar mention (Figure-6.14). Although those pieces are not as easy in insertion or removal as the original card, they still work. The card then, although does not hold openness and flexibility for the users to manage their utilities as they want because of the specific way through which it associates them, is still open and flexible to a certain level in the fact that it could be replaced and associated with its holder in different ways to make the utilities work. Being closed in some aspects and more open in others, rigid at some aspects and more flexible at others, it produces sustainability in different ways in relation to its users.
Figure-6.14: The card is kept above its holder to the left and is replaced by a piece of paper to the right (Source: author).

The preceding scenarios show how the designers and developers have inscribed their design strategies in phase (1-B) in a different way than the ones in phase (1-A) as a result of their alignment, not only with Masdar vision but also the negotiations after it. In other words, they reconfigured and rearranged the collective to achieve their intentions in regards to natural and artificial sources and to incorporate what has been learnt through providing more available and manageable light. Such a collective is then not quite similar to the one developed in phase (1-A), where part of the agency was delegated to technology as the designers and developers have reconstructed it in phase (1-B) to provide less delegation to technology through arranging its relations with LEDs, switches, sensors, and portable lamps. Within such newly-introduced configurations and constructed relations, the collective is less closed or rigid while excluding the user and trapping him inside as the case of phase (1-A). The collective in phase (1-B), on the contrary, is more open and flexible while integrating the user, allowing him to interact. Focus is not anymore on the system and its components to dominate actions. The user is able to act upon and modify the more available and manageable lighting sources through the switches, dimmers, and card being part of his collective, as the suggested way of use is not simple or direct but
negotiable with the users according to the designers and developers. Such actors rearrange the relations within the collective in significant ways. They are further connected to each other while incorporating other services.

Users realise the sufficiency and the suitability of light management that they have acquired. However, and with the switches and sensors that do not fully align with them as expected, they still experience discomfort and disturbance to a certain extent. Additionally, it appears that the card association with different utilities like lighting, cooling, and water makes it less flexible and less manageable, which adds to user discomfort and disturbance as unintended implications and consequences. Users accordingly, and as they describe designs and technologies, reconfigure the collective and start developing or disregarding different relations intended by the designers and developers in response to aspects that include not only comfort, convenience, and suitability, but also control through their living experience and direct interaction with the introduced strategies.

The card is not always in when the user enters the apartment and out when he leaves. The card goes beyond the original scenario or the initial script as it is not connected anymore to some sensors covered by the users or lights not fixed once they break, where both could be dropped from its network. The card itself could be dropped from the collective or replaced by different cards or other objects, providing similar or different levels of workability to the users. Although the collective is not the same as the one intended by the designers and developers with such translations, it still works in specific ways, providing a certain level of light quality and management. It is important here to realise that flexibility and user control provide for a more livable domestic environment and this needs to be taken into account when designers work to optimise the built form.
The preceding scenarios show how a different version of sustainability is reproduced between phase (1-A) and (1-B). Maya confirms, “so I feel people are more sustainable, people get more interaction living in that phase than living in this phase” (Maya 2014, pers. comm., 20 April).

This interpretation shows how sustainability that started as a concept aligned with Masdar vision has translated in different ways on the ground. It has changed again as such translation feeds into the learning loop to produce another design to be implemented and learnt from. As it starts to present specific conflicts in phase (1-A), phase (1-B) comes to proceed with these negotiations amongst the designers, the developers, and the users. It is important here to realise that sustainability is not only negotiated amongst social groups, but also by material aspects that contribute to such negotiations. In this way, with the multiplicity of contributors that participate in sustainability, it is a complex one. As they debate over the concept, it changes and shifts reflecting on its dynamism and transformability while producing predictable or unexpected meanings and outcomes.

6.9 Conclusion

Thinking about the travel of the lighting design strategies in the residential units at MIST and how their collectives have started and evolved commencing from the moment the developers resorted to the designers to plan Masdar City. Their joint effort, in alignment with the delivery, support, and maintenance teams, has resulted in designing and developing the city’s sustainable strategies, among which is its lighting.

Although the project has initially been based on a top-down managerial approach determined by the strong and solid design and development authority, there have been some moments when the designers and developers dissolved within the project; experiencing, observing, and involving
the users. In other words, the designers and developers started to embrace what goes beyond the models they make and the simulations they adapt to engage with the living experience and reality of the world. This potentially emphasises the designers and developers as less rigid or restricted, and more flexible and serviceable in creating, reshaping, and implementing fluid technologies through the development process.

The designers and developers have initiated Masdar City with the intention of delivering a living lab, entailing a recursive loop of learning in which the designers, developers and users are supposed to collaborate to produce or refine sustainable technologies. As the designers and developers deliver technologies, the role of the users is to receive, adapt, and potentially refine them through their experiences and research. In other words, designers and developers have developed their collective in a specific way in consideration and collaboration of particular actors to produce sustainability. This has been important for them considering the fact that there are no similar projects that adapt the project ideas nor a precedence in sustainability, where the project is implemented.

Through the travel of the lighting strategies within Masdar City, a different living lab has been delivered reflecting a different learning process that has emerged in the context of the city demonstrating the transformation between design, development, and use as the project moves from phase to phase. Developers change and improve the design and development of the current or upcoming stages. They shift the original inscriptions of technology on the basis of what they received and collected as they got the feedback from MIST, the maintenance company, and the users themselves. Users are no more mere receivers of technologies, as they have active roles in shaping, recreating, and modifying them through their use, adaptation, and inhabitation, through their different ways of de-scription that support, tinker, configure and resist the lighting
strategies. Technologies reflect transformability and changeability through such recursive loop of learning between the designers, developers, and users, where they are manipulated on the basis of how the developers align user needs with the physical design of the building.

As the developers realised the difficulties that users faced with natural light sources that affected their privacy and artificial light sources that were not sufficient or manageable, they decided to introduce changes to make them more sufficient and manageable. They suggested the card, for example, that was like a key or a switch in the hands of the users that connected different lights and services together. Financial constraints were part of such learning loop that has contributed as an aspect of design revision and shaping.

Such process shows the transformation of the lighting strategies to enhance light quality that has been less sufficient and shift the agency to the user after being in the hand of technology. Technology does not dominate the collective as users have their roles and contribution in it, reconfiguring it in different ways. Light is part of such a collective, while affecting and being affected by its contributions. In this way, the created collective is not straightforward and committed to designers and developers’ intentions; but complex with users’ interactions, not rigid and static but flexible and changeable, and not always expected as there is an arena of unpredicted scenarios and interventions.

Sustainable lighting strategies, despite emerging from a strong and powerful vision, do not ultimately work as a direct, rigid, and expected conception. There is an array of interactions that steers them differently to ensure their alignment, not only with Masdar vision as acquired by the designers and developers, but also with the emerging negotiations over issues of adaptation and re-alignment of user needs with the built environment. They are accordingly changeable with
tensions between the design and use and conflicts over efficiency, comfort, privacy, and management, shifting the original meaning of sustainability through a different angle and interpretation.
Chapter 7: Conclusions

7.1 Discovering Masdar City at Two Different Speeds

Although this is the last chapter of this thesis, I would not consider it as a particular end point or a specific limit of the research. I believe Masdar City is an unprecedented development that offers a mixture of reflections, leaving the researcher with a width and breadth of space for complex and continuous critical thought. I can never forget how I was overwhelmed at that particular point in time as I took the taxi on my first trip to the city. There was a mixture of feelings and thoughts dominated by curiosity and astonishment as a result of what I had read in the wide range of publications and heard from the dominant media about this extraordinary city. I have to admit, though, that everything I felt and thought about had become confused and jumbled as I arrived and first gazed at the city. Amidst such emotions and imaginations, I stepped out of the taxi as the main gate of Masdar City opened before me, offering a futuristic peak, a dream, and a promise that was embedded with ambiguity and vagueness about what lay beyond.

Figure-7.1: Masdar City entrance (Source: author).
A first glance into the city reveals little when compared to the differing, overlapping, and confronting expectations and experiences that I uncovered through my research. The artistically shaped buildings and the skillfully made spaces do not reveal what lies within. I was intent on penetrating these structures to discover their hidden secrets.

I was preoccupied with following the actors, who in themselves kept growing and interacting in so many intertwining and different ways. It became clear to me that whomever I followed and whatever I traced, it only formed part of the actors that contributed to, and continue to contribute to such an achievement. The more I explored, the more I got lost within the wealth of debates, agreements, and conflicts that emerged from within. This time, my confusion was not due to what I read or heard and whether it aligned with or contradicted what I observed and followed. The wealth of stories significantly expanded the spectrum and exceeded my expectations and assumptions. Ultimately, I decided to engage with them, be part of them, and dissolve with everything that could emerge in front of my eyes and that I could grasp with my hands.

I was astonished with the details and the fine points that marked the ornamental designed shell of the balcony that covered the external building facades, where I inquired about its creator. And while I was amazed with the carefully and incrementally made piece, I was even more surprised with an answer that attributed such fine craft to a single actor. I was puzzled with how such attribution had forgotten or disregarded a number of actors, who could have participated and contributed to such “making” in different ways. From the one who initiated its idea, to the one who developed its blueprint, to the one who prepared its calculations, to the ones who supplied the materials, to the ones who constructed the balcony, to the ones who ultimately used it, a long chain of contributors throughout the design travel has been reduced to a single “hero”.

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I would have been interested to trace and follow its journey as it was sketched by the designers, put in place by the developers, and experienced or lived by the users, with all the disputes and debates that might arise between the concerned contributors. This part of the façade, complemented by other pieces of GRC, aluminum, and wood, was undoubtedly at the centre of such disputes and debates around light, heat, and glare as well as its relation to other components. The balcony shell is an intermediary between inside and outside, hot and cold, light and dark. It embodies a multiplicity of contributors that keep growing and changing. While it is there, calm and peaceful, it travels in time and place, cruising through the wide horizons and moving between the different hands while effecting and being influenced by many aspects and creating dialogues and mutual relations along its journey.

This balcony shell, packed with dispute and debate while being part of them, swings between the different actors coming and going, shaping and being shaped, or even returning back to its creator to be re-invented and re-introduced in different ways. I was wondering what the designer would feel, holding his or her pencil over some early blueprints, dragging his or her mouse in front of the computer screen, and putting together a piece into a model, if these debates and disputes were a consideration. I have also wondered how the developer would have felt as he or she received, approved, and put the design in place and to the user, who then experienced it in different ways.

### 7.2 Concluding Remarks

In this thesis, I have discussed how the designs and technologies travel through time and place from where they are designed and created by the designers and developers to where they are used and interpreted by the users, or in other words, from where it is inscribed to where it is de-
scribed. Although I started with such simplified design trajectory, I gradually deconstructed the dualities between design and use as well as inscription and de-scription. I showed how these distinctions collapse and the boundaries between these aspects merge to reveal that design and use are embedded within the same process.

This thesis has developed a theoretical framework to understand the travel between design and use as well as the living lab through utilizing a sustainable architectural case study. Although much has been written about design processes (Houdart, 2008; Loukissas, 2012; Yaneva 2009a, b, c, 2013), use (Brian, 1994, , cited in Yaneva and Guy, 2008; Gieryn, 2002; De Certeau, 1984; Hill 2001, 2003; Lefebvre, 1991), and living labs (Evans and Karvonen, 2011, 2014; König and Evans, 2013; McCormick and Kiss, 2015; Trencher et al., 2014a, b), I was interested in rethinking the traditional divide between design and use and the continuous transition between both through the living lab in a non-Western context. This is relevant because sustainable architectural designs are commonly presented as simple and static products. By closely examining the complex and continuous chain of interactions in the design process, it is clear that technologies and designs do not emerge from simple contributions and they do not merely land and stop evolving upon their delivery.

The thesis also focused on uncovering what happens in between design and use. This is important to sustainable architectural design as there is a tendency to focus on their end results and outcomes without explaining and emphasizing the iterations they have undergone. Such an approach views the processes through which design travels as linear and directed to a predefined end point. Instead, this study took one step back and scrutinised sustainable architectural designs as they emerged. From such a perspective, the processes are revealed as intertwined in continuous feedback loops.
Additionally, the thesis revealed the hidden realities of sustainable designs as they travelled from their source to their situated context. This gained importance as sustainable architectural design could be viewed as predicted. The focus was to show how they produce so many outcomes and surprises as they affect and become affected by the different surroundings.

I have focused on three instances of sustainability strategies in the Masdar City project to illustrate the iterative and recursive character of the design process. The first instance addressed the inscription of sustainability in the Masdar City project. This illustrated how the design and development imagined, envisaged, and projected usage trends, where the use of design strategies is expected but not seen in reality yet. The second instance involved the inscription and decription of sustainability in the mobility network in Masdar City with a specific focus on the PRT. It revealed how design and development is materialised through adaptation, use, misuse, and resistance by users. The third instance addressed the inscription and decription of sustainability in the household in Masdar City with a specific focus on the lighting strategy.

Through such cases, I addressed the research by describing the formation and evolution of the collectives within inscription and decription processes through three main themes. First, unpacking the collective nature of sustainable architectural design. Second, learning through the complexity and dynamism of the design collective. Third, learning through the contingency of the design collective.

7.3 The Collective Nature of Sustainable Architectural Design

I discussed how designs and technologies proceed from where they are created by the designer and developer to where they are inhabited and interpreted by the user or, in other words, from what is inscribed in design to what is decribed in use. One of the main contributions of the
study is to reveal the dynamics of the collective. Flexibility is an important aspect that allows such ongoing and continuous processes. I utilised Latour’s (1987) networked nature of technology to track the collective through which the design strategies were actuated. This was not restricted to the designers and developers but also included other actors, notably users. Latour and other scholars who applied his ideas to architecture, such as Houdart and Minato (2009), Loukissas (2012), and Yaneva (2009a,b,c), addressed the notion of the collective but focused on the design practice. My study goes beyond the design practice to recognise use and implementation as part of the collective that further extends and adds to its complexity and dynamism. Future research could explore additional processes between design and use, such as delivery, construction, and maintenance, to reveal different ways that the collective is extended while adding additional complexity and dynamism. Sustainable architectural designs are not merely there from drawings that are produced by designers and agreed by developers to reality experienced by the users or, in other words, from physical or computational models to real one-to-one buildings. Instead, they undergo changes and shifts that could be further elaborated and explained through future research. I integrated and projected the ideas of fluidity and boundary widening (De Laet and Mol, 2000) from the very start to provide a more nuanced understanding of the collective and the potential processes it undergoes and emphasise how it is continually extending with the exploration of the different processes.

Such an understanding stems from an interpretation of the collective that goes beyond the designers and developers as dominant figures to include other professions that contribute to the design strategies. These contributors include draftsmen, engineers, analysts, and other individuals who are part of the design and development companies. They also include individuals who are involved in the delivery, support, maintenance, and other services to
accomplish the task. The collective extends to include the material aspects as equal participants that contribute to the design strategies in the same way. This can be traced through the designers and developers’ interaction with the material world through models, computers, plans, images, diagrams, and even tables, walls, and floors that allow them to conduct their work. Designers and developers configure the collective and inscribe the design strategies in a particular way while creating associations between what is designed and where it is implemented.

With the examples discussed in the thesis concerning the master plan, the transportation system, and the lighting strategy of Masdar City, the designers and developers’ configurations or inscriptions have been guided by the city’s strong and rigid vision of sustainability that was different and distinguished within a project with high ambitions. They were inspired by a techno-economic approach to sustainability with a top-down, managerial, and hierarchical orientation focused on efficiency and renewable energy as well as user satisfaction as primary goals. They also adapted what they called the living lab, representing a learning process to produce advanced breakthrough designs and technologies of sustainability. Through this concept, they aimed to conduct tests and experiments to produce models and guides that could inform additional projects and influence the GCC, and potentially the world. Such aspirations reflect a specific design philosophy and reveal how the designers and developers aimed to develop their designs and technologies through a dominant perspective that focuses the agency within particular contributions.

From such a perspective, designers and developers initiate sustainable architectural designs that separate technological and human networks. There is an underlying assumption that technologies are controllable, can operate independently, and can steer human actions. The transportation system included the PRT system, magnets, and computers, while the lighting strategy included
lights, sensors, switches and other forms of technology that managed the systems in pre-conceived and directed ways.

The collective of designers and developers restricted the role of users to receiving, adapting, and potentially refining the design strategies. The collective, however, is not limited to designers and developers’ configurations or inscriptions, as users reconfigure or de-script the strategies in a way that could or could not be aligned with or predicted by the designers and developers. Users could adapt, tinker, reconfigure, and resist the design strategies presented to them in a variety of ways. Through these de-scription processes, they extend the collective, adding to its complexity and dynamism.

As the design strategies materialised in reality, they went beyond the expectations of the designers and developers. In the case of the transportation system, users did not conform to the prescribed features. For example, they found it exhausting to change the mean of transport at the entrance of the city, they needed to wait for a long period of time before finding a free pod, and they acquired more privacy. This reflects a misalignment between designer intentions and user acceptance. The bags they carried, the food they needed, and the taxies they ordered contributed to that as main actors of use. This resulted in users abandoning the system, leading to the collapse of PRT as a sole transportation strategy.

In case of the lighting strategy, users encountered difficulties with the system. They found the lights to be limiting, especially that they could not turn them on or off at will. The shutters they used to shut the windows and the cartons they blocked the slots with contributed to such needs and demands as main actors of use that further limited the available light and added more pressure on its control. The result was that some of them aligned with this strategy and utilised
the available capacities, others tinkered with the system by calling on the maintenance company, others reconfigured the system by adding additional lighting sources, and others resisted the system by blocking the sensors. The design of the lighting strategy was not aligned with the expectation of the users.

The cases of the transportation and lighting systems represent specific collective configurations and design strategies that were inscribed with specific logics of efficiency, renewable energy, and user satisfaction. However, issues such as privacy, comfort, and convenience were negotiated differently amongst users who reconfigured and de-scripted the systems to align with their expectations. What has been designed, shaped, or modelled with ideas such as that the technology is controllable, can operate independently, and can steer human actions has not worked as expected within the lived environment that reflect more interaction between technology and humans. In this way, as the collective excludes actors and disconnects relations between technology and human, it could lead to unexpected results in a real world where those aspects cannot be terminated or separated.

Reflecting on sustainability, it does not seem as a concept that could be determined and forced by certain actors through specific design strategies. On the contrary, sustainability emerges through negotiations between a multiplicity of actors within the design strategy collective. One contribution of this study is to expand the notion of sustainability beyond social groups as argued by authors such as Adams (2001), Pepper (1996), and Redclift (1992) to also include material aspects. In other words, although much has been written about the conflicts and debates over sustainability, the thesis emphasises a more collective or networked nature that includes human and non-human actors, where all contribute to it in different ways.
7.4 Learning through the Complexity and Dynamism of the Design Collective

I have discussed how designs and technologies travel from where they are created by the designer and developer to where they are implemented and interpreted by the user. Such designs and technologies continue their travel while potentially feeding back into multiple sources including where they were originally shaped. In other words, what is described could feedback to what is inscribed. This said, another contribution of the thesis emphasised that the complexity and dynamics of the collective result in learning. In other words, the evolution or change in the collective is not simply about a new configuration but about better understanding of how the actors contribute to and fit within the collective. To allow such understanding, flexible actors, human and non-human, are required to distribute actors contributions and fit them in the collectives.

With the examples discussed in the empirical chapters concerning the master plan, the transportation system, and the lighting strategy of Masdar City, the designers and developers have embraced a strong techno-economic approach to sustainability that concentrates agency at the top. However, after users interpreted the design strategies in various ways, they decided to adapt a more flexible stance to their sustainability goals and distributed agency to the users.

Although the living lab as a concept was a focus of Masdar City from the beginning, users were not included in design processes, a central component of the living lab concept. In case of the PRT, learning occurred through experimentation on the system, tracking its consequences and implications, and other sorts of scientific inquiry. In case of the lighting strategy, learning happened through specific ways of monitoring, data collection, and analysis that fed back with similar learning loops. Afterwards, no one spoke explicitly about the living lab. However, user
involvement could be traced more clearly and explicitly reflecting what a living lab could really mean. In other words, it started to reflect a specific learning process and loop that presented a more flexible approach in two ways. One way was through the PRT, when the designers and developers received feedback through informal ways as they watched the users, talked to them, and put themselves in their shoes. The other way was through the lighting strategy that was harder to observe directly, so they adapted more formal ways as they talked to them and had access to their feedback through MIST and the maintenance company. In both case, informal and formal, the learning loops contributed to subsequent design and development stages. In this way, a different notion of the initially-targeted living lab and the learning process emerged, stemming from different aims and incorporating different actors.

This said, a specific living lab and learning processes have shaped the collective through inscription and de-scription processes. With such a new orientation, the designers and developers reconfigured the collective or re-inscribed the design strategies. This exceeded the original project goals because included what they observed, trialled, and collected from the users’ interactions and descriptions as they supported, tinkered, re-configured, and resisted the design strategies.

In the case of the transportation system, the developers suggested changes to not solely rely on the PRT but to supplement it with other transportation options. This resulted in a rearrangement of the initial collective. Some of these options were aligned with the main project goals, such as electric cars, while other options contradicted the goals to ensure user satisfaction, such as the shuttle buses. The developers compromised the zero carbon goals by introducing regular less efficient and non-renewable transport options. They also sacrificed part of the green belt to dedicate to parking. With the lighting strategy, the designers and developers introduced changes
to make the lighting more sufficient and manageable. They added the card as an actor to rearrange the relations of the main collective. Again, this compromised zero carbon ambitions of the project.

As a result, the transportation and lighting strategies were not solely determined by efficiency, renewable energy, and user satisfaction targets. Instead, they included what was negotiated by the users in different ways as they experienced and de-scribed them. They abandoned their models and best practices in favor of the lessons learned from the experiences of the users within their lived environment.

The collective configurations did not stop there as they were continuously shaped and re-shaped through ongoing inscriptions and de-scriptions, offering continuous learning opportunities. As the designers and developers reconfigured the collective and re-inscribed the design strategies, they handed them back again to the users through ones that were implemented in the second phase.

In the case of the transportation system, the users experienced different scenarios and stories with the provided transport options, rendering them less sustainable in terms of efficiency and renewable energy but more sustainable in terms of contributing to user satisfaction. The parking they used and the cars that they took contributed to this. They accordingly abandoned the PRT as a result of such introduced means. In case of the lighting strategy, users interacted with the lights and sensors to align with their needs. However, they still experienced some scenarios of interaction that went beyond their expectations, with the lights that kept switching on when they did not need them and off when they needed them. The TV that they watched, the toiletries they needed from the bathroom, and the water that they took from the kitchen at night contributed to
this. They again tried to adapt to the new system. In other cases, they tinkered with the system as they changed the location of the furniture not to pass by the lights and switch them on by triggering the sensors. They also reconfigured the system by partially covering the sensors or blocking them entirely.

In this way, the collective of the transportation and lighting systems is mutable, convertible, and never fully determined by the configurations or inscriptions of the designers and developers or the reconfiguration or de-scriptions of the users as they are under ongoing emergence and happening as a result of the interaction between both. Through such complexity and dynamics, they offer opportunities for learning that can be applied to current and future stages and projects. Sustainability embraces such contestation and transformability and provides such enlightening opportunities to push the design strategies forward.

The living lab offers a concept where these aspects are further enhanced and supported. It also shows that a collective that could be constructed in a rigid way, similar to what happened at the beginning in the case of Masdar City, could change to be more flexible with the transformation of the living lab itself at later stages of the city. In this way, it produces a different collective with its evolution. The argument here is that, if the living lab was not there, the collective of Masdar City would have still gained relative rigidity, which could have affected the adaptation of its designs. The living lab promotes the flexibility of the collective through involving different actors and focusing on the users. Another aspect of the living lab is that it offers an opportunity of learning through the applied collective that could be further enhanced and applied to current and future stages or projects. This gains importance with the case of sustainability as a new concept that requires such opportunity of learning. This is why the living lab is normally connected with such new concepts.
7.5 Learning through the Contingency of the Design Collective

A third contribution of the thesis is that the contingency and indeterminacy of the collectives can enhance learning processes by broadening the array of choices around sustainable design strategies. The flexible actors, mentioned in the previous section, absorb the surprises and unprecedented consequences and they distribute actors’ contributions and fit them in the collectives accordingly.

I have reflected on such unpredictability and contingency, where what is configured or inscribed by the designer was reconfigured or de-scripted by the user in a different way. The designers and developers relied on models and simulations while users had their own expectations and experiences. In other words, the modeled user is different than the real one. This is emphasised in the case of Masdar City with the fact that the designers and developers needed to predict users who were not present. Users in turn did not align with predicted and suggested visions representing only one type of engagement. On the contrary, they played different roles resulting in supporting, tinkering, re-configuring, and resisting the designs and reflecting different types of users or categories of use. In addition, the heterogeneity of users amplified the conflicts by introducing different interests and actions in various times and places. Meanwhile, the variety of life rhythms and patterns that users adopt as they could work and do their daily activities also added to the conflicts. The models do not capture and embrace such heterogeneity and variety of rhythms or patterns. In addition to that, there were external circumstances that reshaped the initial designs, notably financial constraints. In this way, the collective is shifted and reshaped with such unpredictable conflicts between the inscription and de-scription processes, which offer further learning opportunities to consider flexible scenarios and broaden the window of possibilities for different design strategies.
The designers and developers reflected on the level of vagueness and ambiguity that accompanied the design strategies through the different stages, where Augustine, John, and Ralf acknowledge that they changed as a result with what they already learnt in regards to improving the design strategies and aligning them with the users and with the upcoming financial circumstances. They did not anticipate such changes at the early stages of the project and their results were also unexpected. This is emphasised by Akrich and colleagues (2002a. p. 202), who argue that all forms of rigidity, constraints, and precision must be avoided as design strategies cannot possibly rely on preset criteria and predefined procedures. They accordingly emphasise the instability and uncertainty of design strategies as they are about the different ways of interaction and adaptation to such interaction.

In this way, the introduction of new sustainable architectural designs is not the end result. It is important to recognise that it is an open process of technological innovation as the project is not yet completed. What could or could not happen and what could work more or less sustainably is embedded with similar ambiguity and vagueness. New designs can still arise, contributing to further reshaping and recreation of collectives and embedding new meanings of sustainability in that specific context. Sustainability includes such interactions that make them further complex and dynamic and, at the same time, unstable and un-predictable through the ongoing progression of design strategies.

The argument here is to regard sustainable architectural products as complex, dynamic, and unpredicted from the start and deal with them accordingly. Taking into account that sustainable architecture itself is multidisciplinary, this would necessitate consideration of all aspects that pave the way for such direction. In this manner, the users will no longer be at the bottom of the managerial, top-down process. Instead, a collaborative, continuous, bottom-up approach is more
suitable for dynamism and unpredictability. The role of the government and experts accordingly turns to focus on allowing and facilitating such productive and democratic interaction. Researchers and practitioners would then work together to maintain the openness to embrace new approaches and traditions. The thesis has encouraged the fact that the achievement of sustainable architectural designs would not only require new ways of working and thinking, but different partnerships between all potential stakeholders as well, including scientists, researchers, designers, politicians, and the public. This said, the value of Masdar City is through providing examples on the challenges that could face products that could be taken for granted and then slowly directed into a completely different path to align them with the lived environment.

Going further with such remarks, another argument is that the living lab has contributed to producing sustainable architecture in a specific way that is not only aligned with the designers and developers’ intentions, but also by accounting for user experiences. With the sustainable architectural products that conform to their designers and developers but also bring surprises when they come to the users that could align or misalign with them, the living lab provides an opportunity for interaction between both. Through such interaction, the lab merges with reality, the design with use, and the inscribed with the de-scribed to produce architectural products that go beyond traditional modes of production. The co-design processes and collaborations the living lab offers collapse such distinctions and embrace the co-evolution of the built environment.

The living lab provides the opportunity to integrate social interventions with technological innovation and view them as intertwined, affecting and affected by each other rather than separate as could be viewed through conventional ways. Furthermore, it could provide a platform or arena, where such sociotechnical associations as well as the alignments or misalignments
connected to them are revealed and negotiated through informal or formal processes of learning and feedback loops. This results in the refinement of the products and adjustment of the priorities of all stakeholders. Although the case of Masdar City could or could not be adapted from the early stages to carry such meaning and although this might or might not be intentional, the argument is that it has supported such amendments at the later stages of the project. The thesis has accordingly encouraged the embrace of such concepts in architectural production from much earlier stages of the project. From this perspective, the value of Masdar City is in providing an example of the living lab approach, where it shows its potential for feedback and learning to influence sustainable design processes.
References


References


Flyvbjerg B., 2006. Five Misunderstandings about Case-Study Research. *Qualitative Inquiry*, vol. 12, no. 2, pp. 219 - 245.


Appendix A: Participant Interview Package – Designers

Participant Information Sheet
Design Team Members

You are being invited to take part in a study for a PhD degree in Architecture, focusing on the applicability of sustainable designs in the Middle East. Before you decide to participate, it is important for you to understand why the study is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the study?

The study will be conducted by Ahlam Ammar Sharif from the School of Environment, Education and Development at the University of Manchester, Oxford Road, M13 9PL. Ahlam has received adequate training in taking consent of her research participants as part of her programme.

The study will be supervised by Dr. Albena Yaneva

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School of Environment, Education and Development
The University of Manchester
Manchester, M13 9PL

The study will be co-supervised by Dr. Andrew Karvonen

Humanities Bridgeford Street-1.10
School of Environment, Education and Development
The University of Manchester
Manchester, M13 9PL

Title of the study

Sustainable Design Concepts in the Middle East, Eco-cities in Focus.
What is the aim of the study?

The aim of the thesis is to provide a better understanding of the sustainable design in the Middle East. It will explore in particular the role of and the effect on the technology in achieving sustainability. This research will cover the residential sector related to Masdar Institute of Science and Technology in Abu Dhabi, United Arab Emirates.

Why have I been chosen?

You have been chosen because you have been involved in the design of residential sustainable units utilizing sustainable design concepts and technologies at the residential part of Masdar Institute of Science and Technology.

What would I be asked to do if I took part?

You are kindly requested to add value to the conducted research through the following channels describing your experience and provide your opinion through qualitative interviews that aim to understand the design development process for the completed phase of the project or future phases that are being worked on concerning the residential part of Masdar Institute of Science and Technology.

What happens to the data collected?

The collected data will be analysed and reflected in the findings of the PhD thesis, with the potential of being used in other publications of relevance.

How is confidentiality maintained?

All collected data will be stored in encrypted external hard drives that are only accessible to the researcher and the supervisors, who are the custodians of the research. The names of the research participants will be maintained as confidential unless prior approval was obtained to use such names. Data analysis will take place at my home and my university desk, where both are password protected. The supervisors and researcher will have the sole access to the material that the researcher will explore to conduct the analysis. Both will be involved in the analysis process later on.

The recorded audio material shall be maintained for a period of five years from the date of conclusion of the study, after which they shall be destroyed. Unpublished data will be kept for the same period after graduation.

What happens if I do not want to take part or if I change my mind?

Your participation in this research is absolutely voluntary. It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and
be asked to sign a consent form. If you decide to take part you are still free to withdraw at any
time without giving a reason.

During the course of participation, and in case you experience any discomfort from the
researcher's presence, you are entitled to excuse the researcher from any situation that you feel is
inappropriate. In any case of distress, you can ask for the research activity to be immediately
stopped.

**Will I be paid for participating in the study?**

No payment will be provided for the participants in the research study.

**What is the duration of the study?**

The study is expected to be concluded within a window of six months with one to two months
dedicated for the design office. This will be based on the approval of the office in which it is
conducted. Each participant is expected to dedicate around 45-60 minutes for a qualitative
interview.

**Where will the study be conducted?**

The study will be conducted in the office of the concerned design firm where you work as a
design team member.

**Will the outcomes of the study be published?**

The research outcomes will mainly be presented and discussed in the PhD thesis related to the
research. Such outcomes might also feature on relevant papers and seminars as well.

**Contact for further information**

The researcher can be contacted for any further information or clarification via email
(ahlam.sharif@postgrad.manchester.ac.uk)

The supervisors can be contacted on the following mails:

(Albena.Yaneva@manchester.ac.uk) and (Andrew.Karvinen@manchester.ac.uk)

**What if something goes wrong?**

If there are any issues regarding this research that you would prefer not to discuss with members
of the research team, please contact the Research Practice and Governance Co-ordinator by
either writing to 'The Research Practice and Governance Co-ordinator, Research Office, Christie
Building, The University of Manchester, Oxford Road, Manchester M13 9PL', by emailing:
Research-Governance@manchester.ac.uk, or by telephoning 0161 275 7583 or 275 8093.
Interview Schedule - Designers

General Information

Consent

1. Can you provide a brief description of your role within the design firm? How long have you been in this role?

2. Can you please describe your own contribution to the design of Masdar eco-city? In which area was it mostly focused?

Sustainable Features (how they are understood and how they affect the user)

3. How do you perceive the concept of sustainability in general? How do you tackle it in your designs? Is this a shared notion within the design firm?

4. Where does the designer get the inspiration to design a sustainable project (user, locality, or technology)?

5. What is the role of technology in design? To what extent does it commit the user and restricts the designer?

6. What are the sustainability features available at the residential unit? Can you generally describe their purpose and working principles?

7. What is the difference between phase A and B? How does that reflect on the changes within phase B on the basis on what happened in phase A?

8. From your own experience, can you describe how the developed designs for Masdar differed from other eco-city designs developed in the UK or other parts of Europe?

9. To what extent did this project in specific affect your own understanding of sustainability?

10. Who are the involved designers in this project?
Specific about Masdar (residential in particular)

11. What are the sustainability features and design techniques that were utilised in the residential units of Masdar Institute? Can you generally describe their purpose and working principles?

12. What are the designs used for the following:
   - Heating and cooling systems.
   - Lighting system.
   - Walls, doors, window, furniture, and materials.
   - Kitchen.
   - Water.
   - Waste production.
   - Transport.

13. What is the principle of the wind tower that is in the site? Is it different than the normal wind tower, especially with the faced challenges?

14. What is the role of the atriums, courtyards, and passages in cooling interior spaces?

15. What is the relation between the laboratories and the residential buildings?

16. How were the residential designs of Masdar different from the conventional designs and approaches utilised locally?

17. What are the differences in needs that you consider between the UK and Abu Dhabi? Or in other words, specific to Abu Dhabi?

18. What were the key measures utilised and decisions taken in the sustainable design of the residential units of Masdar Institute? How were such measures and decisions made to reflect your overall understanding of sustainable design?
Local Context

19. How did you obtain thorough insights and understanding of the local context in order to be considered in the design process?

20. Can you provide some examples of the key design decisions that were affected by the local social and cultural aspects of Masdar?

21. What were the key actors involved in the design process to ensure that the generated designs were relevant to the local context? Which of the actors were the most influential in your opinion?

22. To what extent do you believe the developed design was aimed to influence and affect the local surroundings?

23. What do you believe were the key contributions and inputs of the designer to the design of Masdar eco-city, ones that went beyond the traditional design elements of the local surroundings?

24. Were the design measures taken aimed at making the project and its elements independent of the outer surroundings? If yes, in what ways?

Users Involvement

25. How can we categorise and deal with the different categories of users (the "able" and the "un-able", "willing" and "unwilling," as per F+P documents)?

26. Do users understand how the different treatments work? Who has educated them?

27. To what extent were the sustainability design features and technologies aimed to influence and modify the behaviors and life styles of the users?

28. How involved were the potential users of the designed residential units during the design process and after design completion?
29. How was the feedback of the users taken into account? How were the users considered? At what stages was such feedback obtained (during the design process, after the implementation)?

30. In case feedback was obtained from the users, what were their key concerns or issues? How did their opinion introduce changes into the designs of the following residential units? Please provide examples.

31. What were the key issues or concerns faced after the residential designs were implemented? What were the most influential sources of such concerns (users, technical aspects, or local context)?

32. Do you believe that the sustainability arrangements utilised in the developed residential units should be applied in other future residences within the institute? If yes, should they be taken as-is or do you see some needed adjustments for them to become more suitable?

33. Would you like to add anything further?

34. Would you please refer me to some other designers?
The Transferability of Sustainable Design Concepts, Eco-cities in Focus

Consent Form – Interviews/ Site Observations

If you are happy to participate please initial the boxes to indicate your consent to each statement and sign the consent form below.

1. I confirm that I understood the purpose of the research and that the interview will be used for research purposes.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason.

3. I understand that the interviews will be audio-recorded

4. I agree that any data collected may be passed to other researchers

5. I agree that any data collected may be published in anonymous form in academic books or journals.

6. I understand that the researcher will need to take still images.

I agree to take part in the above project.

Name of Participant ___________________________ Date ___________ Signature ___________________________

Name of Person Taking Consent ___________________________ Date ___________ Signature ___________________________
Appendix B: Participant Interview Package – Users

Participant Information Sheet
Residents - Users

You are being invited to take part in a study for a PhD degree in Architecture, focusing on the applicability of sustainable designs in the Middle East and how they relate to the designers and users. Before you decide to participate, it is important for you to understand why the study is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Who will conduct the study?

The study will be conducted by Ahlam Ammar Sharif from the school of Environment and Development at the University of Manchester, Oxford Road, M13 9PL. Ahlam has received adequate training in taking consent of her research participants as part of her programme.

The study will be supervised by Dr. Albena Yaneva

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The study will be co-supervised by Dr. Andrew Karvonen

Humanities Bridgeford Street-1.10
School of Environment, Education and Development
The University of Manchester
Manchester, M13 9PL

Title of the study

The Transferability of Sustainable Design Concepts, Eco-cities in Focus.
What is the aim of the study?

The aim of the thesis is to provide a better understanding of the transferability of sustainable design in the Middle East. It will explore in particular the role of and the effect on the technology in achieving such transfer between the developed and developing countries. This research will cover the residential sector related to Masdar Institute of Science and Technology in Abu Dhabi, United Arab Emirates.

Why have I been chosen?

You have been chosen because you are involved in experiencing the residential sustainable design concepts that have been applied at the residential part of Masdar Institute of Science and Technology. As a resident (or user) of the developed residential units, you have had the opportunity to experience the way sustainable design concepts and technologies have been applied and utilised.

What would I be asked to do if I took part?

You are kindly requested to add value to the conducted research through the following channels:

- Describe your experience and provide your opinion through qualitative interviews that aim to understand the overall suitability of such residential sustainable design concepts at the residential part of Masdar Institute of Science and Technology as per your view as an user.

- You might be asked to take the researcher in a tour through your house to show the sustainable technologies used and other relevant features. You might be asked to provide a brief diary describing your daily activities in regards to your use of specific sustainable technologies at your house. It is important to note that such activities are not meant to interfere in the personal aspects of your daily life, and in case you experienced any sort of inappropriate intrusion you are free to withdraw from the study at any time or ask for the researcher not to be present at specific instances as you see suitable.

You are kindly requested to allow the researcher to take notes, audio recording, and some still images where needed.

What happens to the data collected?

The collected data will be analysed and reflected in the findings of the PhD thesis, with the potential of being used in other publications of relevance. The collected data will solely be used towards the approved research from the Masdar Institute of Science and Technology, and will not be used for other research projects unless been approved again.

All collected data will be stored in encrypted external hard drives that are only accessible to the researcher and the supervisors who are the custodians of the research. The names of the research
participants will be maintained as confidential unless prior approval was obtained to use such names. Data analysis will take place at the researcher's home and university desk, where in both cases laptops used are password protected. The supervisors and researcher will have the sole access to the material that the researcher will explore to conduct the analysis. Both will be involved in the analysis.

The collected material shall be maintained for a period of five years from the date of conclusion of the study, after which they shall be destroyed. Unpublished data will be kept for the same period after graduation.

**How is confidentiality maintained?**

All collected data will be stored in encrypted external hard drives that are only accessible to the researcher and the supervisors who are the custodians of the research. The names of the research participants will be maintained as confidential unless prior approval was obtained to use such names. Data analysis will take place at the researcher's home and university desk, where laptops used in both places are password protected. The supervisors and researcher will have the sole access to the material that the researcher will explore to conduct the analysis. Both will be involved in the analysis.

The recorded audio material shall be maintained for a period of five years from the date of conclusion of the study, after which they shall be destroyed. Unpublished data will be kept for the same period after graduation.

**What happens if I do not want to take part or if I change my mind?**

Your participation in this research is absolutely voluntary. It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason.

During the course of participation, and in case you experience any discomfort from the researcher's presence, you are entitled to excuse the researcher from any situation that you feel is inappropriate. In any case of distress, you can ask for the research activity to be immediately stopped.

**Will I be paid for participating in the study?**

No payment will be provided for the participants in the research study.

**What is the duration of the study?**

The study is expected to last for up to six months. This will be based on the approval of the facility in which it is conducted. Each participant is expected to dedicate around 45-60 minutes
for a qualitative interview in addition to approximately 15-30 minutes for a house tour. Additionally, participants might be required to write a brief diary. This period is expected to be sufficient to observe your living interaction with the sustainable design concepts and technologies available at your residence, but could in some cases be extended based on the faced circumstances.

**Where will the study be conducted?**

The study will be conducted at the residential unit of Masdar Institute of Science and Technology where you live as a resident/ user participants.

**Will the outcomes of the study be published?**

The research outcomes will mainly be presented and discussed in the PhD thesis related to the research. Such outcomes might also feature on relevant papers and seminars as well.

**Contact for further information**

The researcher can be contacted for any further information or clarification via email (ahlam.sharif@postgrad.manchester.ac.uk)

The supervisors can be contacted on the following mails:

(Albena.Yaneva@manchester.ac.uk) and (Andrew.Karvonen@manchester.ac.uk)

**What if something goes wrong?**

If there are any issues regarding this research that you would prefer not to discuss with members of the research team, please contact the Research Practice and Governance Co-ordinator by either writing to 'The Research Practice and Governance Co-ordinator, Research Office, Christie Building, The University of Manchester, Oxford Road, Manchester M13 9PL', by emailing: Research-Governance@manchester.ac.uk, or by telephoning 0161 275 7583 or 275 8093
Interview Schedule - Residential Users

General Questions

1. Can you please state your designation within the institute (faculty member or student)? For how long have you been at this capacity?

2. In which part of the campus, block, and floor do you reside? How long have you resided there?

Sustainable Features (how they are understood and how they affect the user)

3. How do you perceive the concept of sustainability in general? How does it reflect on your daily life?

4. What are the sustainability features available at your residential unit? Can you generally describe their purpose and working principles?

5. How similar or different do you see the design (to western designs and to more conventional designs)?

6. Do you believe in the efficiency and suitability of the sustainability arrangements in your residence? What are the benefits and challenges that you see in them?

7. To what extent did this project in specific affect your own understanding of sustainability?

Specific about Masdar (residential in particular)

8. What are the sustainability features and design techniques that were utilised in the residential units of Masdar Institute? Can you generally describe their purpose and working principles?
9. What are the designs used for the following, and how do you perceive and experience each of them:
   - Heating and cooling systems.
   - Lighting system.
   - Walls, doors, window, furniture, and materials.
   - Kitchen.
   - Water.
   - Waste production.
   - Transport.

10. What is the principle of the wind tower that is in the site? Is it different than the normal wind tower, especially with the faced challenges?

11. What is the role of the atriums, courtyards, and passages in cooling interior spaces?

12. What is the relation between the laboratories and the residential?

13. Describe your walking experience, cooking, showering, sleeping, studying, reading, and other activities.

14. How were the residential designs of Masdar different from the conventional designs and approaches utilised locally?

15. To what extent did this project in specific and dealing with its sustainability features affected or changed your own understanding of sustainability?

**Local Context**

16. Do you believe that the sustainable design of your residence comes in line with the local look and feel in addition to the general culture of the locality you live in? If not, where do you see the differences?
17. Can you provide an example of sustainability feature that you see as aligned or contradicting with the local surrounding?

18. To what extent do you believe the developed design was aimed to influence and affect the local surroundings?

19. What do you believe were the key contributions and inputs of the design of Masdar eco-city that went beyond the traditional design elements of the local surroundings?

20. Do you feel that the sustainability treatments at your residence have affected your relationship with the external environmental, social, and cultural surroundings? Do you sense isolated or different in any way as a result?

**User Involvement**

21. Do you understand how the different designs and treatments work? Who has educated you?

22. To what extent do you see the impact of the sustainability features, technologies, and design elements in your residence on your daily living routine?

23. To what extent did the sustainability design features and technologies influence and modify your behaviors and life styles?

24. Do you believe that the personal life style changes that you had to make to accommodate to the sustainability features in your residence achievable and justifiable?

25. Have you been involved in any way in the design of the sustainability features of your residence or any other sustainable residences within campus, whether by seeking your opinion or suggestions in their regard? If yes, to what extent was your opinion taken into account?
26. Could you provide an example of a case where your contribution was ignored or taken into account?

27. Have your feedback been collected at any stage? At what stage?

28. In case your feedback was taken, what were their key concerns or issues? How did your opinion introduce changes into the designs of the following residential units? Please provide examples.

29. Do you believe that the sustainability arrangements at your residence should be applied in other future residences within the institute? If yes, should they be taken as-is or do you see some needed adjustments for them to become more suitable?

30. Do you utilise all the sustainability features, technology, and design elements at your residence? If not, what are the ones not being used? Have you attempted to influence or adjust any of these features to become more usable to you?

31. Would you rather change your residence to another that utilises less sustainable features and technologies? If yes, why?

32. Would you like to add anything further?

33. Would you please refer me to some other users?
The Transferability of Sustainable Design Concepts, Eco-cities in Focus

Consent Form – Interviews/ Site Observations

If you are happy to participate please initial the boxes to indicate your consent to each statement and sign the consent form below.

1. I confirm that I understood the purpose of the research and that the interview will be used for research purposes.

2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving a reason.

3. I understand that the interviews will be audio-recorded

4. I agree that any data collected may be passed to other researchers

5. I agree that any data collected may be published in anonymous form in academic books or journals.

6. I understand that the researcher will need to take still images.

I agree to take part in the above project.

Name of Participant ___________________________ Date __________ Signature __________

Name of Person Taking Consent ___________________________ Date __________ Signature __________