DESIGN FOR INTERACTION
RUIHUA CHEN 2022

Navigating Pattern Language

— A PRACTITIONERS' GUIDE TO DECIDE ON THEIR APPROACH ON PATTERN LANGUAGE THEORY FOR COMPLEX PROBLEMS

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Summary

Numansgors is a village seeking to improve sustainability by housing renovation. In this process, the effective participation of homeowners faces multiple challenges. The Pattern Language Theory (PLT), a design methodology first proposed by Alexander Christopher in 1970s, shows its potential in tackling these challenges. However, as PLT has been applied in broadening domains, various approaches to using PLT are different from the original one taken by Alexander. As these differences and their basis generally go unarticulated, practitioners referring to such cases may fail to choose an appropriate approach and hence use PLT less effectively. Therefore, to support the effective ue of PLT, either in Numansgors or in other domains, this graduation project aims to support differentiating between diverse PLT approaches, and deciding on a PLT approach.

In the beginning, to better understand the topic, a literature review of PLT was conducted. The benefits of PLT were identified, which later confirmed its suitability in Numansgors. Besides, eight purposes of using PLT were summarised and were later found essential in deciding on PLT approaches.

Next, to understand the different approaches, an integrative review — which I called deconstruction, identifying and reconstruction — of multiple cases was performed. The external manifestations and internal reasons for different approaches were identified. On the outward, the different approaches are manifested in four components. On the inward, the approaches root in practitioners' diverging values and needs. These insights were concretised into three tools, which were later incorporated into the final research output.

Afterwards, to find out how the three tools could be used in practice, workshops were organised for inspiration. In these workshops, some other issues in deciding on PLT approaches were found. These issues were tackled by formulating a procedure to use PLT and refining the classification of activities around PLT. All these insights were synthesised into the final research output, the Activity Kit, to support practitioners in deciding on their PLT approaches. With this Activity Kit, practitioners can first consider their project purposes, then find the activities recommended for the purposes, and finally execute the activities with the support of relevant tools.

To validate the use of Activity Kit, the Numansgors project was taken as an example. A three-stage plan for Numansgors was generated by using the Activity Kit. It is recommended to evaluate the Activity Kit with more cases and keep up with the influence of the pattern language in Numansgors.

Table of Contents

Keywords

Pattern Language Theory (PLT)
The methodology that utilises patterns and pattern languages to deal with complex systems.

Pattern Language
A network of patterns — each of which documents a problem and corresponding solution.

Approach
The way to use the pattern language theory.

The focus of this thesis is on the different *approaches* — the various ways to use PLT.

Reading Guide

Below, the main formats used throughout this report are presented for a preview:

1. At the beginning of each chapter, an overview of the research activities and answered RQs is visualised.

2. A summary is given for each chapter at the end in a blue text box like this.

3. Quotes are formatted as such.

4. In Chapter 6, examples specific to the Numansgors project are given in a light yellow box like this.

Introduction

In this chapter, how was the project initiated from the Numansgors context is introduced. Four research questions were designed to achieve the project objective. Corresponding to the four research questions, the activities taken for this project are divided into four stages. An outlook of the expected contributions, and an overview of the report structure are also presented.

1.1 Project Initiation

Sustainability has become a universal concern of society. Numansgors, a village near Rotterdam, is also in the midst of this revolution for sustainability.

1.1.1 The Numansgors Project

Numansgors is a village located on the water close to Rotterdam, which was built in the 1980s by the architectural bureau Van der Broek & Bakema as a luxury holiday destination. In 2013, it began to offer permanent residence. To meet contemporary requirements on sustainability, the GORS2025 — a voluntary committee — was set up with the aim to make Numansgors more sustainable without losing its architectural aesthetics. In the current stage, the work in Numansgors is focused on housing renovations, such as installing solar panels, improving house insulations etc. In addition, the GORS2025 also looks for new technologies or social values from uni-students. Therefore, the GORS2025 made contact with the WUR Science Shop for collaboration.

1.1.2 Motivation

During the elective course semester, I read the book *The Oregon Experiment* (Alexander, 1975) and got the inspiration for this graduation project. Although the concept of PLT was not new to me, when re-understanding this concept from the perspective of an industrial designer, I found this theory can be used in more domains in addition to architecture and urban planning. After reading some literature, I was amazed to see how PLT had been applied in software engineering and in organisation management etc. I also noticed that some characteristics shown in Alexander's application had been changed in different projects, leading to the various ***approaches*** (ways to use PLT) without enough reasoning. Therefore, I decided to dive deeper into these approaches.

When seeing the graduation opportunity about the Numansgors project, I immediately thought that pattern language could be a good format to collect and present all needed information for improving sustainability.

1.1.3 WUR Science Shop

The Science Shop collaborates with non-profit groups in society by organising student research projects that find answers to their questions. For the Numansgors project, the WUR Science Shop had involved four uni-students respectively working on different topics, ranging from energy technology to landscape design. This graduation project was part of the Numansgors project and involved one researcher, Drs. van Eldik, Z.C.S. from WUR Science Shop in the supervisory team.

1.2 Project Context

This section introduces the concext of Numansgors project.

1.2.1 Challenge

The housing renovation in a community context, as in Numansgors, is complex since it involves multiple stakeholders with sometimes divergent requirements and needs, and usually spans a long period of time. In facilitating housing renovation, the effective participation of homeowners has been acknowledged as a key instrument (Wang et al., 2016; Bukovszki, Dóci & Reith, 2021). However, multiple challenges can be expected in this participatory approach in Numansgors and other housing renovation projects. Among these, two main challenges that will be dealt with in this project are:

(1) Ineffective communication
(2) Lack of coordination

First, ineffective communication would hinder the participation of end users. On one hand, professional knowledge is less accessible to end users, as the end users usually lack relevant expertise (Jowkar et al., 2022). For such reason, end users may gradually be excluded from the decision-making process, either actively or passively. On the other hand, as stakeholders usually shun from communicating underlying values or motivations (Bos-de Vos, 2020; Y. Wang et al., 2022), conflicts often exist, sometimes on a superficial level (Swyngedouw, 2014). For example, the GORS2025 and residents seem to hold conflicting attitudes towards individual measures and cannot come to a consensus. However, upon closer examination, the actual need of GORS2025 is to avoid aesthetic fragmentation, which does not necessarily oppose residents to perform individual measures.

Second, without a coordinated order, the participation of end users will be less efficient. Stakeholders lack a common overview of the project because the knowledge possessed by each of them does not connect to each other (Finidori, 2016). For example, the problem of insulation may recur in several households. If each homeowner conducts the same consultation and purchasing process on their own, they will be doing redundant work and the cost of decision-making will be multiplied. In addition, if each household uses different solar panels, the aesthetics of the park will be affected. Therefore, for favourable participation, coordination between individual homes should be achieved.

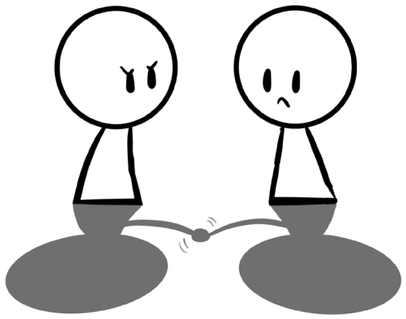


figure 1.1
ineffective communication can lead to superficial conflicts

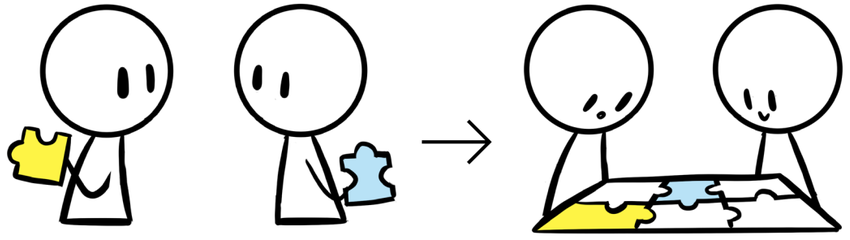


figure 1.2
from lacking consistency to building consistency

1.2.2 Opportunity

In face of these challenges, the design methodology, Pattern Language Theory (PLT) shows its potential to be applied in Numansgors. On one hand, this methodology allows knowledge to be easily captured and communicated (Borchers, 2008; Van Welie & Van der Veer, 2003; Erickson, 2000; Brugman, 2021). On the other, it can leverage consistency and create an overview of wicked problems (Finidori, 2014) or complex systems. The potential of PLT in dealing with sustainability has been confirmed by a series of research such as (Finidori, 2014; Finidori, H. 2016; Kuenkel, 2017; Ricaudet al., 2021).

PLT has been successfully applied in participatory project contexts such as medical service system design (Athavankar et al., 2014) and policy making for community dwellings (Palmieri et al., 2021) etc. As PLT being applied to different domains, the original way proposed by Alexander has been changed (figure 1.3), e.g. in terms of the activities and roles involved. However, these differences have usually been unspecified in the cases, and the underlying reasons are scarcely articulated. This would result in confusion, when practitioners refer to these cases to consider how to use PLT in Numansgors or other renovation projects, and may hence decrease the effectiveness of PLT (Wania & Atwood, 2009; Alexander et al., 1977). Therefore, **to grant the effectiveness of using PLT in the new project/domain**, such as housing renovation, **taking an appropriate approach is a prerequisite.**

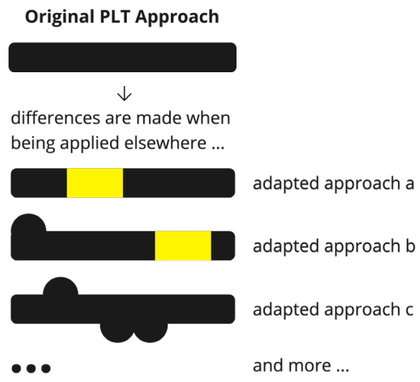


figure 1.3
the original approach has changed when PLT is applied elsewhere

1.3 Scope & Structure

As previously discussed, ***to use PLT effectively in a project, an appropriate approach should be taken***. Since many approaches exist, **to identify the most appropriate one, it is needed to differentiate between the existing approaches**. Therefore, a complete application of PLT should involve three phases (as shown in figure 1.4), namely

(1) differentiating PLT approaches,
(2) deciding on one appropriate PLT approach, and
(3) executing PLT.

However, to differentiate between approaches, one would have to read and synthesise a lot of cases, which would be a burden for practitioners considering their intense project agenda. For this reason, this differentiation work makes more sense to be conducted by researchers.

Moreover, suppose researchers are able to differentiate PLT approaches, how to translate this knowledge to practitioners, and how may practitioners make use of it to decide on PLT approach (phase 2) also requires investigation. Therefore, this research project sets the scope on the former two phases of differentiating and deciding on PLT approaches (figure 1.4), and aims to provide a practical guide for practitioners.

In addition, as this project intends to inform practitioners in diverse domains, the research activities for these two phases are not limited to housing renovation or the Numansgors context. To be specific, in the first phase, PLT cases from diverse domains are studied and synthesised into more abstract findings. Later in the second phase, the theoretical findings are output into a more practical format, and should be applicable in different domains.

Finally, the generated practical guide is expected to inform the execution of PLT in real projects. Within this graduation project frame, the Numansgors project is taken as a validation of the research outcomes. This process also generates practical suggestions for Numansgors.

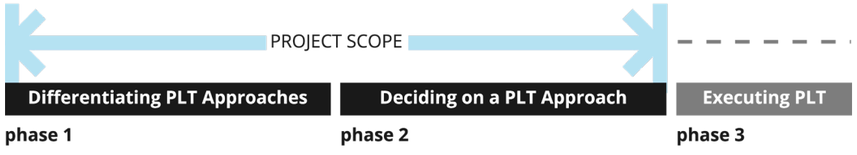


figure 1.4
three phases of PLT application
As shown by the blue arrow, this project scopes on the former 2 phases.

1.4 Objective & RQs

As previously mentioned, by filling the gap in differentiating and choosing PLT approaches, the ultimate objective of this project is **to provide instruction for practitioners to decide on the approach to using PLT.** To achieve this objective, the following research questions are formulated.

First, at the beginning of this project, to attain a comprehensive overview of the research field and to confirm PLT's relevance to the Numansgors project, the first research question is:

Research Question (1)
What is Pattern Language Theory?
a. What are the benefits of it?
b. What are the purposes of using it?

Second, as previously mentioned, different approaches to using PLT exist in diverse projects and domains. However, these differences generally go unarticulated, and their basis is often not well grounded. Without being aware of the differences and their reasons, providing support to decide on an approach is not achievable. Therefore, the second research question is:

Research Question (2)
How is pattern language theory applied?
a. What are the components of a PLT approach?
b. How are the approaches different?
c. Why are the approaches different?

Third, after differentiating the approaches, practitioners need to decide on their own approach. To translate the insights learned from the above questions into a practical guide, and to finally achieve the project objective, the main research question of this project is:

Research Question (3)
How can practitioners be supported in applying PLT?

The above three research questions are expected to lead to the main project output, which puts an end to the former two phases of the "applying PLT to the Numansgors project" procedure (as in figure 1.4). To validate this output, a case study of the Numansgors project is performed. In this case study, the fourth research question is:

Research Question (4)
How can the Numansgors project be supported in applying PLT?

Among the four research questions, RQ3 as the main question, on one hand requires the input from RQ1 and RQ2, and on the other hand generates the output to inform RQ4. The relationships between the four questions are visualised in figure 1.5.

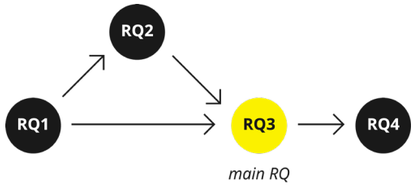


figure 1.5
relationships between research questions

1.5 Approach

Corresponding to the four research questions, the activities taken for this project are divided into four stages. The relevant report chapters and switches between theoretical and practical findings are presented in figure 1.6.

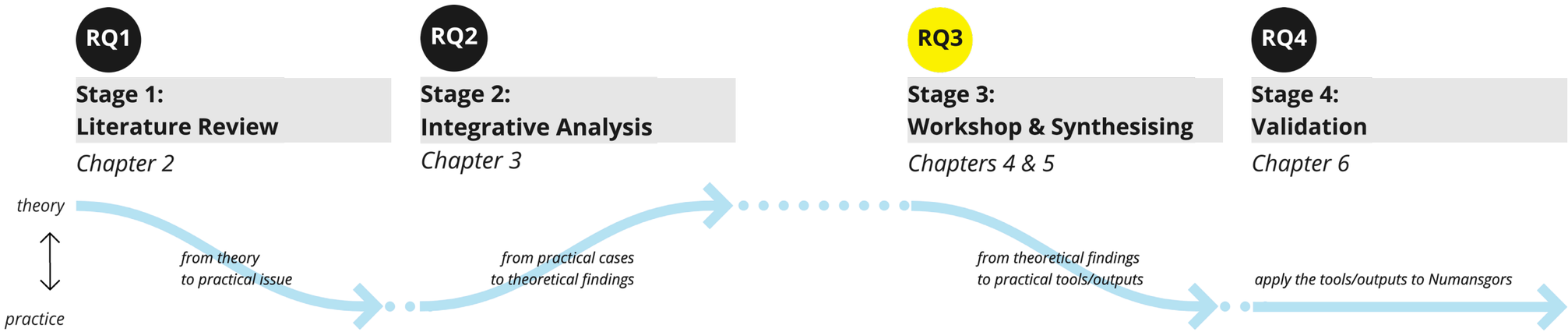


figure 1.6 An overview of the research questions, corresponding stages and report chapters

At the beginning, to gain a better view of the topic, a literature review on the pattern language theory (PLT) is performed. This literature review helps confirm the importance to investigate different approaches of using PLT and finally sets the project focus on "approaches". The concept of PLT, the benefits and purposes to use PLT summarised in this stage also contribute to the formulation of the project outputs.

Next, to understand the different approaches, an integrative literature review is performed on 46 cases that have applied PLT. The integrative literature review examines the commonalities and differences between various PLT approaches. The "how" and "why" of these different PLT approaches are concluded and are concretised into several tools which contribute to the final project outcomes. A simple categorisation of the activities in various PLT approaches is also summarised from this stage, which is later modified.

In the third stage, workshops are organised to gather inspiration on how the theoretical findings can be used in practice. Insights from the workshops are later synthesised into the requirements for the final output and its structure. The insights also help refine the findings from the previous stages.

Afterwards, based on the requirements and structure, the final output is formulated by synthesising the the refined findings from previous stages.

Finally, a case study is performed to confirm the suitability of PLT in supporting Numansgors. A series of desk research and field research is performed and analysed for this case study.

As the case study shows that the situations in Numansgors can be supported by PLT, the Numansgors project is used to validate the Activity Kit. Practical suggestions for Numansgors are generated in this process. Limitations of the Activity Kit, as well as recommendations for further research are reflected on.

1.6 Contribution

This project was expected to generate three-fold contributions.

In the first place, the research and theoretical outputs can inform **academia** with a new lens to examine PLT cases. Future researchers can base on the classification of PLT approaches provided in this project, to deepen their understanding of PLT and hence promote its application in diverse domains.

For **practitioners**, this project outputs a practical guide to using PLT more effectively. This guide aims to support decision-making on PLT approaches. As this guide is generated by studying cases from diverse disciplines, it is universally applicable rather than only useful for any single domain.

In addition, this project will be the starting point for executing PLT in the **Numansgors** project. By using the guide generated from theoretical research, insights on using PLT in Numansgors can be generated. Besides, it may also inform similar projects in other locations, as practitioners and researchers start developing the pattern language for renovating houses.

1.7 Summary

1. The objective of this project is to provide instruction for practitioners to decide on the approach to using PLT.

2. Four research questions have been formulated to achieve this objective:

Research Question (1)
What is Pattern Language Theory?
a. What are the benefits of it?
b. What are the purposes of using it?

Research Question (2)
How is pattern language theory applied?
a. What are the components of a PLT approach?
b. How are the approaches different?
c. Why are the approaches different?

Research Question (3)
How can practitioners be supported in applying PLT?

Research Question (4)
How can the Numansgors project be supported in applying PLT?

3. This project is divided into four stages, each answering one research question. In the following report, to signify which research question is being answered, this visualisation (figure 1.7) is used as a progress bar on the start page of each chapter.

☆ *The star indicates the research question to be answered.*

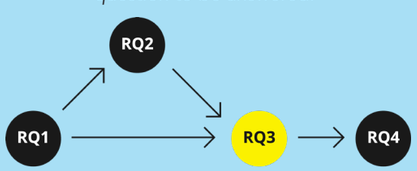
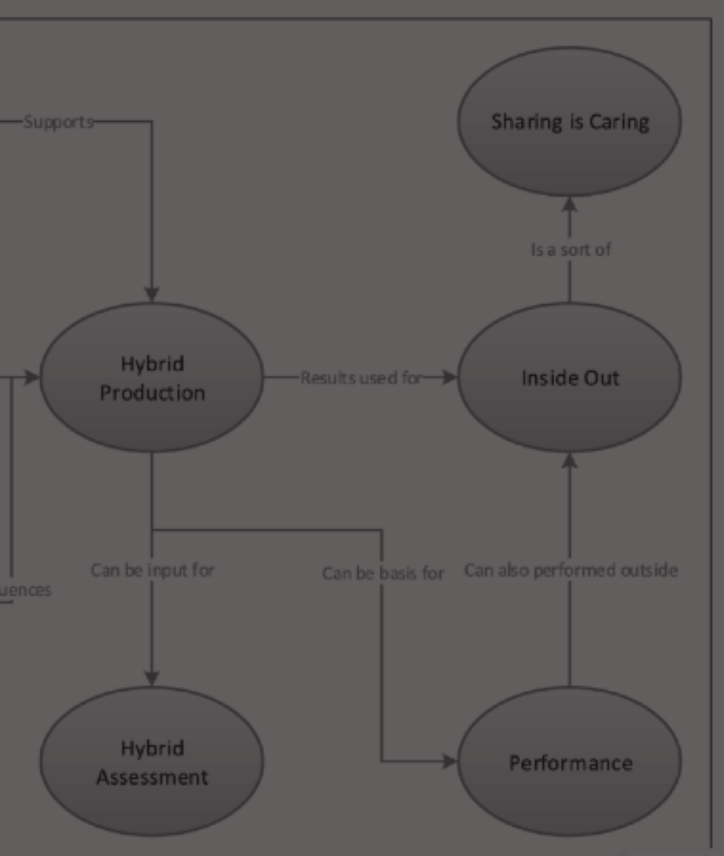


figure 1.7
The visualisation of report progress used in the following chapters



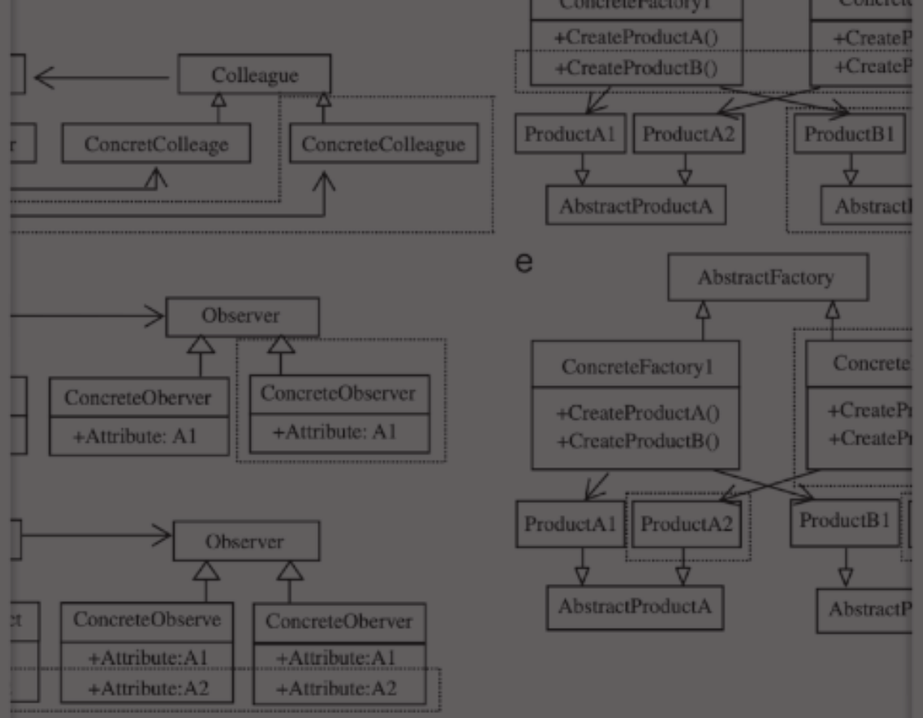
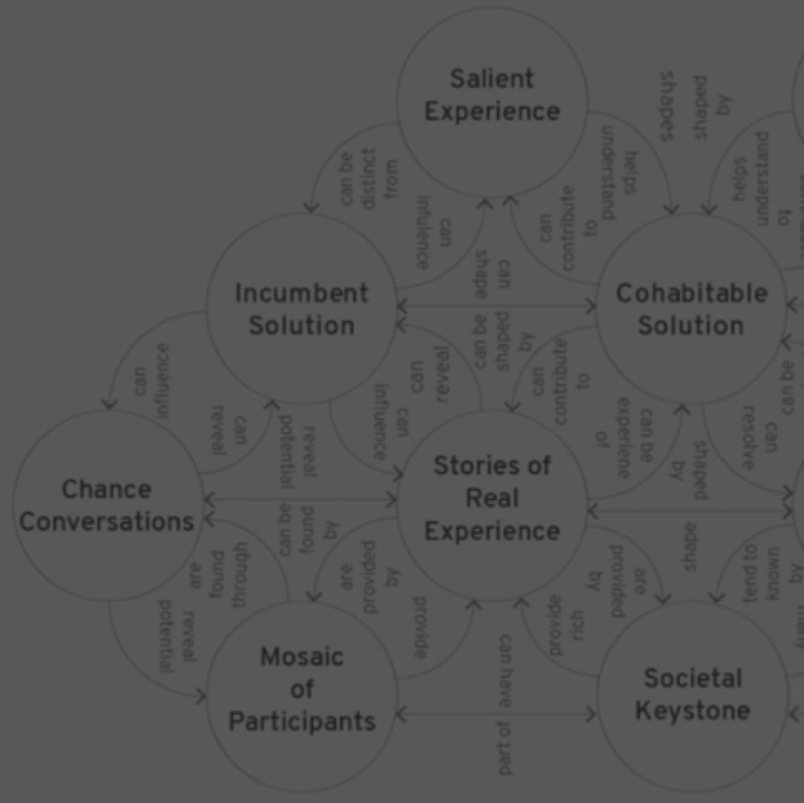
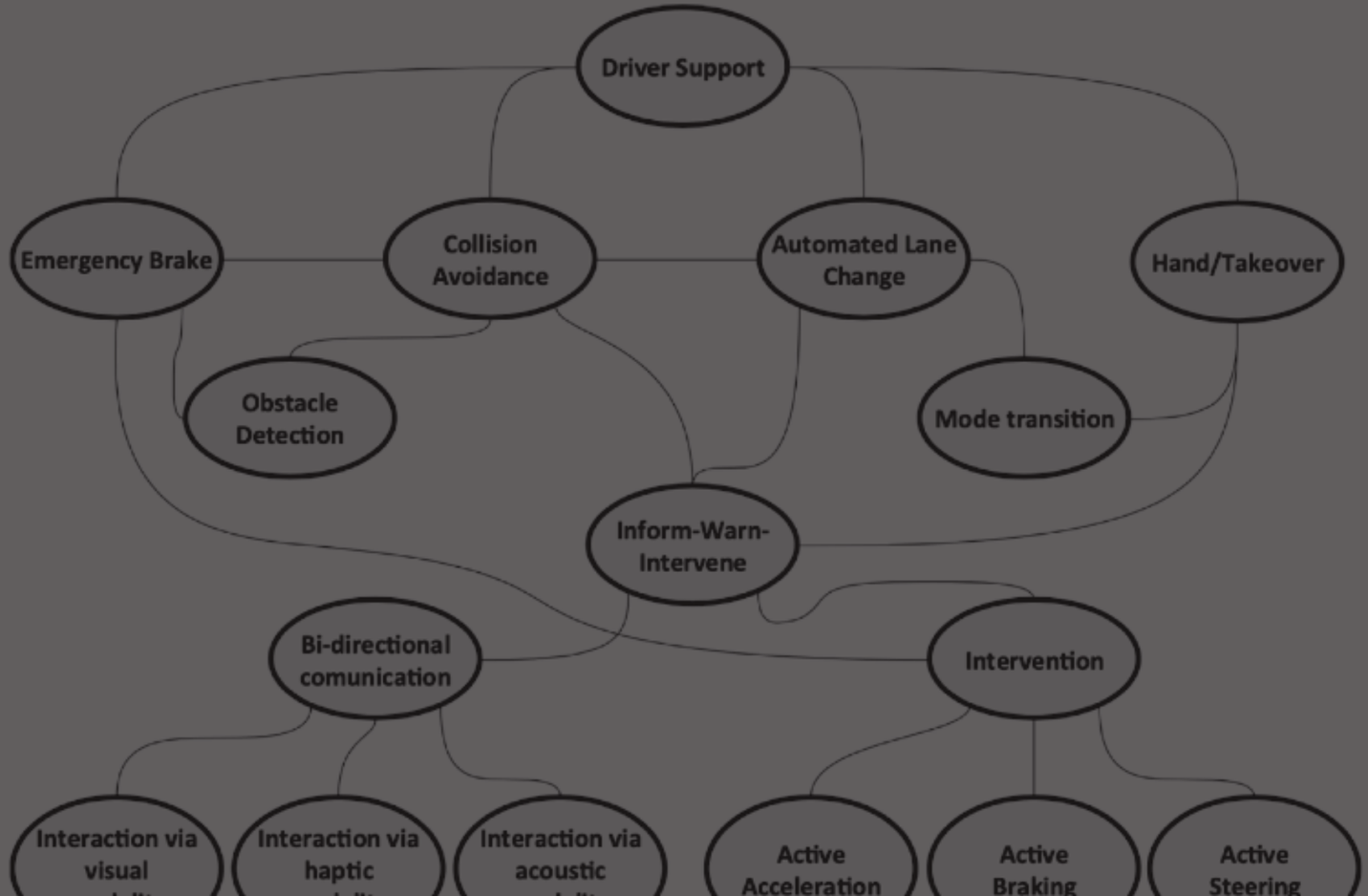
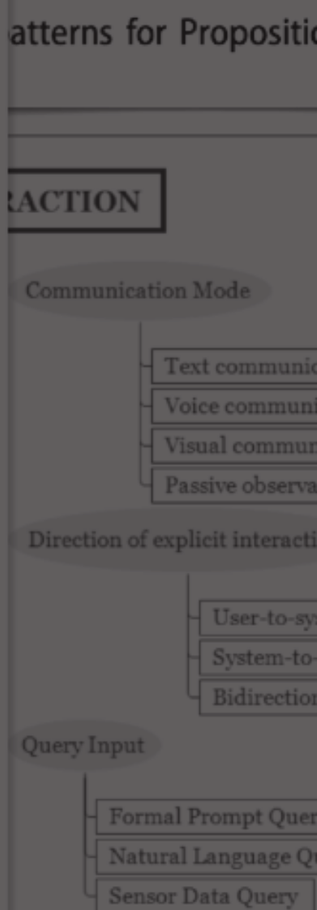
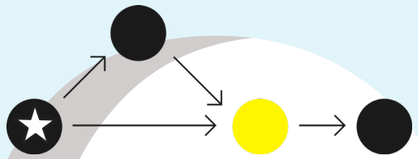


Fig. 5. Classification of possible evolutions.









Literature Review

This chapter presents the literature review insights on the pattern language theory (PLT), which shows an overview of the research field and helps define the project focus.

The concept of Pattern Language Theory is first introduced to present the topic overview. The benefits of PLT and the purposes of using PLT have been identified. In addition, the project focus on different PLT approaches is confirmed through the literature research.

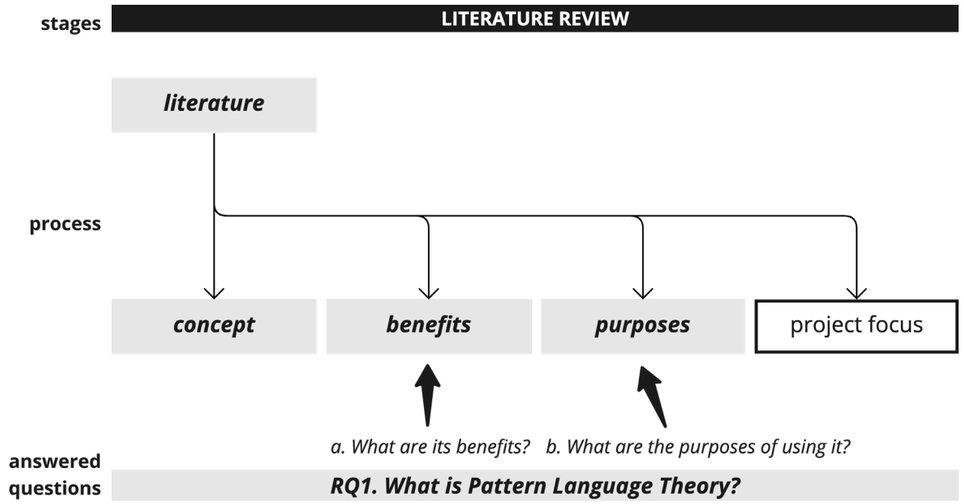


figure 2.1
Chapter 2 overview

2.1 Pattern Language Theory

As an effective method to present an overview of the research field (Snyder, 2019), a literature review was performed on Pattern Language Theory. For the literature review, the search strings involve ("pattern language" AND ("process" OR "implementation") OR "review"). The search was performed on Google Scholar, with access to Google Books, Elsevier, Springer, IEEE, ACM digital library, and Wiley online library. The references provided by each document were checked for snowball sampling (Wohlin, 2014) and some relevant documents were also added to the sample for selection. After removing duplicates, the titles, abstracts and keywords were checked again to filter and classify the documents.

Documents specifically focused on the ***application*** of the pattern language theory were collected in one sample group. An overview of this literature sample can be seen in Appendix A. In addition to The Oregon Experiment (1975) by Alexander, this reviewing sample involved 45 documents including 7 books, 35 papers, 2 master thesis and 1 doctoral thesis. The scopes of the sample documents include architecture, urban design, policy-making, business upgrading, sustainability, software engineering, interaction design, and service design.

Other reviews or criticisms focused on the ***theory*** were singled out and reviewed respectively.

The pattern language theory, simply put, is a design methodology that enables people without the expertise to make decisions for a complex system, such as the urban planning of a community, the design of a service etc. It was proposed by Christopher Alexander initially for the urban design domain in the 1970s. To clarify the important concepts first, this section presents (1) the concept of *Pattern*, (2) formatted pattern, (3) the relations between patterns, (4) the concept of *Pattern Language* and (5) the *Pattern Language Theory (PLT)* step by step. Along with each topic, an example related to making chocolate chip cookies is given for ease of understanding.

2.1.1 Pattern

The concept of “pattern” was not specified in Alexander's trilogy (Alexander, 1979) but was embodied with examples. Since then, a number of definitions have been given by various researchers. To name a few here:

> *"A pattern describes possible good solutions to a common design problem within a certain context, by describing the invariant qualities of all those solutions (Tidwell, 1999)."*

> *"A Pattern is a discovered solution that has been tested for some time, and under varying conditions (Salingaros, 2000)."*

> *"... a structured description of an invariant solution to a recurrent problem in context (Dearden & Finlay, 2006)."*

> *"A pattern is a concise discussion of a solution to a problem in some area of focus. Further a pattern contains suggestions about how to think about solving a problem and the actions needed (Schuler, 2008)."*

In these definitions from literature, three elements were found common, including *the invariant*, the *solution*, and a *recurring problem*. Therefore, I synthesised these three elements into this definition:

> ***A pattern is (1) the invariants in (2) the solutions to (3) a recurring problem.***

"Invariants" means what does not change or always exists. "The solutions" refers to all the tried-and-true practices. "A recurring problem " refers to a problem that repeatedly happens in a certain context.

For example, many homes of a community are concerned with the high energy cost. This common concern is hence a recurring problem in this community context. The solutions to this problem provided by different consultants may vary in detail, but there must be something common among them. For example, improving isolation is recommended by all the consultants. Therefore, we can summarise such a pattern: improving isolation can help reduce energy cost.

2.1.2 Formatted Pattern

A pattern can be concretised into an artefact (Alexander, 1979) which is tangible and concrete, in contrast to e.g. a saying or a "suggestion", which is elusive and intangible.

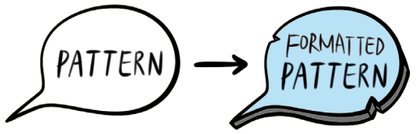


figure 2.2
A formatted pattern is more tangible.

In trials of explaining this format to my fellows, I found "card" is an easy-to-understand expression. Therefore, for ease of understanding, I use “card” to represent the format of a pattern in this report. As recommended by Alexander, a pattern usually consists of the elements as shown in figure 2.3.

1. **Name**: an evocative name
2. **Visual**: a visualisation of the pattern
3. **The context**: the context in which this pattern is applicable
4. **The problem**: a brief statement of the problem
5. **The forces**: the (conflicting) factors that shape the problem
6. **The solution invariant**: the essence of the best solution
7. **Related pattern**: the patterns that should be solved earlier, and the patterns that can be solved afterwards
8. **References**: validated examples of the pattern

figure 2.3
A format of a pattern usually consists these elements, adapted from (Alexander, 1979)

For ease of understanding to people from different disciplines, I took making chocolate chip cookies as an example. Here is a pattern summarised from Grandma's solutions for how much chocolate should be added:

recurring problem → How much chocolate to add

solutions vary in different contexts → Grandma gives a different number each time.

but there is an invariant → Each time Grandma tries maintaining the texture of the basic dough.

This pattern can be formatted into a card as adapted from (Wikipedia contributors, 2022) in figure 2.4.

Pattern Name: *ChocolateRatio*

Context: You are baking chocolate chip cookies in small batches for family and friends. You have finished the basic dough with sugar, flour and egg and you are ready to add chocolate to the dough.
Consider these patterns first: *SugarRatio*, *FlourRatio*, *EggRatio*
Problem: Determine the optimum ratio of chocolate chips to cookie dough
Forces: Most people consider chocolate to be the best part of the chocolate chip cookie. Also that too much chocolate may prevent the cookie from holding together, decreasing its appeal. Since you are cooking in small batches, cost is not a consideration.
Solution: Therefore, use the maximum amount of chocolate while maintain the dough texture you already achieved with *SugarRatio*, *FlourRatio*, and *EggRatio*.
Consider next: *NutRatio* or *CookieDough*

figure 2.4
A formatted pattern for how much chocolate to add.

2.1.3 Relation between Patterns

The 7th item in the pattern format (figure 2.3), related patterns, signifies the interrelations between individual patterns. Two common relations are:

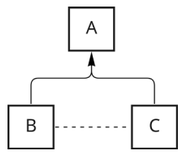


figure 2.5
two common relations between patterns

1. A requires B: *To fulfil Pattern A, Pattern B needs to be fulfilled first. Also addressed as A "uses" B (Noble, 1998), or B "refines" A (Porter et al., 2005).*

2. C complements B: *Pattern C and Pattern B complement each other (in fulfilling Pattern A). Also addressed as C "refines" B (Noble, 1998).*

As for the chocolate cookie example, the other patterns related to the *ChocolateRatio* pattern (figure 2.4) can be visualised as such in figure 2.6:

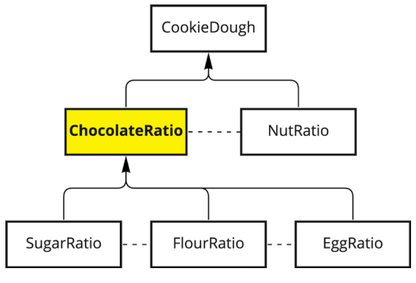


figure 2.6
ChocolateRatio Pattern and its related patterns

2.1.4 Pattern Language

A series of such related patterns together formulate a "pattern language". In other words, a pattern language is a network of patterns. Or by the definition given by Alexander, Pattern Language is a system of patterns (Alexander, 1979).

With each pattern solving one problem, a complete pattern language can solve a series of recurring problems in a complex system because of the connectedness of patterns (Schümmer & Lukosch, 2007). Based on some learnings about cookie-making and the example adapted from (Wikipedia contributors, 2022), I made an overview of the complete pattern language for making chocolate chip cookies (figure 2.7).

The ***ChocolateChipCookies*** pattern on the top is the ultimate pattern that the whole system aims to realise. To achieve this ultimate pattern, multiple scales of smaller patterns need to be realised systematically.

Although this pattern language is presented in a pyramid structure, the relations between patterns are not strictly hierarchical. For example, the ***FreezingMethod*** pattern both contributes to the ***CookingTime*** pattern and directly contributes to the ultimate pattern ***ChocolateChipCookies***.

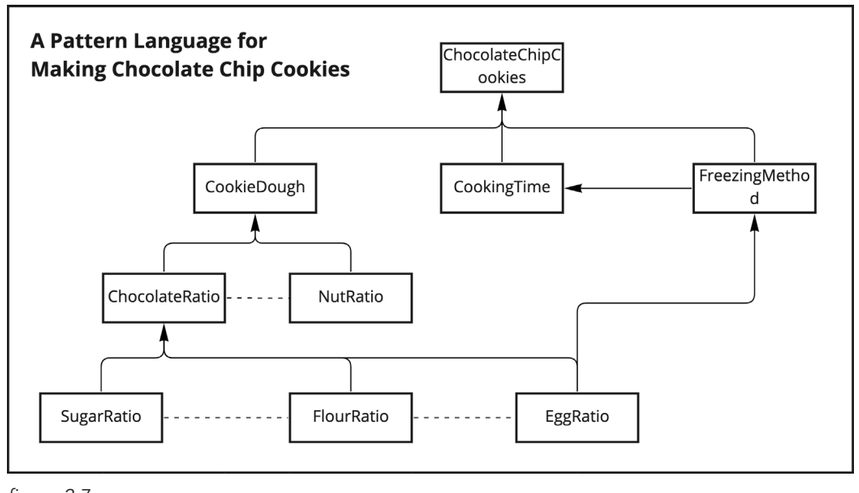


figure 2.7
A pattern language for making chocolate chip cookies

2.1.5 Pattern Language Theory

PLT is elaborated by Alexander through his famous pattern language trilogy in the 1970s. In *The Timeless Way of Building* (1979), Alexander explains the concept and rationales of PLT. In A Pattern Language (1977), a pattern language consisting of 253 patterns for urban design and architecture — ranging from town-scale to building-scale — is presented. Finally, in The Oregon Experiment (1975), Alexander presents the campus planning process of the University of Oregon as a demonstration of using PLT for design.

Pattern Language Theory (PLT) is basically the methodology making use of patterns and pattern language. It was proposed by Alexander Christopher for participatory design in urban planning to study existing human-pleasing designs. People can analyse how the "human-pleasing" quality is achieved (figure 2.8) by concretising insights into patterns. Then by replicating the individual patterns and their connections, people can replicate that quality to a new design.

In addition to the capacity to deconstruct and re-build the quality of a good design, Alexander also created PLT for its power to engage end users. Before the theory of pattern language, traditional urban design takes a master plan approach. Since end-users cannot understand a professional master plan, they are excluded from the design process. This deprives end users of the opportunity to express their real needs. The users are therefore losing control and the sense of ownership of their habitats. In addition, reading a master plan resembles reading the site from god's view (figure 2.9). An urban planner easily ignores the nuanced, subtle interaction and ever-changing life details of individuals from such a perspective.

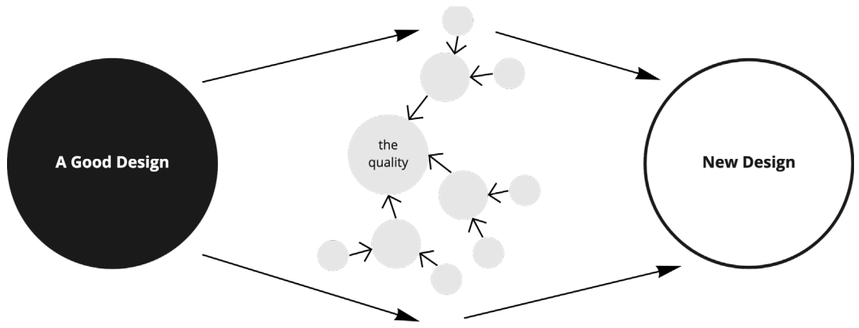


figure 2.8 use pattern language to deconstruct and reconstruct a good design

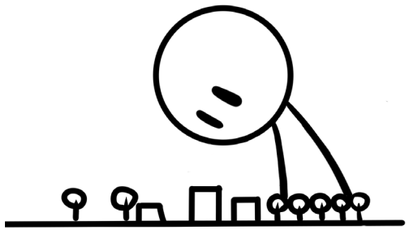


figure 2.9 In a master plan approach, an urban planner read the site from god's view and losing details of people's life

On the contrary, PLT can engage end users. First, a formatted pattern makes construction knowledge more understandable, which allows end users without the expertise to get involved. Second, as a pattern language contains patterns at scales from detail to the whole (figure 2.10), local and detailed acts can be taken more care of by using the smaller patterns.

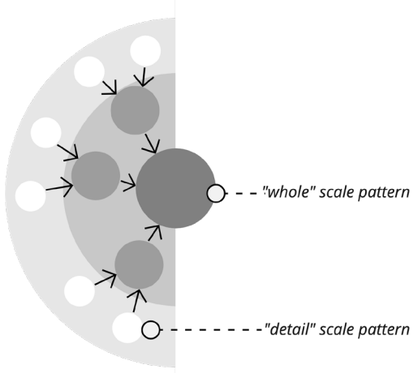


figure 2.10
a pattern language contains patterns at different levels — from detail to wholeness

After understanding what is Pattern Language Theory, practitioners would wonder how is this methodology helpful for them.

In the following pages, sections 2.2 and 2.3 collectively give an answer on the benefits and purposes of using PLT. In section 2.4, the issue about PLT's diverse but unreasoned approaches is confirmed.

2.2 Benefits of PLT

figure 2.11
relation between PLT, its benefits, and practitioner's purposes

In this project, the direct advantages produced by the characteristics of PLT are addressed as its "benefits". The project goals that could be achieved with PLT are addressed as "purposes". The relationship between the benefits and the purposes used in this report is visualised in figure 2.11. The purposes that can be achieved with PLT will be elaborated on in the next section (2.3). In this section, the benefits of PLT are introduced.

PLT's benefits can be attributed to the ***concreteness*** brought by the format of individual patterns and the ***generativity*** brought by the relations between patterns (Khambete, 2013). First, the format of patterns helps externalise tacit/abstract knowledge into a concrete artefact, either as a card or a website etc. The use of "evocative" pattern names (Alexander, 1975), problem and solution descriptions can clarify a piece of knowledge in depth. Second, the relations between patterns can connect fragments of knowledge into a coherent and generative whole, as patterns are not existing in isolation, but are embedded in a complex system.

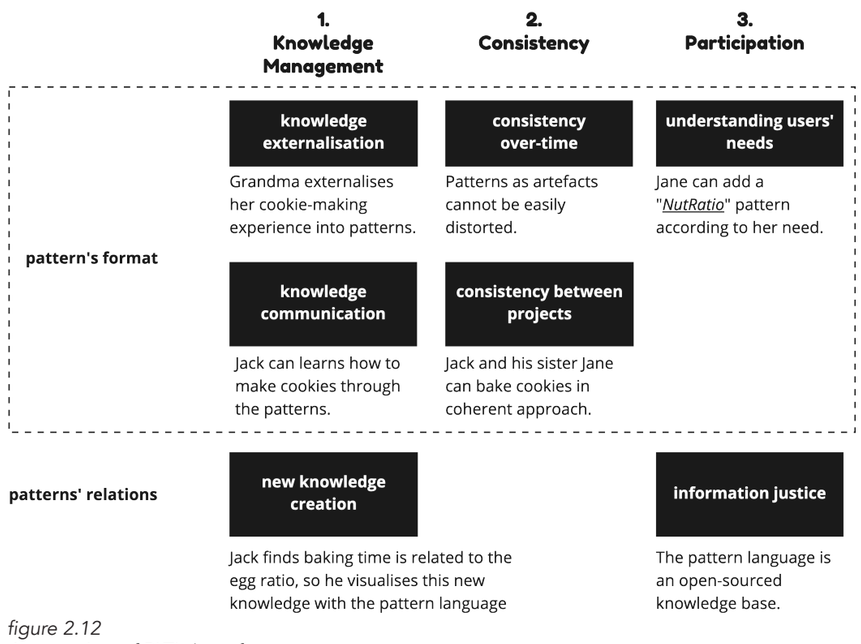


figure 2.12
An overview of PLT's benefits
One simple example related to chocolate cookies is given for each benefit.

Although the concreteness and generativeness together can amplify the power of PLT when tackling complex systems, patterns can also be used in isolation to solve simpler problems. For example, a user may use the solution in one pattern for one question but does not further explore other related patterns/ problems. In fact, it is already common for a designer to look for existing design solutions online or from competitors.

Based on the literature review, three categories of PLT's benefits have been manifested in various cases, involving (1) promoting knowledge management, (2) promoting consistency, and (3) favouring the participation of end users. An overview of the benefits and simple examples about chocolate chip cookies are given in figure 2.12.

Among these, PLT's benefits for knowledge management and consistency are more mentioned in the diverse cases. While the benefit for participation seems optional, depending on the willingness of practitioners to involve end users. These three benefits are detailed as follows.

2.2.1 Knowledge Management

In terms of knowledge management, PLT is helpful in externalising knowledge, communicating knowledge, and facilitating the production of new knowledge.

First, the format of a pattern provides a medium for experienced individuals to externalise their tacit knowledge — or even personal experience — into explicit and tangible words without losing its essence (Köppe et al., 2017; van Welie & van der Veer, 2003; May & Taylor, 2003; Iba, 2014). This process of translating knowledge into a formatted artefact is often termed "mining" a pattern (Iba, 2014). When a practitioner tries to dismantle knowledge into elements including context, problem, forces, solution, related patterns etc., that are informal and easy to comprehend, conveying knowledge hence becomes

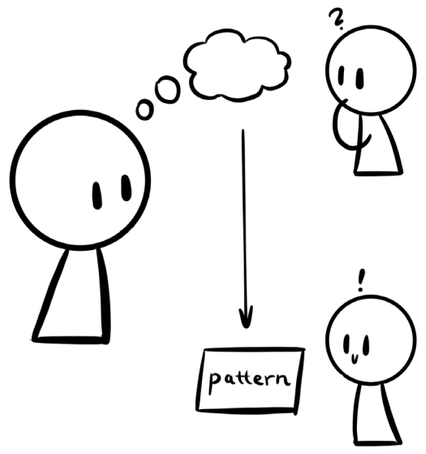


figure 2.12
PLT for knowledge externalisation and communication

easier (May & Taylor, 2003). The relations between patterns even allow practitioners to output knowledge systematically into a network (van Welie & van der Veer, 2003).

Second, patterns can be used as a currency of knowledge (Miller, 1956; Iba, 2014). Without repeating complicated details, stakeholders can recall and directly refer to a certain piece of knowledge by the pattern's name (Borchers, 2008; Van Welie & Van der Veer, 2003; Erickson, 2000). It is also generally acknowledged that patterns help multidisciplinary collaboration, both inside and across teams (Borchers, 2000; Erickson, 2000).

Third, the relations between patterns allow a pattern language to be ever-growing. Compared to the knowledge distributed in a book, patterns can be listed/dumped together in a more visual way. Therefore, spotting the linkings in between becomes easier (Köppe et al., 2017).

2.2.2 Consistency

Using PLT can promote both the consistency over time and the consistency between teams or between projects.

When a project spans a long period, the right of decision-making may be handed over between multiple stakeholders (Palmieri et al., 2021). In this process, spoken contents may lose their original meanings. In this case, a pattern language can act as a heuristic or design principle that is acknowledged by most stakeholders (Alexander, 1979).

2.2.3 Participation of End Users

PLT can facilitate the understanding of end users and promote information justice in decision-making.

Although interviewing end users for their needs has become a sure go-through in most projects, there is a need to prevent interviewers from a genetic or condescending understanding of users' life which actually is more nuanced (Palmieri et al., 2021). Compared to traditional design languages developed by professional communities, the pattern language can be co-created by end users (Alexander, 1977). The insights from end users can therefore be retained as authentic and original.

As a pattern language allows open access of all stakeholders, social justice in information sharing can be promoted. For any non-professionals interested in improving their own environment or system, the pattern language can act as an open-sourced knowledge base. People can adapt the patterns to their situations or even add new patterns.

2.3 Purpose of using PLT

The purpose of using PLT means what users can achieve with PLT. The original purpose proposed by Alexander in architecture and urban planning is to study and copy the human-pleasing quality from existing good designs (Alexander, 1979; Khambete, 2013). However, this purpose is a bit abstract for practitioners not in design domains. Therefore, I summarised from the literature of more specific project purposes that could be achieved with PLT, as listed in Table 2.1.

Simpler ↑	
1	Looking for an overview of a domain.
2	Looking for reusable solutions/measurements to diagnose or make decisions for the current situation.
3	To create a toolkit for participatory (design) project.
4	To identify and externalise reusable solutions from past project experience.
5	To understand needs or externalise knowledge of stakeholders (and retain the authenticity of these insights throughout the project).
6	To elicit visions from stakeholders (and retain the authenticity of these visions throughout the project).
7	To identify future research priorities.
8	To build an ever-growing knowledge database for a domain.
↓ *More Complex*	

table 2.1
Eight common purposes to use PLT

The purposes that can be achieved with PLT can be small as "to use a pattern to solve a problem", or can be large as "to build a knowledge database for a domain". These purposes are sorted from lower to higher complexity in Table 2.1. The detailed purposes and their sources are as below.

1. To gain an overview of a domain.

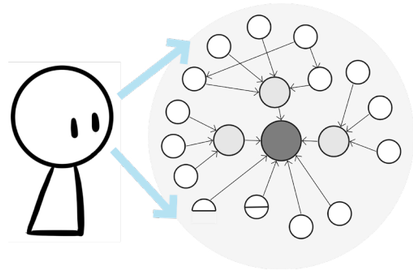


figure 2.13 purpose1

As can be seen from the chocolate cookie example, a complete structure of the pattern language presents an overview of all relevant problems that need to be solved to achieve the final pattern. Other researchers such as (Khambete, Roy & Devkar, 2015) and (Salingaros, 2000) also agreed on this purpose.

According to (Salingaros, 2000), in the design of a complex system, a pattern language provides practitioners with a way to ***understand*** the system. (Khambete, Roy & Devkar, 2015) addressed that a pattern language as “a design framework” with which a coherent roadmap can be made clear to everyone.

2. To find individual reusable solutions to diagnose/evaluate or make decisions for the current situation.

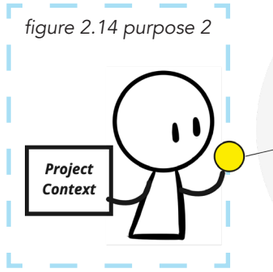


figure 2.14 purpose 2

According to Alexander, any individuals can pick the patterns that they resonate with from A Pattern Language (Alexander, 1977). The picked patterns can be directly used in designing or improving an individual's home (Alexander, 1979) or other systems (Salingaros, 2000).

A pattern can present an example to show what is a quality solution and serve as a prescriptive guideline or reference (Bayle, et al. 1998; Khambete, 2013). Individual patterns can also be used to evaluate a design (Wesson & Cowley, 2003; Pauwels et al., 2010).

3. To create a lingua franca/toolkit for a multidisciplinary/participatory (design) project.

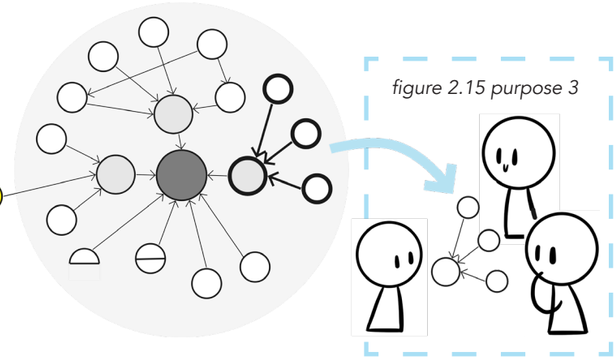


figure 2.15 purpose 3

Multidisciplinary teams can use part of a pattern language that is relevant to their project scope to facilitate communication (as a "lingua franca") among experts and end users (Erickson, 2000; Borchers, 2000; Khambete, 2013; Granlundet al., 2001).

4. To identify and externalise reusable solutions from past project experience.

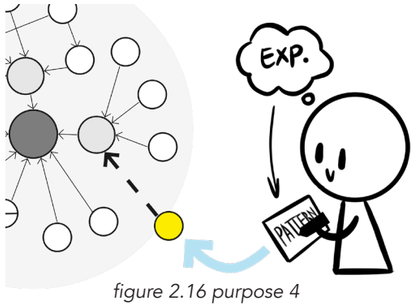


figure 2.16 purpose 4

Formulating a pattern is a way to study an existing solution and make it accessible to others (Bayle, et al. 1998). Moreover, the format of a pattern leads users of it to recall their personal experience (Linsey et al., 2007) in a more systematic way.

5. To understand needs or externalise knowledge of stakeholders (and retain the authenticity of these insights throughout the project).

Patterns can capture situated, contextual or even personal wishes in an authentic and systematic way (Bayle et al., 1998; Palmieri et al., 2021).

6. To elicit visions from stakeholders (and retain the authenticity of these visions throughout the project).

Designers can carry out experiments by creating and iterating patterns (Schön, 1983). In participatory design, patterns and pattern templates could be used for requirement elicitation (Wesson & Cowley, 2003). Existing patterns can be used to visualise the possible impacts of a decision (Bayle, et al. 1998).

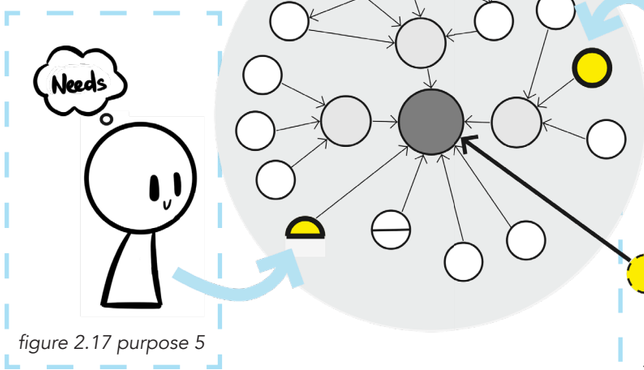


figure 2.17 purpose 5

In addition, a pattern language can also be helpful for researchers:

7. To identify future research priorities.

Among patterns, researchers can identify which solutions to the problems still await updating or improvement. Within a network, researchers can also identify whether new patterns are required to complement the pattern language.

All the purposes above can collectively promote the development of a whole discipline, as for the broadest purpose:

8. To build an ever-growing knowledge database for a domain.

figure 2.18 purpose 6

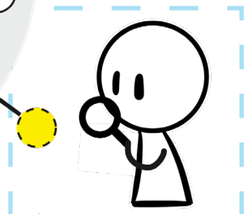


figure 2.19 purpose 7

2.4 The Issue of "Approaches"

As a design methodology, PLT has successfully informed the architecture and urban planning. In addition, various fields, including software engineering (Kent & Ward, 1987), interaction design (Avgeriou et al., 2003), computer science (Vaishnavi, 2007), interface design (Tidwell, 2010), web design (Qian, Chen & Woodbury, 2007; van Welie, 2010), computer-mediated collaboration (Schummer & Lukosch, 2013), knowledge management within an organisation (May & Taylor, 2003), service design (Khambete et al., 2015), and business (Granlundet al., 2001, August) etc. have acknowledged the use and benefits of PLT. **With PLT being applied in broadening domains, the original approach taken by Alexander has been more or less changed.**

The first common change is in whether ***end users*** of the design are involved in the decision-making process, or only ***experts*** are involved. For example, in the original PLT approach followed in The *Oregon Experiment*, end users initiate and design a project themselves (Alexander, 1975). While in software design such as in (Borchers, 2008), patterns are used by software developers, while end-users are not involved anymore.

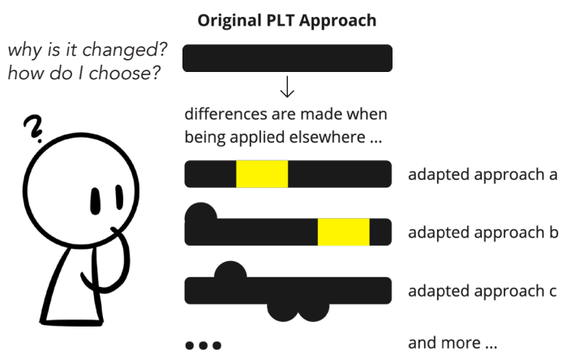


figure 2.20
practitioners get confused at unreasoned changes to the original approach

Another common change to the original PLT approach is that the patterns used in *The Oregon Experiment* were all mined from empirically proven practices (Alexander, 1977). Much criticism is against this over-focus on ***empiricism*** or replicability (Dawes & Ostwald, 2017; Palmieri et al., 2021) while shutting up the possibility of creating ***new*** practices (Saunders, 2002; Stark & Schümmer). Criticisms of this type further argue that designs produced from traditional patterns do not have transformative power (Broadbent, 1980; Protzen, 1980; Dovey, 1990; Lang, 1994). Some recent PLT applications have echoed this criticism and are using newly created based on visions patterns instead of the empirically tested ones. For example, in (Palmieri et al., 2021), instead of repeating the existing patterns of community dwelling policies, residents collaborated to produce new dwelling patterns according to their own wishes. These visionary patterns allow end users to challenge the dominant and promote industry transformations (Bhatt, 2010; Dawes & Ostwald, 2017; Dovey, 1990).

In addition, Alexander did not explain the ***development*** of *A Pattern Language* but gave more emphasis on the ***use*** of it (Alexander, 1975; 1977; 1979). The development seemed merely a preparation for the use process. While in some recent cases, the development process is being more emphasised. For example, in (Palmieri et al., 2021), the development process is taken as a way of user research, through which end users' needs and wishes were elicited. Another example was raised by (Schön, 1983), who consider the development of patterns can act as an experimentation.

However, differences as such generally go unarticulated, and their basis is often not well grounded. Whether a difference is an unintentional mistake or intentional for a certain reason is unknown. **Without the right reason to choose different approaches, the users may apply PLT in an inferior way**, which would hence decrease its value. For example, it is argued that PLT has been long misused in the HCI domain (Wania & Atwood, 2009). Instead of focusing on results, the HCI domain should focus on the process of using patterns. The result of such misuses, according to Wania and Atwood, is the reduced effectiveness of PLT in HCI. Therefore, to assure that practitioners can use PLT effectively, there is a need to clarify the reasons for different PLT approaches. Research for differentiating and reasoning PLT approaches is then planned and detailed in the next chapter.

2.5 Summary

Answers to Research Question (1)
What is Pattern Language Theory?
a. What are the benefits of it?
b. What are the purposes of using it?

1. PLT is a design methodology making use of the concrete format of a pattern, and the generative power of patterns' relations.

2. PLT is beneficial to knowledge management, maintaining consistency, and promoting participation.

3. The original PLT in architecture and urban planning aims to create a quality design. More concrete purposes — ranging from using a single pattern to creating a knowledge base for the whole domain — can be achieved.

In addition, the literature review has confirmed the research focus on the "Approaches" to using PLT.

4. Many PLT application approaches differ from the original Alexandrian approach. However, the reasons for these differences are scarcely explained. Without qualified reasoning, PLT would be used less effectively.

5. Therefore, to help practitioners use PLT effectively, further research to clarify the reasons for different approaches is required.

make complex problem easier

create overview

create preview

reusable

communication between sciplines/non-professionals

expected benefits

identify new possibilities

coordination/consistency

information justice

empirical

visionary

format

the pattern language / patterns

created by users

created by experts

externally related

internally related

prepare

gather from ready-to-use knowle

professionals

develop

use

people

end users

supporting the activities / external tools

Integrative Analysis

Learned from the last chapter, different PLT approaches exist, but a systematic way to differentiate them is lacking. This may lead to an improper choice of the approaches, and hence result in less effective use of the PLT. Therefore, to help practitioners use PLT more effectively, this chapter aims to first ***differentiate*** the approaches.

First, to make approaches comparable (differentiable), their commonalities or common denominators need to be clarified. Through a coding and clustering process on the literature — which I called as "**deconstruction**" — four common components of PLT approaches have been made clear, allowing the approaches to be compared later.

Second, to describe the differences between two approaches, the variances of each individual component need to be made clear. Through another round of clustering — which I called "**identifying**" — the possible choices of individual components were identified and described with a set of dimensions.

Finally, the dimensions for individual components need to be synthesised to describe a complete approach. By clustering these dimensions — which I called "**reconstruction**" — two higher-level dimensions were generated. These dimensions have been refined into four tools (Chapter 4).

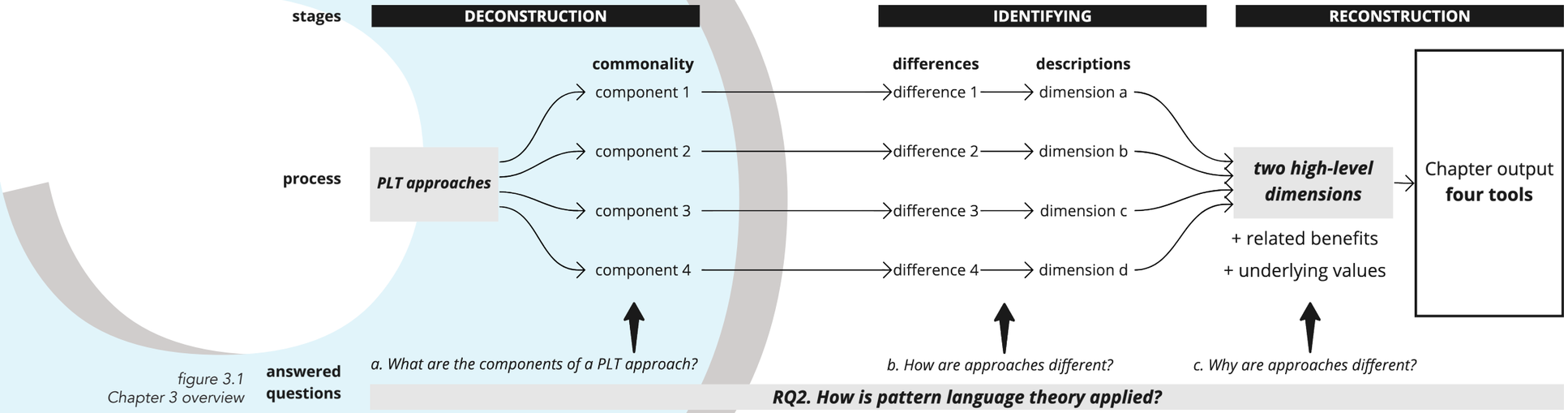


figure 3.1
Chapter 3 overview

Based on the literature review in the last chapter, approaches to using PLT differ. However, insufficient understanding on these differences can lead to an improper approach, and hence result in a less effective application of PLT. Therefore, to support practitioners to take an appropriate PLT approach, there is a need to differentiate the various approaches.

There have always been difficulties in clarifying how the PLT approaches vary. The alterations that various cases made to the Alexandrian PLT, such as in interaction design domain (Borchers, 2000) and software architecture design (Gamma et al., 1995; Golden et al, 2009), have been the subject of continuing discussions (Gamma et al., 1995; Golden et al, 2009; Gamma et al, 1995; Borchers, 2000). Even though these cases have traits that unmistakably point to the use of PLT, their approaches diverge from Alexander's.

There has been a body of literature investigating how PLT is used differently (Wania & Atwood, 2009; Pan & Stolterman, 2013; Dawes & Ostwald, 2017). Proposed solutions to deal with an approach that is different from the original Alexandrian approach mainly fall into two categories (figure 3.2), either by (1) coining new terms for the new approach, such as the "pattern catalogue" raised by (Salingaros, 2003), or (2) by disassembling an approach into a collection of smaller components for analysis. After disassembling, the source of the differences can be more easily identified and further studied (van de Vijver & Leung, 1997; Wirth & Kolb, 2004). Studies taking the second solution include (Lea, 1994) which captured the essential properties of an approach, (Meszaros & Doble, 1997; Birukou, 2010) which studied only one activity related to PLT, and (Athavankar et al., 2014; Köppe et al., 2017) which applied PLT by performing a series of individual activities.

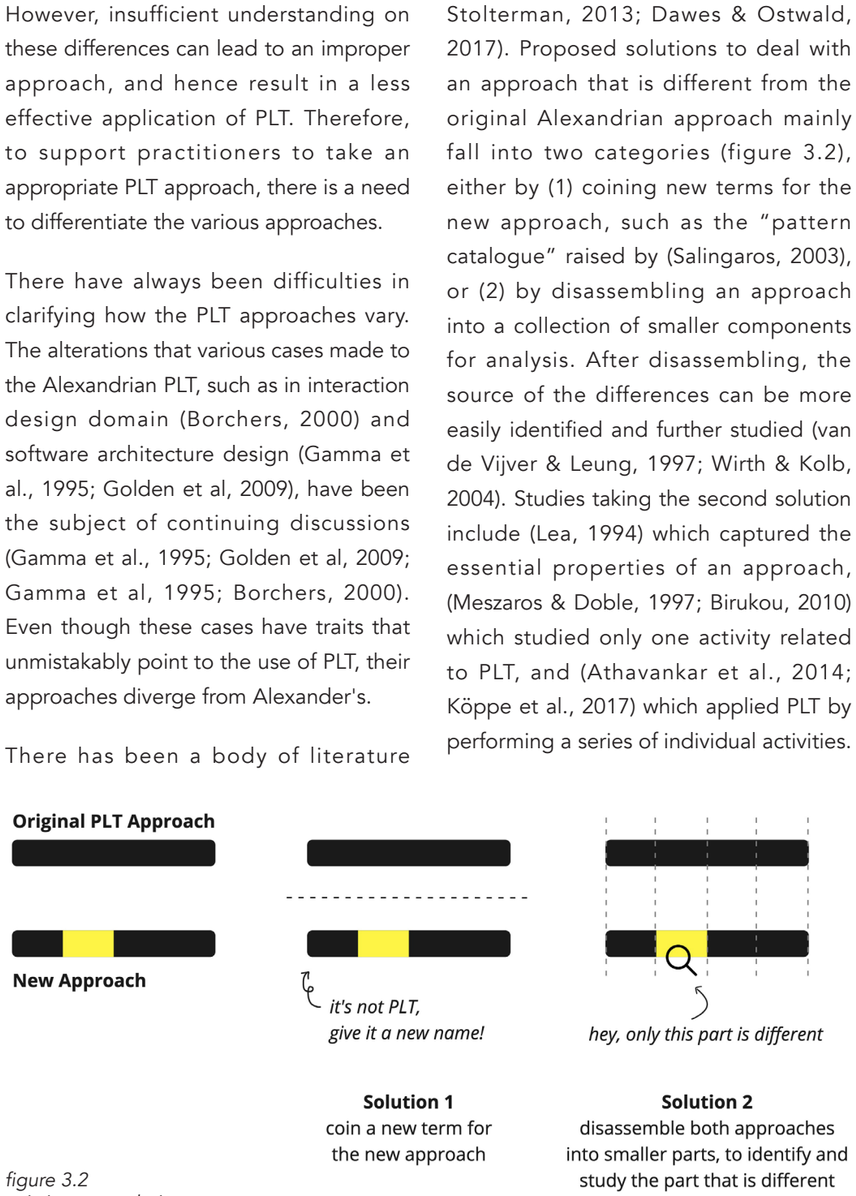


figure 3.2
existing two solutions to tackle new approaches

In this graduation project, I have no intention to coin a new methodology but would like to clarify the existing ones. Therefore, I also take the second solution — disassembling or deconstructing PLT approaches into a collection of simpler constructs to analyse them.

First, a ***deconstruction*** analysis aimed to break PLT approaches into smaller components, to make the approaches more comparable. Later, for each component, a set of initial dimensions describing its common variances were ***identified***. This was followed by a ***reconstruction*** process, in which the dimensions for describing individual components were combined to describe a complete approach. Finally, the two higher-level dimensions, with practitioners' expected benefits of PLT and underlying values, were documented into two tables, which were finally made into four theoretical tools.

The sub-questions of the second research question have been refined:

> ***Research Question (2)***
> *How is pattern language theory applied?*
> *a. What are the components of a PLT approach?*
> *b. How are the approaches different?*
> *c. Why are the approaches different?*

3.1 Deconstruction

First of all, to find out the common denominators of various PLT approaches, an integrative literature review on the 46 PLT application cases (see Appendix A) — which was called "***deconstruction***" — was performed.

3.1.1 Method

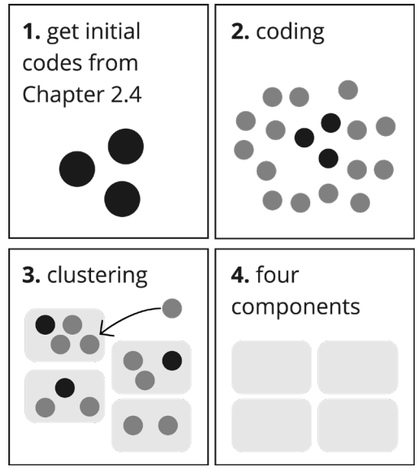


figure 3.3
the process of deconstruction

To make use of the previous findings (Fereday & Muir-Cochrane, 2006), the elements that repeatedly appeared in the previous literature review were taken as the initial codes for a deductive coding. In addition, to avoid being biased, other elements not overarched by these initial codes but related to how PLT was applied (methodology) were also coded in an inductive approach.

Later, the resulted codes were clustered according to their relevance. Four themes were generated from clustering,

which could represent the four common components of various approaches.

The deconstruction process was carried out on a Miro board. The details can be seen in Appendix B & C.

3.1.2 Initial Codes

In Chapter 2, three elements (***bold and oblique*** in section 2.4, page 26 & 27) have been found repeatedly mentioned in different approaches. Here is a brief recap of these three elements:

> ***1. End Users or Experts**: In the original approach by Alexander, end users were actively engaged to design for themselves. However, in software engineering and some other domains, end users are excluded while only experts are involved. Whether the end product is still human-pleasing for end users in such an approach is unknown (Borchers, 2008).*
>
> ***2. Empirical or New:** Alexander has strongly emphasised the value of PLT in reusing empirically proven solutions. However, as mentioned in Chapter 2, this has also incurred criticism for limiting the creation of new practices (Saunders, 2002). Some new approaches, therefore, use envisioned patterns to replace empirical practices in response. This difference often occurs in the domains that seek industrial evolutions, such as policy-making, or social changes for sustainability.*
>
> ***3. Use or Develop**: Using PL and developing PL are two divided activities in different approaches. Although in Alexander's approach, the development of a pattern language was more of a preparation for its use, in some other cases the development procedure has become more important than the using procedure. For example, when the development of a pattern language was taken as user research (Palmieri et al., 2021), or experimentation (Schön, 1983) etc.*

These three elements were taken as the entry point for deductive coding.

3.1.3 Results

The four themes resulted from deconstruction — representing the four common components in PLT approaches — are

> ***(1) Artefact**: the pattern language used in the application case,*
> ***(2) Activity**: the actions around the artefact,*
> ***(3) Role**: the people involved in the activities, and*
> ***(4) Tool**: the agencies supporting the activities.*

These four components are closely related to each other (figure 3.4). The Artefact can both inform and be informed by Activity. The "Role"s are involved in activities and influence the activities and artefact's characteristics. The "Tool"s can support the activities.

Component 1: Artefact

A pattern language is an artefact, often physical, such as cards, or virtual, such as websites etc. Although Alexander and some other developers published their pattern languages in a book form, Alexander recommended readers to make a copy of the patterns so that ticking,

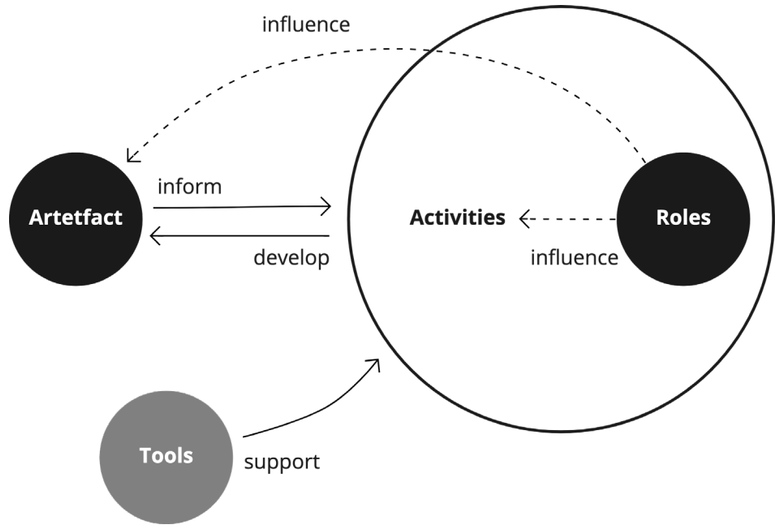


figure 3.4
relations between the four components

picking and referring to the patterns can be easier. Some pattern languages are documented on websites and provide ultra-links in between, such as *A Pattern Language for User Interface Design* (Experiences — A Pattern Language for User Interface Design, n.d.). According to (Khambete, 2013), a visualised format of pattern language can embody the connections between patterns and make it simpler for users to navigate across.

Component 2: Activity

It was found that all studies first and foremost clarified their approaches by introducing what activities were performed. Even though the combinations of activities were different in each project, the activities seemed the most significant component. In Alexander's pattern language trilogy, four activities around the pattern language can be identified, including developing a pattern language, and three ways of using pattern language, as shown in image:

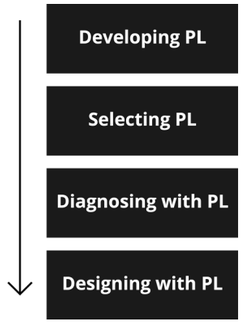


figure 3.5
four activities around PLT. Sorted by their appearance sequence in The Oregon Experiment (Alexander, 1975).

1. Developing the PL: Alexander did not specify how his colleagues and himself came up with the 253 patterns, yet the development of the pattern language is an indispensable activity. (Fincher, 1999) argues that the development of pattern language should be an intentional process. It involves mining the good practices and embodying them into formatted patterns. In some cases, the development of pattern language is taken as user research, since the process of development can elicit stakeholders' needs and wishes. For example, in (Palmieri et al., 2021), the wantings of the residents are elicited by co-producing dwelling patterns. (Khambete, 2013) also interviewed actual users of the service design touchpoints to understand their needs and translate the understanding into patterns.

2. Selecting PL for Project: The second activity suggested by Alexander is to select certain patterns from *A Pattern Language* to formulate a smaller pattern language specific to the target project (Alexander, 1975; 1977). This process is termed identifying patterns in (Athavankar et al., 2014). As there are usually a lot of patterns in a pattern language, this selection process can help exclude the ones not related to the project scope. This selection activity is often performed by a more professional group than the end users, such as the so-called "board" in *The Oregon Experiment* (Alexander, 1975). This can save all stakeholders from extra mental effort in Diagnosing and Designing activities.

3. Diagnosing with Pattern Language: Alexander recommends that after selecting the patterns, each pattern should be taken as a benchmark for designers to review/evaluate the current situations. One map can be used for each selected pattern to highlight where this pattern has been achieved and where not. With all such diagnostic maps, the whole situation can be better understood. In addition to the diagnosis before design activities, pattern language can also act as a mechanism to evaluate design outcomes (Wesson and Cowley, 2003; Pauwels et al., 2010).

4. Designing with Pattern Language: The most common activity around pattern language is to design or make decisions with it for the target system, involving generating solutions and detailing the solutions (Athavankar et al., 2014).

Component 3: Roles

For ease of reading, I classify the roles in a project into three groups, namely experts, professionals and end users, in terms of their relative expertise in the domain. These three groups can be involved or excluded in different PLT approaches.

1. Experts — the pioneers of the domain. This group is usually composed of researchers or senior designers that have the capacity of extracting methodologies from their practices. In Alexander's theory, this group corresponds to Alexander himself, as the advocate of applying pattern language. The experts usually have highest expertise, but sometimes do not have enough influence on the context (as seen in figure 3.6).

2. Professionals — the main practitioners of the domain, or the designers of a system.
This group is traditionally the sole functioning roles in a design/decision-making process. For example, the "full-time architects or planners" in *The Oregon Experiment* (Alexander, 1975, p35), the teachers as the designers of their curricula etc. The professionals are usually criticised for making the results idiosyncratic (Alexander, 1975, p30) when not involving end users.

Different professionals have different radius of influence sphere. For example, a professional working in municipality generally has more impact on the context than other professionals (as figure 3.6).

3. End users — the users of the system.
This group is traditionally excluded from the design process. For example, in Alexander's theory, the end users in urban planning are the inhabitants. In education domain, the end users of a course/ curricula are the students.

The end users can be engaged in a bottom-up approach, which is also what Alexander advocates for in his PLT trilogy. In such an approach, end users will be

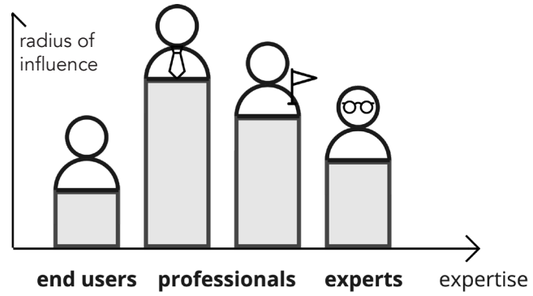


figure 3.6
Three types of roles involved in PLT approaches. Mapped according to their expertise and influence sphere.

able to input their insights and regain political power. However, the end users are still the minorities, who have the lowest impact on the context around them and often with the least expertise. At the same time, end users are most sensitive to any changes in the context.

Component 4: Tools

In diverse cases, various tools have been applied to support the PLT application. For ease of understanding, I grouped these tools according to their main functions. These functions also reflect the common difficulties encountered by practitioners when using PLT.

1. Tools for aligning: Some tools can help align stakeholders. In (Khambete, 2013, p173), researchers use a value system to present end users' goals and standards for a good design. By constantly reflecting on the value system, the researchers make sure the patterns are developed and used in line with end users' needs. In (Köppe et al., 2017), a "value based workshop"

was organised to identify stakeholders' common values. This helped stakeholders be able to make joint efforts in the other activities.

2. Tools for framing: Another type of tools is for framing or scoping in a project. In (Athavankar et al., 2014), a service blueprint was used to choose which touchpoints should be focused on in the project. In addition, prototypes in website design (Dearden et al., 2002), master plans in urban design (Alexander, 1975) and storyboards in service design (Dearden et al., 2002) can achieve the same goal.

3. Tools for making patterns: To translate knowledge into patterns, practitioners need to deconstruct their insights into items of information, such as the context, the problem and the solution etc. The pattern format can assist this process.

3.1.4 Conclusion

Based on the deconstruction results, each PLT approach is made up of four components. The differences between PLT approaches can be attributed to the differences in these four components.

To make it simpler, think of each approach as a fast food combo. Each combo consists of four items — a burger, a drink, a snack and a dip. These combos are different because of the differences in each item (figure 3.7).

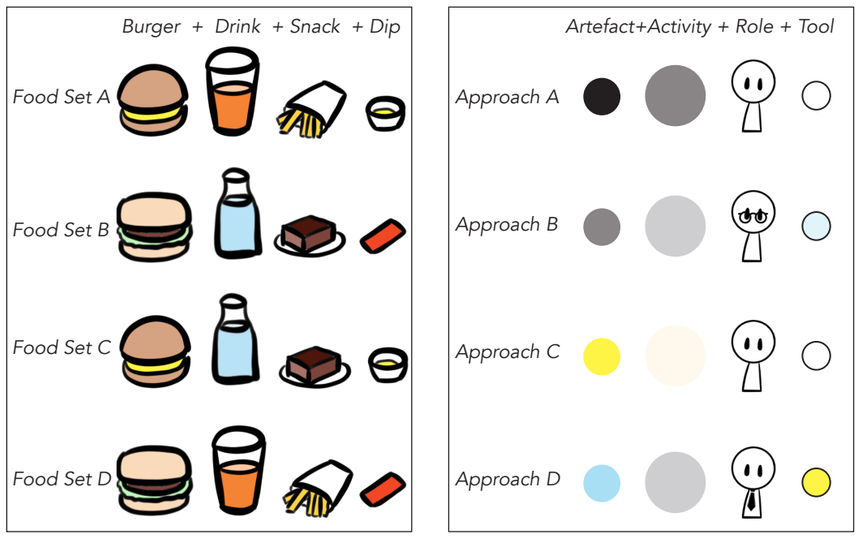


figure 3.7
Different food items result in different food sets.
In the same way, different components result in different approaches.

3.2 Identifying

Informed by the deconstruction results, a PLT approach is made up of four common components. The variances in these four components can be used to explain the differences between PLT approaches.

Therefore, I carried out another round of clustering — which I called "***identifying***" — to examine how each individual component can be different. It is like to check: for each food item, what choices are available. For example, coke, juice and milk are three available choices under the "drink" component. Then in all combos, the drinks can be covered by these three choices.

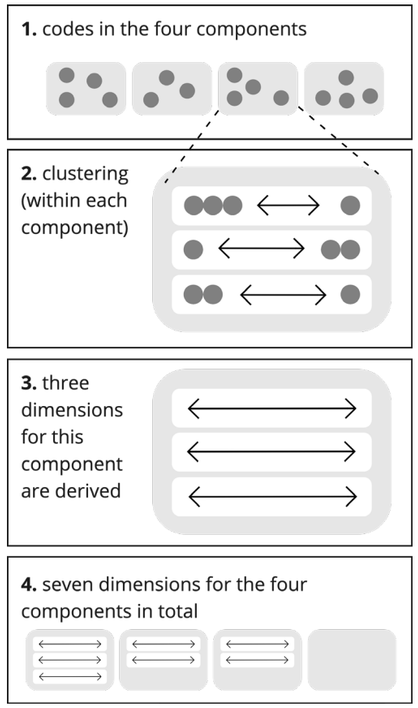


figure 3.8
the process of identifying

3.2.1 Method

In the Deconstruction stage, a great amount of codes have been generate and were merely clustered roughly into the four components. In this step, the codes within each component were clustered more finely.

The codes describing the same or opposing characteristics were summarised into a dimension that can describe two extreme choices of this component. For example, there is a dimension named "Artefact: User-created vs. Professional created". This means the Artefact used in different PLT approaches are either created by end users or created by professionals.

In total, seven dimensions were identified in this process, including three describing Artefacts, two describing Practices, and two describing Roles. The differences between Tools have not been extensively described in the literature, hence no dimension was generated for it.

3.2.2 Results

An overview of the seven dimensions can be seen in table 3.1. Details of the dimensions are as follows.

Artefact can be ...			
①	user-created	⟷	professional-created
②	internally hierarchical	⟷	externally hierarchical
③	empirical	⟷	visionary
Practice can be ...			
④	circular	⟷	(multi-)linear
⑤	bottom-up	⟷	top-down
Roles can be ...			
⑥	end user involved	⟷	end users not involved
⑦	hetero geneous	⟷	homo geneous

table 3.1
an overview of the seven initial dimensions

Artefact

Artefact means the pattern languages used in the cases. Three dimensions were identified for the artefact component.

1. The Artefact can be either user-created or professional-created.

The pattern language used by Alexander was created by his colleagues and himself (Alexander, 1979). Therefore, their expectations inevitably lie behind the pattern language. Compared to this, the patterns created by the end-users can better represent users' dreams and needs (Palmieri et al., 2021).

2. The Artefact can be either internally hierarchical or externally hierarchical.

The pattern language created by Alexander and his colleagues was internally hierarchical, meaning the connections between patterns naturally exist. For example, "adding chocolate to a dough" naturally requires "a dough has been finished". Compared to this, an external hierarchy is created by the pattern developer but does not occur naturally. For example, after having a set of separated patterns, (Gamma et al., 1995) found a way to classify all the unrelated patterns into three groups: creational patterns, structural patterns, and behavioural patterns. This hierarchy allows users to find a pattern more easily but was "forced" by the developers (Coplien & Schmidt, 1995). The researchers who take the "coining a new name" solution (see figure 3.2) called such pattern languages as "pattern catalogues" or "pattern collections".

3. The Artefact can be either empirical or visionary.

Alexander's patterns came from empirical experiences. Patterns can also be visionary. For example, end users could write their ideal living as visionary dwelling patterns (Palmieri et al., 2021). In addition, designers could use patterns as unfinished prototypes (Schön, 1983) which later on can be tested and iterated on through design activities.

Activity

Two dimensions were found for activities.

1. The Activities can be either circular or (multi-)linear.

The Oregon Experiment (Alexander, 1975) presents a circular process between developing pattern language and using pattern language. The users who were involved in design were encouraged to improve the patterns according to their new experiences. In turn, the improved patterns can feed back to improve the design. In comparison, some projects such as (Zhang et al., 2007; Ortega-Arjona, 2010) followed a linear process, without iterations on pattern language.

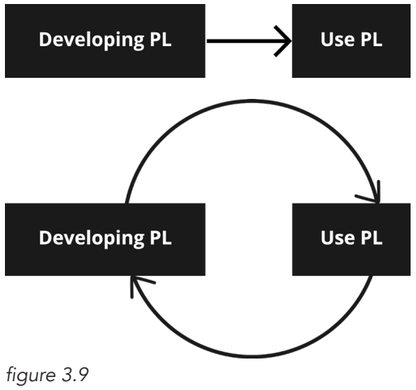


figure 3.9
linear practice vs. circular practice

2. The Activities can be either bottom-up or top-down.

Alexander argued for a bottom-up approach, in which residents themselves initiate and design a complete project (Alexander. 1979). Yet in other domains, such as education (Köppe et al., 2017), the students were not involved to design the course for themselves.

In real life, most cases fall between the two extremes. For example, in The Oregon Experiment (Alexander, 1975), Alexander presents a complete bottom-up design activity but a top-down pattern development activity.

Roles

1. The end users can be either involved or excluded.

This dimension is similar to the "bottom-up vs. top-down" dimension for Activity.

2. The composition of roles can be more heterogeneous or more homogeneous.

This depends on the nature of a project, whether it is multi-disciplinary — such as service design or interaction design — or not — such as software engineering.

Tool

No dimension was generated to describe the Tools. This might be because the tools are applied in diverse domains and hence did not show many comparable similarities or differences.

3.2.3 Next Step

The seven dimensions identified in this section only describe individual components of an approach. To describe a complete approach, these results will be reconstructed in the next section (3.3).

3.3 Reconstruction

After seven dimensions were summarised to describe individual components, a ***reconstruction*** process — consisting of clustering the seven dimensions and relating them to PLT's benefits and practitioners' values — was initiated.

This is because, the seven dimensions only describe individual components, while the goal is to understand a complete approach consisting of all four components. In addition, I tried to relate these dimensions to PLT's benefits and practitioners' values. This could help answer the RQ2-c about the underlying reasons for approaches:

Why are the approaches different?

3.3.1 Method

This reconstruction started by clustering the initial dimensions gained from the last step. Among all the seven dimensions, some obvious interrelations can already be identified. For example, in an approach, whether the Activity is ***bottom-up vs. top-down*** is closely related to whether the Artefact is ***created by end users vs. created by professionals***. Such two dimensions were hence put together.

After all the dimensions were examined on whether they can be clustered, two higher-level dimensions were generated. Next, to investigate the underlying reasons for these two higher-level dimensions, their relations to PLT's benefits and values were examined. The findings were documented into two tables with a basic structure in figure 3.9. Each

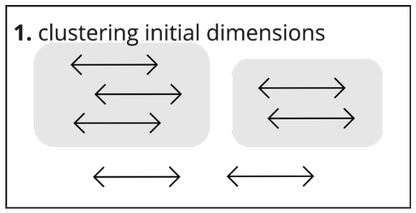


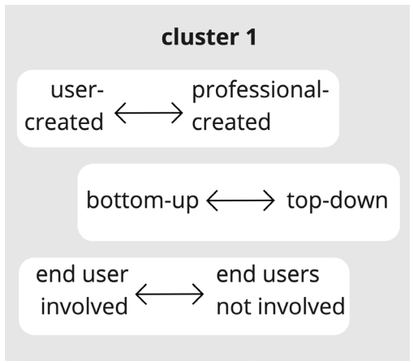
figure 3.9
the process of reconstruction

table described one high-level dimension. The two ends of each dimension were explicated in terms of their external characteristics (answering RQ2-b. How are approaches different) and internal reasons (answering RQ2-c. Why are approaches different).

3.3.2 Clustering

The reconstruction activity was performed by first clustering the initial dimensions to formulate higher-level themes according to their similarities and relations. This clustering activity resulted in two high-level dimensions and left out two initial dimensions that do not fit in.

The ***first high-level dimension*** was made up of three initial dimensions: "Artefact: user-created — professional-created", "Practice: bottom-up — top-down", and "Roles: involving end-users — not involving end-users". This is because although these three dimensions respectively describe three components, they are all about whether a change or a decision-making process is initiated by the end users (grassroots) or by someone with higher authority, such as professionals or experts.



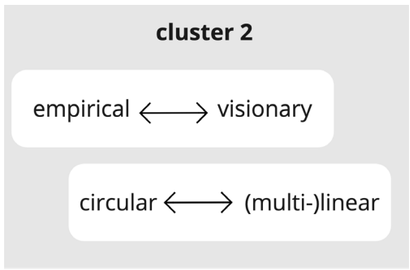


figure 3.10
two clusters of related dimensions

The ***second high-level dimension*** was made up of two dimensions: "Artefact: visionary — empirical", and "Practice: circular — linear". In a circular practice, the pattern language is constantly improved through iteration with design. In a visionary pattern language, the patterns are created brand new. Despite this little difference, both dimensions reflect practitioners' belief on whether a better alternative to the current best practice could exist. Or in other words, whether industry revolution/transformation is welcomed.

The other two initial dimensions were not clustered as they show little relevance to the other ones.

3.3.3 Relating to Benefits

The two higher-level clusters were also examined in their relations to PLT's benefits, because the expected benefits of PLT should ideally align with the approaches (Wania & Atwood, 2009). After all, the ultimate goal of this project is to support practitioners to use PLT effectively, in which practitioners' expected benefits should be realised.

It was found that the first high-level dimension about "bottom-up and top-down" was closely related to the third benefit of PLT — "participation of end users" as introduced in Chapter 2. If practitioners consider the participation of end users as an expected benefit of using PLT, it is naturally recommended to take a bottom-up approach, bringing end users into the process.

In addition, the second high-level dimension of "visionary and empirical" was found highly related to PLT's benefit in "consistency over time". This is because, the visionary patterns are usually developed for the future, so they need to survive the time and be future-proof. For example, in (Palmieri et al., 2021), the researchers argue that the format of a pattern can retain the authenticity of users' insights, even when the patterns will be used by multiple stakeholders in a long term.

3.3.4 Relating to Values

Finally, the two high-level dimensions were further examined in their relations to practitioners' underlying values. This is because a value system is always embedded in a pattern language (Fincher, 1999). If practitioners use PLT in an approach not in line with their underlying values, they may fail to get satisfying results (Wania & Atwood, 2009). Therefore, an ideal state is that the characteristics of the PLT approach can reflect their real underlying values.

By sorting out the cases applying a "bottom-up" approach versus the cases applying a "top-down" approach, and with the assistance of the framework of values by (Bos-de Vos, 2020), I identified the values of "social justice" or "egalitarian" most in line with the bottom-up cases. The common expressions used in bottom-up cases include "depolarisation" and the "ownership" of citizens etc. While top-down cases do not necessarily express an injustice value, their reasons for not involving end users were seldom mentioned.

In terms of the cases that use visionary patterns, common expressions included "transformative", "challenging" or "transforming" the dominant etc. This is in line with their critiques against Alexander's approach which is "over-focusing on replicability" (Palmieri et al., 2021). Compared to that, cases using empirical patterns were more inclined to reconfirm the traditional or existing best practices. However, I did not find a more succinct expression for these two values in the framework by (Bos-de Vos, 2020). Therefore, I used "industry transformation" and "reusing known solutions" to represent the two underlying values.

Throughout the process of reconstruction, the clustered high-level dimensions, expected benefits, and underlying values were documented in two tables (figure 3.11). The upper part of the table contains the artificial characteristics of PLT approaches, and the bottom part contains the underlying reasons.

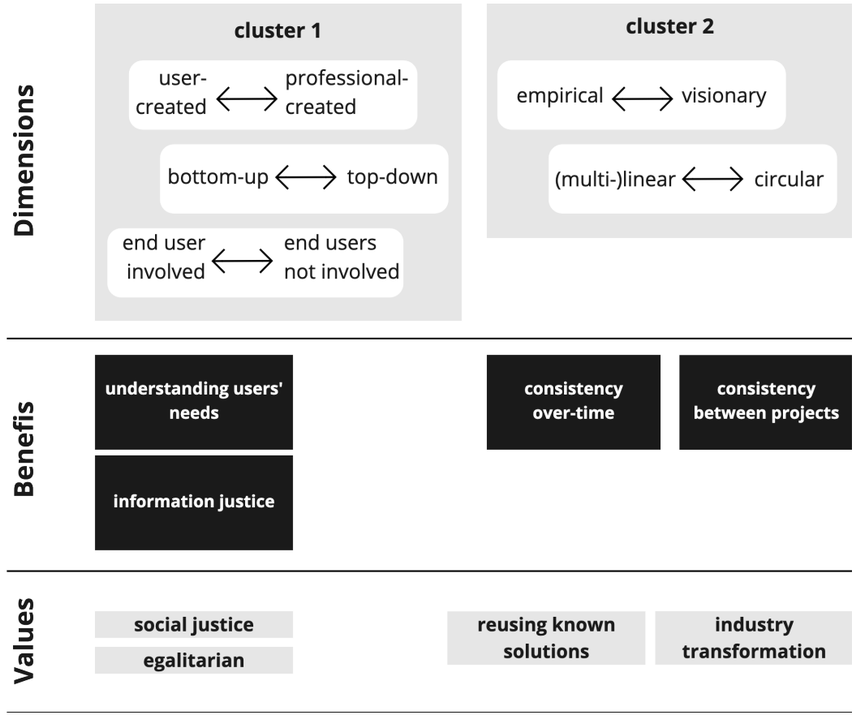


figure 3.11
relating two clusters to values and benefits

3.4 Synthesising

Finally, the reconstruction results — the two tables documenting the two high-level dimensions, their related benefits and values, and two left-out individual dimensions — were refined or synthesised into four theoretical tools.

Tool 1: Approach Axes

The Approach Axes contains two tables, which came from the table in figure 3.11. Each table details one of the two high-level dimensions: "bottom-up vs. top-down", and "industry transformation" vs. “reusing known solutions".

The external characteristics and internal reasons for the two extremes of each dimension are introduced in each table. The external characteristics include common expressions, key activity, source of patterns and user of the pattern language. The internal reasons include the underlying values of the practitioners and their expected benefits of applying PLT. These elements were extracted from the literature.

Decision-making vs. Vision-making

The first dimension describes whether an approach is more inclined to maintain the status quo (decision-making) or to transform it (vision-making).

A decision-making approach tends to reuse existing good solutions as patterns, hence reconfirming the status quo. In contrast, a vision-making approach explores new patterns which represent stakeholders' dreams. Transforming the current dominance to find a better or future-proof solution is the goal.

In addition, the benefits expected when applying PLT approach also differ between a vision-making approach and a decision-making approach. In a vision-making approach, maintaining consistency over a long term is more important. In contrast, maintaining consistency between projects or teams is the main expected benefit when applying a decision-making approach.

Bottom-up vs. Top-down

The other dimension describes whether the change is led by end users (bottom-up) or by experts (top-down) in an approach.

An utmost bottom-up approach tends to gather patterns from end users and have end users use the pattern language either for diagnosing or for designing. In contrast, in an utmost top-down approach, both the developers and users of a pattern language are professionals.

In addition, there seems a trade-off between social justice and efficiency. As a bottom-up approach shows a higher value of social justice, the efficiency can accordingly be decreased when more people are involved in decision-making. As suggested in *The Oregon Experiment* (Alexander, 1975), a series of organisational practices were required to ensure fairness and the 1balance of finance distribution. These complex

Axis of Change-making Direction

Bottom-up ← change led by end-users — **Top-down** change led by experts

External Characteristics

common expressions	*end-users*, *individual*, *participatory*, *engagement*, *ownership*, *social*, *political*, *depolarise*, ...	might mention *participation of experts* from multiple disciplines, rather than the *participation of end-users*
key user of PL	user-designer	professional designer
source of patterns	user-designer	professional designer

Internal Values

expected benefits specific to this dimension	participation	
key value	**egalitarian** social justice	**mastery** efficiency

Axis of Innovation

Decision-making ← reusing extant solutions — **Vision-making** seeking transformation

External Characteristics

common expressions	*solving recurring problems*, *learning from existing experiences*	*visionary*, *predictive*, *transformative*
key activity	1. Diagnosing with PL 2. Designing with PL	1. Developing the PL 2. Selecting Sub-PL for Project
source of patterns	by extracting from experience	by envisioning

Internal Values

expected benefits specific to this dimension	consistency between teams/projects	consistency over-time
key value	**reusing known solutions**	**industry transformation**

figure 3.12
Approach Axes

practices appear too demanding for some other disciplines. For example, in software development, (Rising, 1997) commented that the concepts proposed by Alexander appeared unconscious of the “daily struggles with deadlines and requirements changes”.

Most cases lie in somewhere between the two extremes. For example, in *The Oregon Experiment* (Alexander, 1975), the development of the pattern language was performed by Alexander and his colleagues, while the design activities were mostly initiated and progressed by end users.

Although some cases mentioned "participation" as well, they meant the involvement of professionals or experts,

while end users were not involved. For example, in a service design for rural healthcare system (Athavankar et al., 2014), the "participation" of experts such as psychologists and sociologists etc. was required, yet end users were excluded. Therefore, this case was taking a top-down approach.

Tool 2&3: Navigation Panel & Approach Detail Table

The Navigation Panel (figure 3.13) is a combination of the two approach axes. The plane is divided by the two axes into four areas, each representing one typical approach to using PLT.

The four approaches are detailed in the Approach Detail Table (figure 3.14). This table combines the Approach Axes tables and adds a slogan and a representative example for each approach.

In the bottom-up approaches, the slogans feature a first-person plural imperative — let's — to make suggestions that include everyone, also the end users (Cambridge Dictionary, 2022). In contrast, for the top-down approach, experts are the object of the imperative sentence and the roles taking actions.

This Navigation Panel allows researchers to map and compare the approaches to using PLT in a more visual way. More practical uses of these tools are researched in Chapter 4.

Tool 4: Complementary Dimensions

The two initial dimensions not covered by the two Approach Axes were kept as complementary dimensions. These dimensions may provide additional references to understand the differences between PLT approaches.

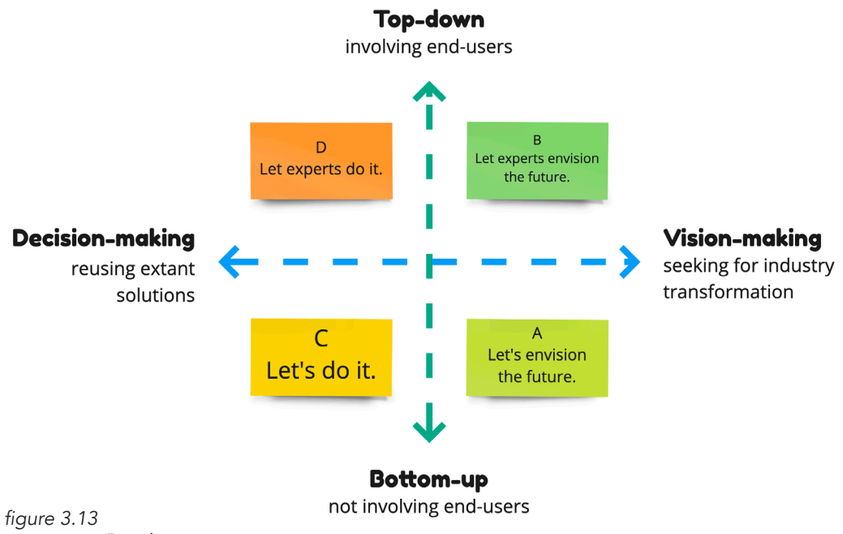


figure 3.13
Navigation Panel

		A bottom-up vision-making	B top-down vision-making	C bottom-up decision-making	D top-down decision-making
internal values	**Value**	1. social justice 2. transformation	1. transformation	1. social justice 2. mastery of immediate problem	1. mastery of immediate problem
	special purpose	1. participation 2. consistency over time	consistency over time	1. participation 2. consistency between teams/projects	consistency between teams/projects
slogan		Let's envision the future.	Let experts envision the future.	Let's do it.	Let experts do it.
external characteristics	**User of PL**	user designer	professional designer	user designer	professional designer
	Developer of PL	**user-designer**	**professional designer**	**user-designer** by empirical experience	**professional designer** by empirical experience
	Innovativ eness	envision new possibilities	envision new possibilities	reuse existing solutions	reuse existing solutions
Example cases		te Duits, 2022	Köppe et al., 2017	Silva e Santos, 2012	Noble, 1998; Zhao et al., 2007

figure 3.14
Approach Detail Table

Four Examples

Existing cases applying PLT can be mapped in this Navigation Panel. Four cases are given as examples in this section. The four cases are:

- α : *Co-producing, curating and reconfiguring dwelling patterns: A design anthropological approach for sustainable dwelling futures in residential suburbs (Palmieri et al., 2021)*
- β : *Towards a Pattern Language for Hybrid Education (Köppe et al., 2017)*
- λ : *The Oregon Experiment (Alexander, 1975)*
  - λ 1: *developing pattern language*
  - λ 2: *using pattern language*
- δ : *Multidisciplinary Team Dynamics in Service Design — The Facilitating Role of Pattern Language (Athavankar et al., 2014)*

These cases were chosen as references for their consistency between internal values (de jure), and external characteristics (de facto). In other words, the four cases have presented an honest application of pattern language, with actions well aligned with the purpose.

Case α (Palmieri et al., 2021) took a vision-making & bottom-up approach. It aimed at depolarising the policy-making in the sustainable dwelling domain. Residents, as the end users, were involved as the dominant pattern developers, making the case bottom-up.

Case β (Köppe et al., 2017) describes a vision-making & top-down approach. A 80-pattern pattern language was developed to cut across and circumvent the marketisation, managerialism and standardization in traditional education. The development of pattern language only involved experts in design, education and technology. It was designed to be used by professional designers (educators) instead of the end users (students).

Case λ (Athavankar et al., 2014) took a top-down & decision-making approach for medical service design. The pattern language was developed in (Khambete, 2013) by experts. The design team also comprised of experts from diverse disciplines. Four workshops were organised to generate solutions based on validated best practices.

However, in reality, most pattern language implementation cases may fall somewhere in between two approaches or may move from one approach to another. For example, *The Oregon Experiment* (Alexander, 1975) initiated from a top-down and decision-making approach, since the pattern language was developed by professional designers based on empirical experience. Later, it moved towards a bottom-up and decision-making approach, since end users were involved in the design stage. In addition, the approach displayed vision-making nature in the design stage, as end users can modify the original patterns based on their expectations, instead of totally following the empirical "best practices".

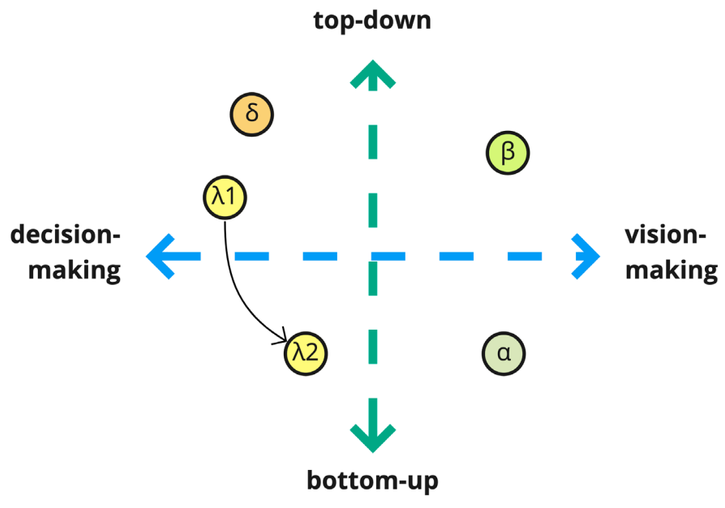


figure 3.15
the four examples mapped in Navigation Panel

3.5 Summary

Answers to Research Question (2)
How is pattern language theory applied?

Different approaches to applying PLT exist. To distinguish these approaches, a deconstruction-identifying-reconstruction approach was taken.

a. What are the components of a PLT approach?

PLT approaches are comprised of four common components: (1) Artefact, (2) Activity, (3) Role, and (4) Tool.

b. How are applications different?

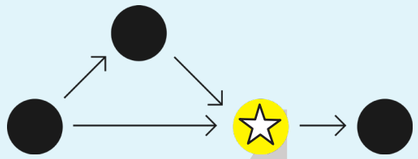
PLT approaches manifest their differences through the variances of each component. Seven dimensions have been identified to describe these variances.

c. Why are approaches different?

PLT approaches are different because of the diverse expected benefits and practitioner's different values.

These insights were communicated with two higher-level dimensions:
(1) Bottom-up vs. Top-down
(2) Vision-making vs. Decision-making

The two high-level dimensions were concretised into four tools. How these tools might be used requires further investigation in the following chapter.



Workshops

In the previous chapter, PLT approaches have been differentiated in terms of external manifestations and internal reasons. As this project aims to provide practical support (RQ3), there is a need to inquire how the tools can be used in practice.

RQ3-a. How can the tools be supportive?

To answer RQ3-a, **workshops** were organised to provide inspiration. Participants ideated on applying PLT to a real problem. Throughout this ideation process, the issues encountered were reflected by participants if they could be solved with the tools.

Through the workshops, the tools were found helpful in three ways. Besides, suggestions on how to improve these tools were offered by participants. In addition, four other issues not supported by the tools were documented.

How these issues might be tackled will be elaborated on in the next chapter. The insights gained in this chapter will also be synthesised into the final deliverable to answer RQ3 in the next chapter.

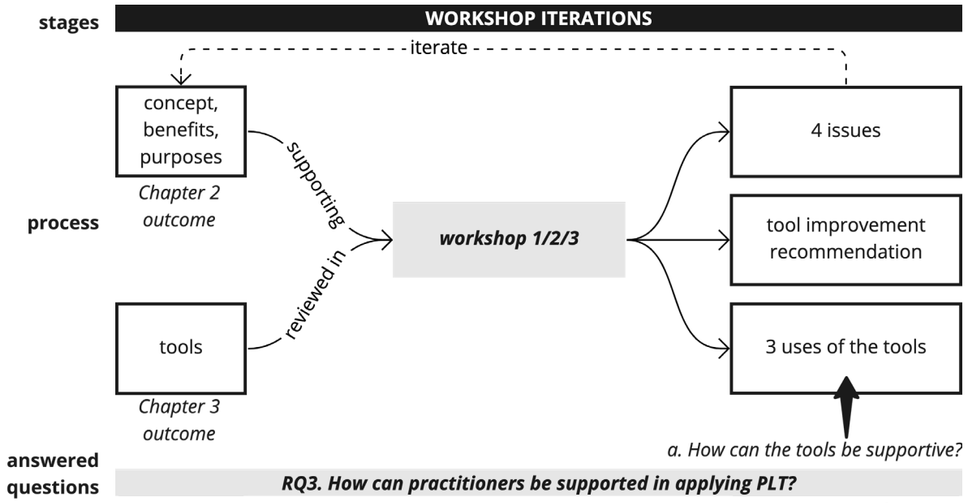


figure 4.1
Chapter 4 overview

Why workshops?

The four tools developed in Chapter 3 were totally based on literature analysis. As an answer to RQ2, these tools are already helpful for a researcher (me) to differ between various PLT approaches. However, as this project ultimately aims to provide practical support for practitioners in using PLT (RQ3), it is required to research how these tools can be supportive in PLT application in practice. A sub question was added to RQ3:

> *RQ3-a. How can the tools be supportive?*

An ideal context to test the tools should be in a project that has just started using PLT. Yet this would make recruitment difficult. In addition, as cases applying PLT usually span a long term, I can hardly expect a result to come within the graduation timeframe. Therefore, a compromise was taken to test the tools in a laboratory setting. Participants "ideated" about using PLT — instead of really using it — to study whether the tools could support them in the ideation process. A workshop format was chosen, as workshops provide more intense engagement of participants, which can offer information-rich data (Creswell & Poth, 2017). In comparison to a one-on-one session, chances for interaction and discussions between participants can facilitate the reiteration and betterment of ideas (Inmark, 2010).

4.1 Method

The objective of the workshops was to review the previous desk research results and get inspiration on how these results could be used in practice. In this chapter, the overall design of the workshop sessions is discussed.

4.1.1 Recruitment

The workshops applied an internet-based participant recruitment via directly approaching the student population in related organisations and snowballing (Barnwell et al., 2005). Each session involved three or four participants. Ten participants — in three groups — were finally involved. The information of these participants is documented in table 4.1.

	Profession	Expertise	Project Type
1	UX Intern	UX (Dfl)	Design
2	Student	Dfl	Design
3	Researcher	Dfl	Research
4	Intern	Dfl	Design
5	Student	Dfl	Design
6	Student	SPD	Research
7	Student	IPD	Design
8	Student	Dfl	Enterpreneurship
9	Student	SPD	Design
10	Student	Dfl	Design

table 4.1
an overview of the workshop participants

4.1.2 Materials

To facilitate the workshop sessions, materials introducing the concept of PLT and the four tools etc. were used. For the first workshop, the materials were directly adapted from the desk research results. Based on the insights from the first workshop, the materials were iterated to be used in the second workshop. Another iteration was performed to improve the workshop materials for the third workshop. In this way, each workshop fed into the next one.

In the first workshop, the materials were presented on the Miro board. In the other two workshops, the materials were printed and handed out in person.

4.1.3 Data Collection

Each workshop consisted of four activities — **Stinky Fish**, **Understanding**, **Ideation**, and **Discussion**. The Stinky Fish was a sensitising activity allowing participants to think of a real case that they were familiar with. The Understanding activity aimed to familiarise participants with the concepts. The Ideation activity was where participants considered how PLT could be applied to the case they had just thought of, and how the tools could support this application. Finally, in the Discussion, the ideas generated from the whole session were shared. A more detailed process of each workshop is detailed in the next section (4.2).

During the sessions, ideas regarding the materials, the four tools and the PLT application process were collected from participants. Most insights were generated from the Ideation activity, while were discussed and deepened in the Discussion activity.

The audios of the three sessions were recorded for analysis. In addition, notes related to the issues in the workshop materials (such as a better sequence of presentation, or any part that had caused confusion) were also taken throughout the sessions. Note-taking was a more efficient way for me to quickly process the feedback and iterate on the workshop materials.

4.1.4 Data Analysis

Two rounds of data analysis were conducted. First, after each workshop, the data were coded line by line, to quickly gain ideas for the iteration of workshop materials in complement to my notes.

Second, some commonalities could be spotted among the codes. Therefore, after three workshops, the codes generated in line-by-line coding were clustered according to their relevance. The clustering resulted in several themes, which will be detailed in the findings section.

4.2 Process

The first workshop was organised online on a public Miro board. The other two workshops were organised in person at the TUD IDE faculty.

Each workshop consisted of four activities — Stinky Fish, Understanding, Ideation, and Discussion. It basically followed a structure consisting of icebreaking, provoking, thinking and reflection, which is common in workshop designs (Ahmed & Asraf, 2018).

The detailed information of each activity is elaborated on in this section.

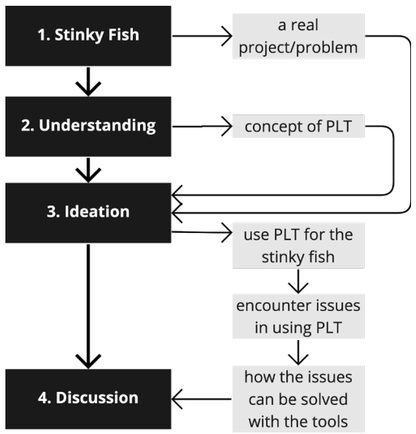


figure 4.2
the four basic activities in each workshop

4.2.1 Activity 1: Stinky Fish

As discussed before, the workshops aimed to find out how the tools might be supportive in practice. To assure that the participants could think about real cases that they were familiar with, the workshop was initiated with an activity called “Stinky Fish”.

“Stinky fish” means one's concern, worry or difficulties. In the workshops, participants were sensitised by writing and sharing their "stinky fish" met in an ongoing project with the others. This assured that in the following activities, participants could relate to their own situations and think more concretely about a familiar project, instead of performing purely theoretical and random thinking.

Stinky Fish is also an icebreaking activity performed at the beginning of each workshop (Stinky Fish, n.d.). First sharing each other’s stinky fish, which represented participants’ worries or concerns, allowed them to get more comfortable talking and discussing in the following activities.

4.2.2 Activity 2 & 3: Understanding & Ideation

In the Understanding activity, participants got familiar with the PLT by reading materials. In the Ideation activity, participants were asked to consider using PLT to address their own stinky fish. The Understanding activity and Ideation activity went hand in hand, especially in the latter two workshops where these two activities were combined with each other.

The procedure and facilitating materials for these two activities underwent twice iterations (figure 4.3). In the first workshop, the Ideation only started after all the materials had been read through. While in the latter two workshops, the Ideation was divided into **two** or **three** cycles (figure 4.3). Within each cycle, part of the materials for Understanding was presented to the participants, to provide guidance in a step-by-step manner. This was because, in the first workshop, presenting all materials at once was found “overwhelming” for the participants.

More importantly, if all tools were presented at the beginning, I could not make sure whether participants had referred to them and what would be the differences if they had not. In contrast, in the second and third workshops, participants first performed ideation without the tools, and later with the tools. By comparing the two rounds of ideation, the function of the tools can be more clearly understood. More detailed processes of Understanding & Ideation in the three workshops are elaborated on below.

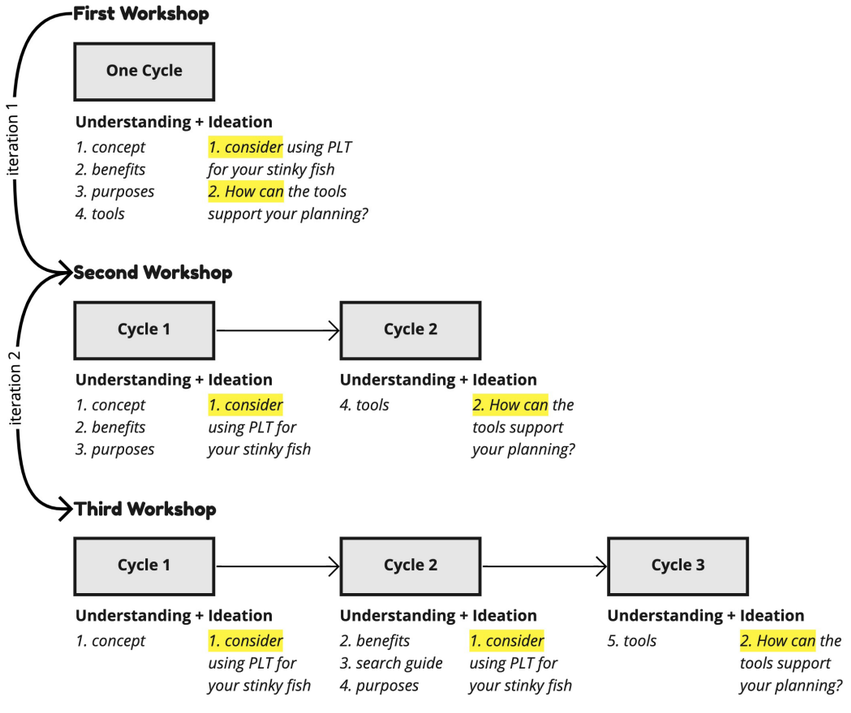


figure 4.3
combinations of Understanding & Ideation activities in three workshops

First Workshop

In the Understanding activity of the first workshop, an "I like, I wish, I wonder" (User, 2021) exercise was performed. Participants left post-its about what they like, wish or still wonder about the PLT concepts. This activity meant to help

participants read the materials with a purpose and help me revise the materials for the next workshop. However, I found this activity had caused participants to overthink and over-focus on details, sparing less time as planned for Ideation and Discussion. Therefore, the "I like, I wish, I wonder" exercise was removed in the other two workshops.

In the first workshop, the Ideation started when all materials had been presented. This means the participants not only had understood the concept, benefits, and purposes of using PLT, but also the four tools.

When reflecting on this setting, I found this approach not good enough. Participants would acquiesce that these tools "must be" useful and try to find a reason for it, even if they actually did not meet the difficulty that they talked about. Therefore, in the second and third workshops, the tools were introduced after participants had ideated for one or two rounds and possibly had met some real difficulties.

Second Workshop

In the second workshop, the Understanding & Ideation involved two stages (figure 4.3).

First, after understanding the concept, benefits and purpose of using PLT, participants were asked to ideate with some very basic questions provided. Participants met different difficulties in this process. Second, based on the difficulties and confusion they met earlier, the four tools were introduced to them. Then another round of ideation was conducted.

In this workshop, it was found that all the information about PLT's benefits, common practices and roles in PLT application was again too much for participants:

[P6] It's a little bit overwhelming.

Therefore, in the third workshop, these parts were divided again and resulted in the **three-stage** as shown in figure 4.3.

In addition, it was found that participants were not aware of the existing pattern languages that might be useful for them. Therefore, in the materials for the third workshop, a simple guide for "searching a pattern language" was added.

Third Workshop

In the third workshop, the Understanding & Ideation involved **three stages** as shown in figure 4.3.

First, participants understood the concept of PLT and immediately ideated without any support. Second, participants were introduced to (1) PLT's benefits (see Chapter 2.2), (2) a simple guide for searching a pattern language, (3) several project purposes that could be achieved with PLT (adapted from the eight purposes in Chapter 2.3), and (4) the roles that could be involved (see Chapter 2.2). Then the participants were asked to conduct a second round of ideation. Finally, participants were provided with the four tools and conducted the third round of ideation.

In this workshop, **two of the three participants thought the materials provided before the second ideation did help them take one step back.** While the other participant misunderstood that her initial ideation could not be changed, but had to be iterated on. Therefore, although she felt her initial approach was too difficult and might be a little broad for her real purpose, she sticked to it.

4.2.3 Activity 4: Discussion

Finally, the process was reflected on by participants through a discussion. In this activity, all participants shared their ideation process and talked about which tools or materials were useful to them. Through the interaction with each other, some consensus were achieved. Some new ideas were also generated through discussion. These showed that the workshop format had exerted its advantages in spotting agreement and inspiring new ideas (Ahmed & Asraf, 2018).

4.2.5 Iterating Workshop Materials

First of all, as mentioned above, the sequence to present materials had been altered in the three workshops. The sequence applied in the third workshop, where all materials were dividedly presented, was found to cause the least mental effort for participants.

In addition to the materials for facilitating Ideation, some other parts were also iterated. First, the introduction to the PLT part was modified after the first workshop. Second, the order to present the tools also changed twice to see which sequence best promoted understanding. All the materials for the three workshops are presented in Appendix G.

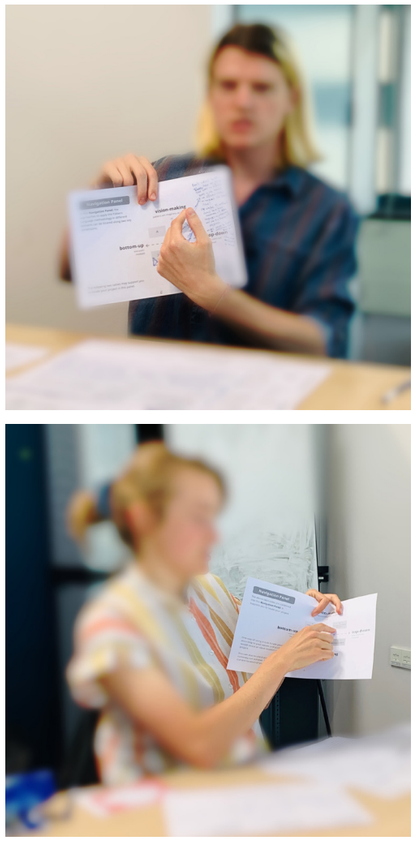


figure 4.4
participants sharing their ideation and process

4.3 Findings

The tools developed in the previous chapter were found to be helpful in three ways: urging participants to consider and communicate their underlying values in the projects, choosing a suitable approach to use PLT, and taking a long-term outlook on the project.

In addition, the workshops also helped me find out some other difficulties in applying PLT.

An overview of these findings is in table 4.2. The details are elaborated on as below.

	findings
using the tools	1. for aligning practitioners
	2. for choosing approach
	3. facilitating long-term planning
refining the tools	1. axis names
	2. axis directions
	3. three complementary dimensions
other difficulties	1. not considering purposes
	2. rushing in developing PL
	3. overlooking non-professionals
	4. not searching existing PLs

table 4.2
an overview of the workshop findings

4.3.1 Using the Tools

As previously mentioned, for researchers, the tools can provide a new lens for describing and classifying different PLT approaches. In addition to that, three functions of the tools that are useful for practitioners have been identified through the workshops.

Aligning Practitioners

For practitioners going to use PLT, the tools are helpful in aligning with other stakeholders. The Navigation Panel provides a discourse system for practitioners to articulate their underlying values. For example, one participant shared her experience in the workshop:

> *[P4] And maybe, for example, if you're working with other stakeholders, like agreeing on what are we aiming for, for this project? Yes, yeah, a nice way to be on the same page. Because I was thinking maybe I was thinking too hard for my project, I was on a vision-making, or maybe what they want is just decision-making. So I don't need to make it difficult for myself.*

Choosing Approach

For practitioners going to use PLT, the tools are helpful in choosing the approach to using PLT, such as in figure 4.5. The description of the two axes and four approaches can be used to select the suitable approach based on the practitioner's values and purposes.

For practitioners already applying PLT, these tools can help position their current approach, reflect on whether they are using it in a way aligned with their own values, and probably decide for a change when disconformity exists.

Facilitating Long-term Planning

The Navigation Panel also facilitates practitioners to consider the project approach in a long term. Although practitioners can find out the approach that ideally aligns with their underlying values and purposes, they may be subject to limitations — such as the incapability to involve end users etc. — and have to take an inferior approach. In the workshops, quite a few participants scribbled the route between the ideal approach and the limited but viable approach to create a long-term plan on the Navigation panel, such as in figure 4.6.

For example, one participant first decided that a bottom-up and vision-making approach would be the best approach for her research project. Yet she admitted that due to the difficulty to access end-users, the project might have to start from a top-down and decision-making approach. Therefore, she clarified her project as following a curved route in the Navigation Panel. This gave her a clearer vision that she should endeavor to involve end users and shift from using ready-to-use solutions to inventing more radical ones.

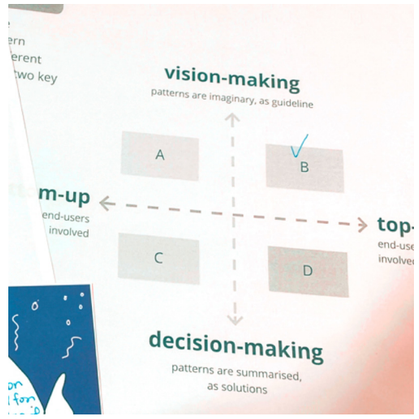


figure 4.5
a choosing approach example from workshop

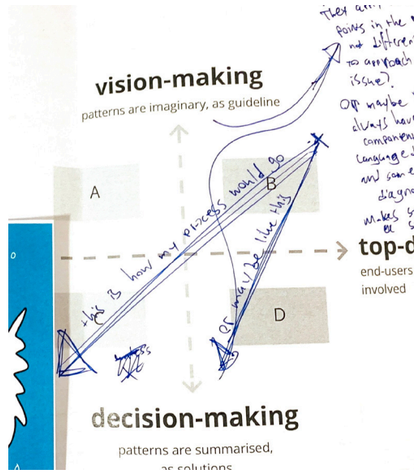


figure 4.6
a long-term planning example from workshop

4.3.2 Refining the Tools

Participants also provided suggestions on how to improve the tools.

Axis Names

In the workshop materials, each axis was termed the "vertical axis" or "decision-making vs. vision-making axis" etc. Participants agreed that these naming methods could not inform what aspect of the approach was described by the axes.

Axis Directions

The directions of the axes were reported not in line with participants' verbal perceptions. For example, bottom-up and top-down were preferred to be positioned vertically, with one end at the bottom and the other end at the top of the panel.

Three Complementary Dimensions

Participants did not find enough reasons to use the three complementary dimensions. This tool was considered less useful in supporting practitioners who just started planning their PLT approach. More research can be expected to see if the three complementary dimensions might be useful in other stages of using PLT.

4.3.3 Other Issues

Although the tools were helpful, participants also encountered other issues when trying to use PLT in the workshops. I summarised four main issues as follows. Corresponding solutions to them will be put forward by developing a final document in the next chapter.

Issue a: Not Considering Purposes

At first contact with the concept of PLT, most participants directly considered developing a pattern language for their specific problems. Other possible interactions with a pattern language had been overlooked (which had also happened to myself). This is usually an over-qualified way to use PLT and could fail to match their project purposes. For example, a practitioner may only need a solution for his/her issue, but ended up spending time developing a complete pattern language. Therefore, practitioners need support in finding a way to use PLT that is aligned with their purposes.

It had been found in the workshops that presenting some achievable purposes can help participants take one step back to consider their own purposes. **This list should be presented separately** from other materials, to help practitioners better digest the information. In the 1st and 2nd workshops, common purposes of using PLT were introduced along with the concept of PLT. However, this did not create much awareness among participants. Compared to that, in the 3rd workshop, the purpose list was presented after one round of ideation. This helped participants digest the information more easily. More participants hence realised that they should consider what would be a more effective way to make use of PLT:

> *[P9] This part, it's getting me to think about what's the purpose of the pattern language and how to use it. So I just briefly gave up making the structure and starting to think about the purpose ... so one step back before making the plan ...*

Issue b: Rushing in Developing a PL

When considering developing a pattern language, most participants started by building the structure first.

> *[P10] I have already chosen this stinky fish I still try to break down the task into sub-tasks according to the definition of Pattern Language. So I tried to break it down into different steps, and also try to make relation[s] between those [steps] in this pattern language.*

However, participants found this process difficult. One reason was that they had not known all the patterns required for the complete pattern language:

> *[P9] I don't know how to deconstruct it (the problem). It [there] is not even a dimension, it is actually multiple dimensional.*

The other difficulty was in finding the inter-relations between the known patterns. The relations could hardly be identified exhaustedly at once. Iterations are required for a comprehensive structure to be built.

> *[P10] But I think, in general, it is hard for me to write down the Pattern Language neatly.*

> *[P10] Because I need to consider, oh, maybe this (a pattern) will be done before that (another pattern). And sometimes I need to rearrange the order or their relations.*

In addition, a pattern language is also generative. When answering one problem, more problems might be discovered. As more problems and solutions are documented, the relations between patterns would become more complex and informative. Therefore, it is necessary to make users aware that the development of a pattern language is usually long-term. The record of the problems and solutions are often not synchronised in time. This phenomenon has also been discussed in previous literature such as (Wania & Atwood, 2009; Alexander et al., 1977).

Issue c: Overlooking Non-professionals' Value in Developing PL

Another finding was that few participants considered looking for patterns — either a complete pattern or part of it — from non-professionals or inexperienced people. However, in fact, inexperienced practitioners are as important — if not more important than — as experienced practitioners in developing a pattern language (Alexander et al., 1977; Wania & Atwood, 2009).

Experienced practitioners (experts) may know all the patterns needed for a

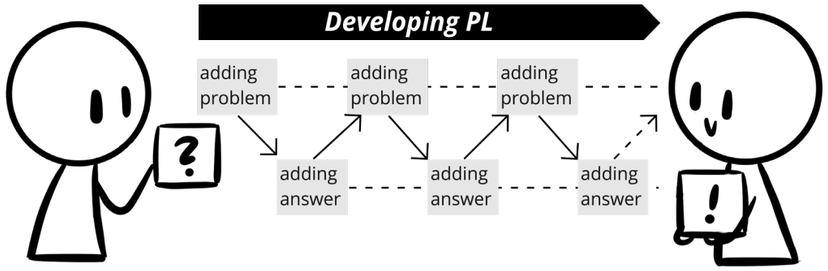


figure 4.7
the development of a pattern language is usually long-term and interactive, with adding problems not synchronised with adding answers. Experienced and inexperienced practitioners both contribute to this progress.

pattern language. However, they would feel at large when trying to externalise these patterns without assistance. Takes teaching as an analogy, a professor may know everything about her course, but she doesn't automatically figure out how to help when a student feels confused. Instead, she can only give an answer when the student asks a question. This interaction of asking and answering between the inexperienced and the experienced makes a course more understandable.

In the same way, the separate documenting of problems and solutions can promote a pattern language to be developed. As in-experienced practitioners input new problems, experienced practitioners can accordingly reflect on and input their solutions and good practices (figure 4.7).

Therefore, activities such as workshops are needed to encourage both inexperienced and experienced practitioners to input their knowledge.

Issue d: Not Searching Existing PLs

In addition, it was found that participants were not aware of the existing pattern languages that might be helpful. This is also in line with the findings by (Birukou, 2010). Although a simple guide for "searching a pattern language" was added in the materials for the third workshop, its effect was trivial. This argues the need to develop more dedicated supporting materials or tools to help participants search for an existing pattern language.

4.4 Discussion

My initial objective of the workshops was to seek inspiration on how the tools developed in Chapter 3 could be used in practice. Finding the other difficulties (discussed in 4.3.3) was not expected. These out-of-expectation findings made me notice the value of the eight concrete purposes of using PLT (Chapter 2.3) — which was previously overlooked by myself.

However, the workshop set-up still requires improvements. First, the invited participants were limited to the design domain. As the project objective is to support practitioners from diverse domains, participants from other disciplines should also be involved. Second, in these workshops, there were only ten participants involved. A larger sample is needed to provide more solid insights.

In addition, although the two axes in the Navigation Panel can cover most initial dimensions with simplicity, they only address several types of values (egalitarianism and mastery). Although these values are sufficient for discussing PLT approaches, a more comprehensive discussion on values in a real project may require other tools.

Last but not least, although the testing in the laboratory setting is reasonable considering the project timeframe, real-world testing is still recommended to complement it.

4.5 Summary

RQ3-a. How can the tools be supportive?

1.The tools can be used in three ways:

a.Researchers can clarify and differentiate between different PLT approaches.

b.Practitioners can consider, articulate and communicate their values which are relevant to choosing PLT approaches by referring to the tools.

c.Practitioners can map the short, mid and/or long-term approaches on the Navigation Panel.

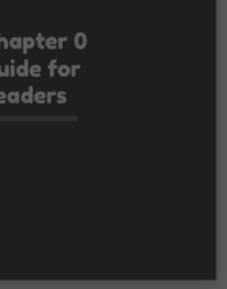
2.Four other issues were found in PLT applications:

Issue a. Practitioners usually do not consider their project purposes. *Defining purpose is an important process to make sure only important activities are performed.*

Issue b. Practitioners feel like rushing to complete a pattern language. *Making practitioners aware the development of a pattern language is usually long term can be helpful.*

Issue c. Practitioners sometimes overlook the importance of non-professionals in developing a pattern language. *Activities helping involve non-professionals in the development process are required.*

Issue d. Practitioners need guidance to find existing pattern languages*, to avoid reinventing the wheel.*



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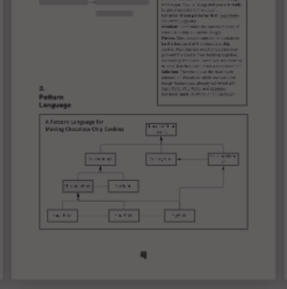

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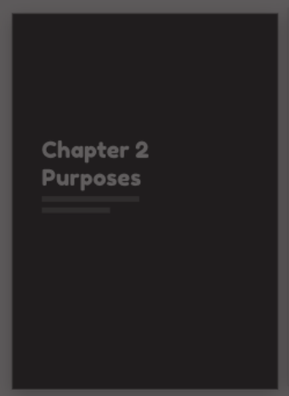

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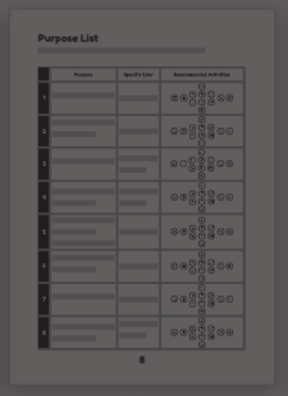

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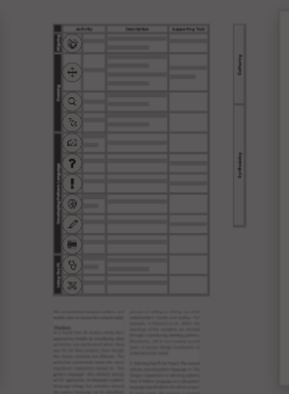

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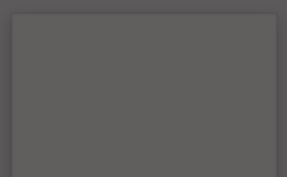

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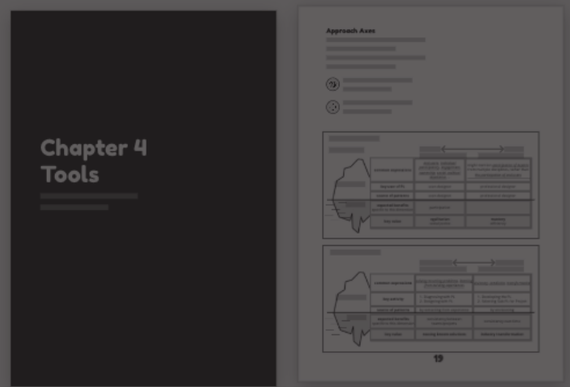
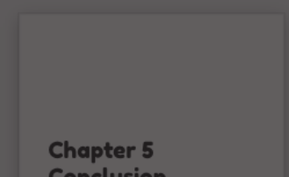




Develop the Activity Kit

In this chapter, how the research insights were synthesised to answer the main research question (RQ3) is detailed. Primarily, based on the relations between the four components and Issue a from the workshops, a procedure to use PLT and the **structure** of the final document were defined. Afterwards, informed by the Issues b, c, and d, the main **contents** of the document were developed by refining or synthesising previous research outputs. These contents and the concept of PLT from Chapter 2 were synthesised into the outcome — the **Activity Kit**.

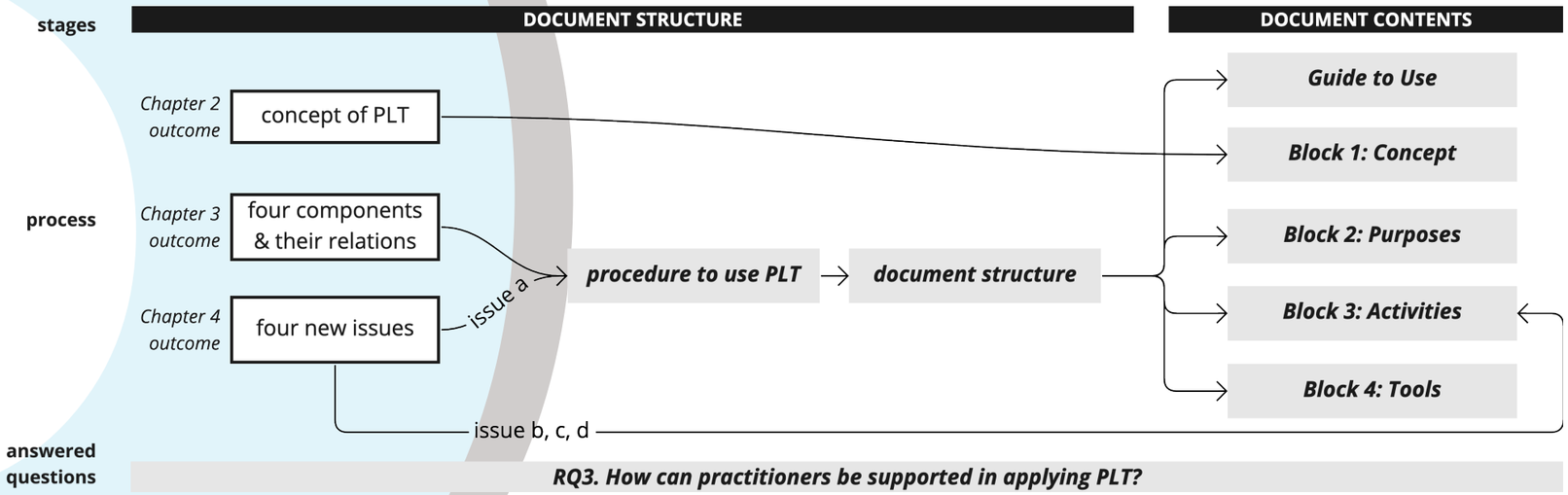


figure 5.1
Chapter 5 overview

5.1 Procedure to Use PLT

The Issue a (identified in Chapter 4) is tackled by formulating a recommended procedure to use PLT.

Understanding the concept of PLT is undisputedly the first step. Only after knowing what is PLT and how does it work, can a practitioner begin to use it.

The second step, according to ***Issue a***, should be **considering the purposes**. This can help practitioners decide on an appropriate approach that contributes to their project purposes. Otherwise, they would spend time on the activities not needed, or may exclude necessary ones. For example, in the workshops, most participants directly considered developing a pattern language. However, it was an over-qualified activity in terms of their purposes.

After knowing the purpose, practitioners then need to know what activities can achieve it. From the previous study, a PLT approach usually consists of four components, namely ***Artefact, Activity, Role,*** and ***Tool***. Among these four components, the Activity component has direct correlation with all the other three and hence should be the primary component to decide on. Therefore, **selecting the activities** to perform is defined as the third step.

Then the other decisions on Artefact, Role and Tool can be made if needed in the final step — **performing activities**.

Therefore, the recommended procedure of using PLT involves four steps as shown in figure 5.2. It helps define the requirements, the format, and the structure for the final output.

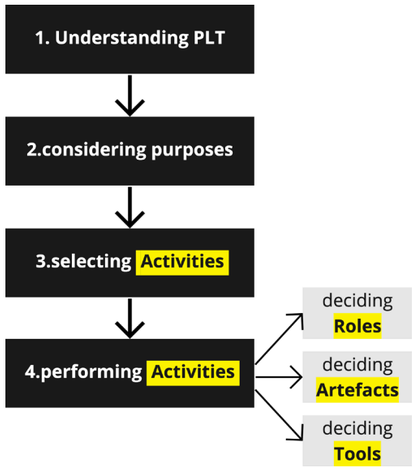


figure 5.2
procedure of using PLT
The four components of an approach are highlighted in yellow.

5.2 Setting up the Final Output

This section introduces how the final output was initiated.

5.2.1 Requirements for the Output

As this project aims to provide practical guidance for practitioners to use PLT effectively, a set of requirements for this output need to be defined first. According to the procedure of using PLT (figure 5.2), these requirements were formulated:

> *(1) The instruction needs to help practitioners reflect on their purposes.*
>
> *(2) The instruction needs to help practitioners choose relevant activities for achieving their purposes.*
>
> *(3) The instruction needs to help practitioners in performing the activities.*

In addition, I hoped the instruction itself could be intuitive to use. Therefore, another requirement on the output was:

> *(4) A guide to using the document should be provided to lead practitioners through the procedure step by step.*

Based on these requirements, the following sections elaborate on the development of the final document.

5.2.2 Format of the Output

This research project aims to provide practical instruction. However, as a PLT approach always depends on the specific context of the project and the values or expectations of the practitioners, it is impossible to provide a "fit-for-all" approach.

In contrast, what can be done is to allow practitioners to customise their own approaches according to the context. Due to this need for customisation and to fulfil the four requirements, the format of a **toolkit** was chosen for its practicality and

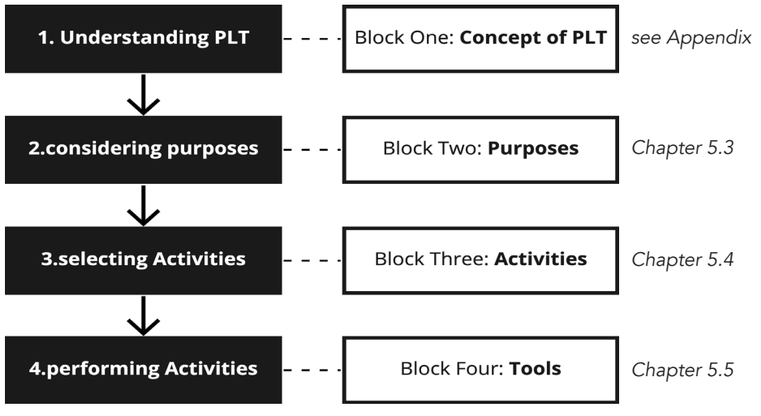


figure 5.3
the four steps of the procedure of using PLT corresponding to the four blocks of the toolkit

interactive nature (Behold and Beware, Design Toolkits - School of Design and Creative Technologies - The University of Texas at Austin, n.d.).

5.2.3 Toolkit Structure

According to the four-step procedure of using PLT defined in Section 5.2, the final toolkit was structured into four major blocks — **the concept of PLT**, **Purposes**, **Activities**, and **Tools** (figure 5.3).

However, this project did not aim to address all of the procedures, although the complete structure had been set up. Within this graduation project frame, only the parts relevant to ***deciding on approaches*** will be addressed. More specifically, the focus was on the ***Purposes*** and ***Activities*** blocks; and in the ***Tools*** block, only the tools contributing to choosing PLT approaches will be included in the current version of this document. While the other tools still require further research in future.

The first block — the concept of PLT — had been iterated through the workshops. In the following sections, the other three blocks, namely Purposes, Activities, and Tools, will be addressed.

5.3 Block Two — Purpose

The final document starts with a list of purposes, in response to the first requirement:

> ***Requirement (1)***
> *The instruction needs to help practitioners reflect on their purposes.*

In the workshops, providing some example purposes has been proven helpful to take participants one step back before deciding on their PLT approaches (see 4.3.3). Therefore, the purpose list (table 2.1) developed in Chapter 2.3 was incorporated in the toolkit document.

Simpler ↑ … ↓ *More Complex*

1	Looking for an overview of a domain.
2	Looking for reusable solutions/measurements to diagnose or make decisions for the current situation.
3	To create a toolkit for participatory (design) project.
4	To identify and externalise reusable solutions from past project experience.
5	To understand needs or externalise knowledge of stakeholders (and retain the authenticity of these insights throughout the project).
6	To elicit visions from stakeholders (and retain the authenticity of these visions throughout the project).
7	To identify future research priorities.
8	To build an ever-growing knowledge database for a domain.

table 2.1
Eight common purposes to use PLT

5.4 Block Three — Activity

Next, practitioners need to choose activities according to their purposes:

> ***Requirement (2)***
> *The instruction needs to help practitioners choose relevant activities to perform according to the purposes.*

This section contains three parts, Refining the Activities, Presenting the Activities and Choosing Activities.

First, by Refining the Activity (Chapter 5.4.1), the issues b, c, d identified in the workshops were tackled. This refining process involved adding certain activities and combining some activities into a new group. Four groups of 12 activities were generated. The four groups are (1) Aligning, (2) Framing, (3) Developing PL, and finally (4) Using PL.

Second, how are these activities presented in the final document is introduced in 5.4.2.

Third, how the document supports selecting activities is addressed in 5.4.3.

5.4.1 Refining the Activity

In Chapter 3, I had summarised four activities around a pattern language from Alexander's trilogy. According to ***Issues b, c, d*** from the workshops, these four activities were not comprehensive enough to support users to conduct PLT applications. Therefore, I refined these four activities into four categories containing 12 activities in total, as shown in figure 5.4.

The complete refinement process is visualised in figure 5.5.

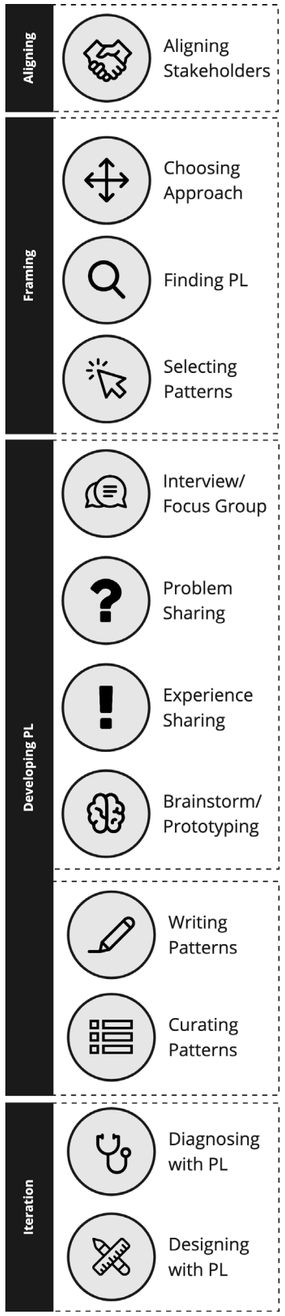


figure 5.4
12 activities and icons overview

Category 1: Aligning

An exclusive activity, ***Aligning Stakeholders***, was added.

This was because, for some complex purposes, in addition to choosing the Activities, practitioners also need to make decisions on Artefact and Roles, which fundamentally depend on practitioners' values and expected benefits. Therefore, clearly articulating and aligning the values or expectations is needed.

In addition, the value system of involved practitioners has been regarded as an essential element of PLT (Athavankar et al., 2014; Fincher, 1999). As values are usually concealed by practitioners (Van Onselen & Valkenburg, 2015; Bos-de Vos, 2020), an exclusive value aligning activity can practitioners express themselves, such as the Value-based Workshop in (Köppe et al., 2017). This activity can prepare the team to fundamentally eliminate possible disagreements in future activities, and it hence should be performed in the earlier stage of a project.

The Navigation Panel, the Approach Axes, and the Approach Detail Table are three tools that can jointly help practitioners choose a suitable approach (what and how) based on their values and purposes (why).

Category 2: Framing

Next, ***Selecting PL*** activity was complemented with two other activities — ***Choosing Approach*** and ***Finding PL***. These three formulated the second category of activities, namely *Framing*.

First, a Choosing Approach activity is needed to provide direction for finding and selecting the pattern language, including whether the pattern language should be visionary or empirical, and created by end users or professionals etc.

Second, before Selecting Pattern Language, practitioners need to find usable pattern languages to select from (in response to Issue d). Most cases or literature do not specifically detail this trivial but important process. Besides, in the workshops, participants also reported that they did not know the existence of relevant pattern languages (Issue d). Therefore, Finding PL was added as a particular activity to emphasise this underscored process and to prepare for the Selecting PL activity.

Finally, Selecting PL is where practitioners decide on the patterns to use in the project. This activity is helpful for defining the project scope (Alexander, 1979).

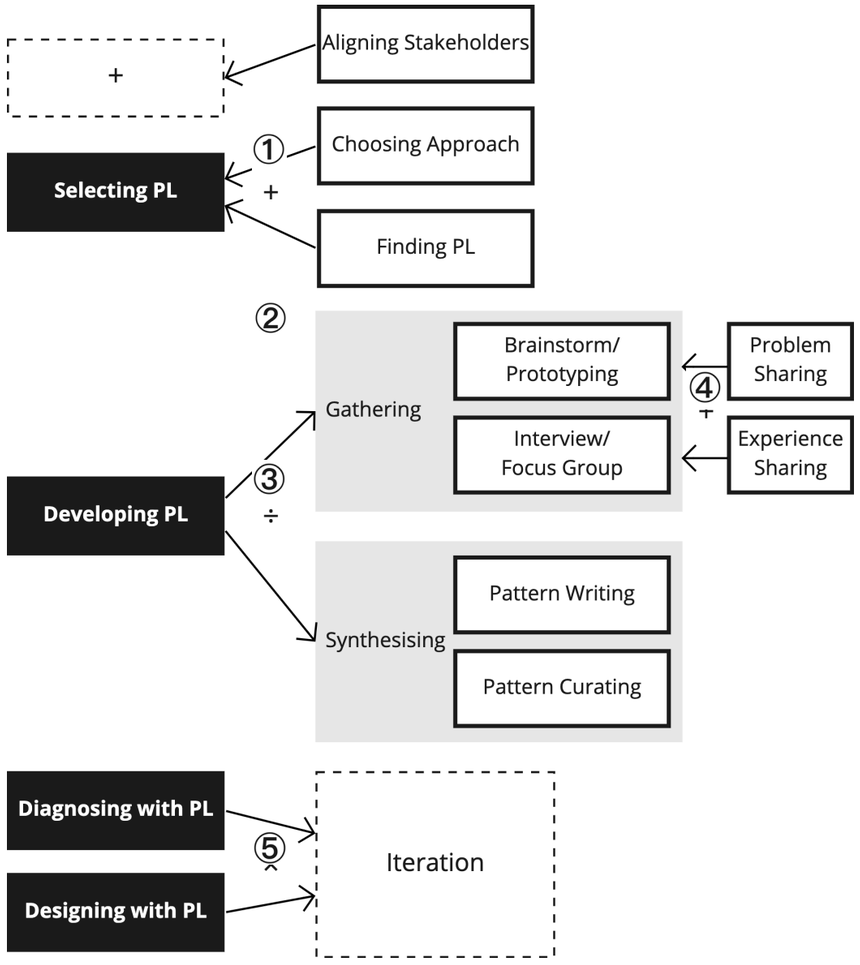


figure 5.5
an overview of refining the activities. Black rectangles represent the original four activities summarised from Alexander's trilogy.
① Add "Aligning Stakeholders"
② Add "Choosingn Approach" and "Finding PL" to "Selecting PL"
③ Divide "Developing PL" to gathering and synthesising
④ Add "Problem Sharing" and "Experience Sharing" to gathering
⑤ Combine "Diagnosing with PL" and "Designing with PL" into "Iteration"

Category 3: Developing PL

In the Developing PL activity, it was found that practitioners usually rush to complete a pattern language structure (Issue b). Therefore, to remind practitioners that the development process is usually long-term, I separated the Developing PL into two processes, namely Gathering and Synthesising.

First, the Gathering process means collecting knowledge. This process has usually been termed as "mining" (Iba, 2014) in literature, but this verb suggests what is being "mined" has already existed. As patterns can also be envisioned (Palmieri et al., 2021), I used the verb “gathering” instead. Four activities were included in the Gathering process, namely ***Interviews/Focus Group***, ***Brainstorming/Prototyping***, ***Problem Sharing*** and ***Experience Sharing***. The former two activities have been common in existing literature. The latter two were added to remind practitioners of the importance to involve non-professionals (in response to Issue c).

Second, ***Pattern Writing*** and ***Pattern Curating*** are two activities in the Synthesising process. These two activities have been commonly applied in diverse domains (Iba & Isaku, 2016, October).

Category 4: Using PL

The ***Diagnosing with PL*** and ***Designing with PL*** in Chapter 3 were combined into the fourth category, Using PL. Although the functions of Artefact (patterns or pattern languages) are different in these two activities, they are both activities of using a pattern language.

5.4.2 Presenting the Activity

The refinement ended up with 12 activities divided into four groups (figure 5.4). These results are presented in the final document in two ways.

First, the activities within each category are listed in a table, such as in figure 5.6. Each activity item in the table contains an icon, a brief description and existing supportive tools for it. In this way, practitioners can quickly have an overview of all activities.

Second, the detailed information of each activity is presented in a card format (or actually a pattern format itself). This card presents the essential information on how may an activity be performed and can direct readers to its related activities or helpful tools. Figure 5.7 is an example card of the activity Aligning Stakeholders.

	Activity		Description	Supporting Tool
Aligning		**Aligning Stakeholders**	**Stakeholders** reflect on and communicate about their underlying values.	**Navigation Panel** **Approach Axes**

figure 5.6
an overview table for activities in a category

Aligning

Aligning Stakeholders

Aim To elicit stakeholders' underlying value. To facilitate communication. To seek alignment in a long term.

Participants Any stakeholder. (Whether end-users are involved also reflect stakeholders' value.)

Timing Usually at the beginning of a project. Also could be used throughout the process to check the project progress.

Tool Navigation Panel, Approach Iceberg

Use After ... ...

Move on to ... **Choosing Approach**

Basic Procedure
1. Participants read the Navigation Panel and Approach Iceberg individually.
2. Participants consider which values and approaches are ideal for them.
3. Participants share their ideas and discuss.

Expected Outcome Ideally, stakeholders might align on their values. Another possibility is although an ultimate value consensus is achieved, stakeholders have to acknowledge that their current (short-term) values are divided.

However, even if no consensus was reached, this activity provides a chance for stakeholders to reflect on and articulate their values more explicitly, rather than remaining them tacit.

figure 5.7
The card of "Aligning Stakeholders"

5.4.3 Selecting Activities

The previous section introduces how the Activities for practitioners to choose from had been refined and presented. To meet the second requirement on the document, the correspondence between purposes and activities needs to be signified to practitioners.

> ***Requirement (2)***
> *The instruction needs to help practitioners choose relevant activities to perform according to the purposes.*

To illustrate this correspondence with ease, a visualisation tool — the activity icon map (figure 5.8) — was created. In the activity icon map, 12 activities in four categories (as defined in 5.4) were organised into a memorable shape. For each purpose, the activities that are recommended to perform are colour-coded to provide an immediate visual representation.

For example, the icon map for Purpose 3 in figure 5.8 (to create a toolkit for a participatory project) shows that 5 activities (coded as yellow) should be performed: Aligning Stakeholders, Choosing Approach, Finding PL, Selecting Patterns, and Diagnosing the Situation.

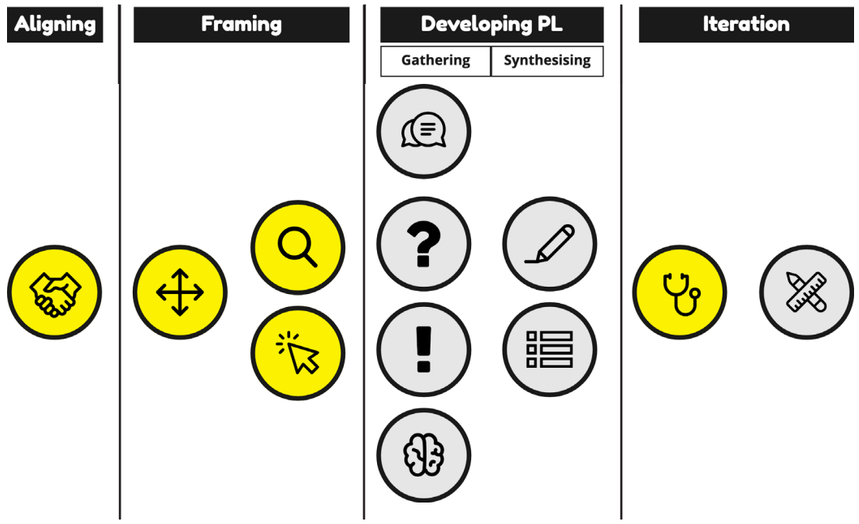


figure 5.8
the activity icon map for purpose 3 "to create a toolkit for a participatory project". The recommended activities are coded yellow.

5.5 Block Four — Tools

Previous sections introduce the document contents that can lead practitioners to first consider their purposes, and second find a recommended combination of activities. Finally, the document needs to help practitioners carry out the recommended activities.

> ***Requirement (3)***
> *The instruction needs to help practitioners in performing the activities.*

The last component of PLT approaches, Tool, is taken as the medium to provide support for performing activities. In the final document, the three tools — the Approach Axes, the Navigation Panel, and the Approach Detail Table — are included since they are helpful in Aligning and Framing activities. In addition, the pattern format proposed by Alexander (Chapter 2.1.1) is added since it is supportive to Developing PL activities.

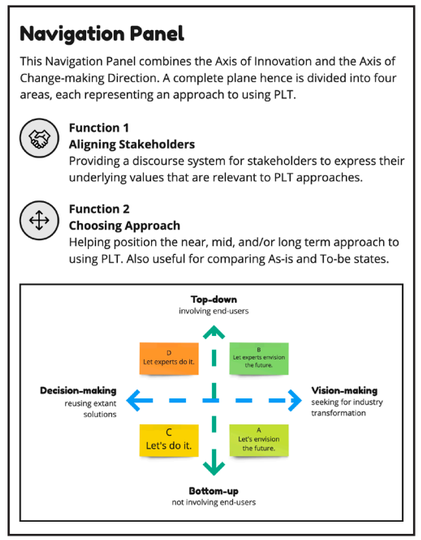


figure 5.9
a detailed description for Navigation Panel

These tools are presented in the final document in three ways. First, for each tool, a description, plus the activities that it could support is introduced (such as in figure 5.9). This provides detailed information about each tool, and allows practitioners to explore it by themselves. Second, all the four tools are presented in one table to provide an overview. Third, the tools' names can be seen in the activity overview table (figure 5.6) to provide a quick index, allowing practitioners to find the needed tools when reading about activities.

5.6 Synthesising

With all the blocks ready, the final document was formulated. As suggested in the 4-step procedure of using PLT, ***Activities are the fundamental elements to decide on in a PLT approach***. Therefore this document was named the **Activity Kit**. A guide to using it has been developed to fulfil the fourth requirement:

> ***Requirement (4)***
> *A guide to using the document should be provided to lead practitioners through the procedure step by step.*

5.6.1 Chapter Overview

The Activity Kit was structured into 6 chapters from 0 to 5, with Chapter 0 as the introduction chapter and Chapter 5 as the conclusion chapter. The main contents from Chapter 1 to Chapter 4 are:

> *In Chapter 1, the concept of Pattern Language Theory is introduced.*
>
> *In Chapter 2, 8 common project purposes that can be realised with PLT are presented in a table. For each purpose, the activities that should be performed are visualised with an activity icon map.*
>
> *In Chapter 3, 12 activities commonly involved in PLT projects are introduced. First, an overview of the 12 activities is presented in a table. Second, the details of each activity are presented.*
>
> *In Chapter 4, 4 tools that can assist the activities are introduced in detail.*

5.6.2 Guide to Use

The Activity Kit was designed for those who are new to PLT but should also prove useful to more experienced practitioners. For practitioners not knowing the pattern language approach, the introduction chapter inspires them to consider how the advantages of PLT might be useful.

As discussed in 5.1, a recommended procedure to apply PLT involves four steps. In this Activity Kit, each step is deliberated with one chapter. A flow map (figure 5.10) was formulated to provide an overview of the four-stage procedure and introduces which chapter should be referred to at each step.

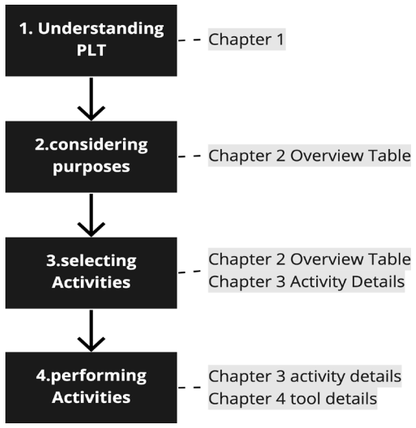


figure 5.10
The guide to use the Activity Kit

5.7 Discussion

The Activity Kit is not a final version. A disclaimer is added to the Activity Kit to provide these reminders.

First, the purpose list does not exhaustively enumerate all the purposes that can be achieved with PLT. Users of the Activity Kit are encouraged to be creative in combining activities according to their specific purposes.

Second, in addition to the four tools, more tools are needed to support the execution of some activities.

5.8 Summary

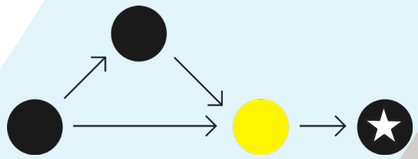
> ***Answer to Research Question (3)***
> *How can practitioners be supported in applying PLT?*

1. The Activity Kit was developed as the final document which can provide step-by-step instruction for practitioners to take an appropriate approach to using PLT. The complete procedure involves four steps:

   a. understanding PLT
   b. considering purposes
   c. selecting activities
   d. performing activities

2.The Activity Kit contains four parts — an introduction to PLT, eight common purposes that can be achieved with PLT, twelve activities to choose to use PLT, and four tools to support carrying out the activities — each part corresponding to one step.

3.The Activity Kit is not yet complete due to the timeframe of this graduation project. Users of it can create new combinations of activities to fulfil their specific purposes. More tools still await development to support the other activities.



Validate the Activity Kit

At the end of the research, the Numansgors project was taken as a validation case to show how PLT and the Activity Kit could be used. Practical suggestions for Numansgors were also generated in this stage.

To first confirm the suitability of PLT for the Numansgors project, a **case study** was performed. Proofs for the case study were gathered from a review, interviews, and surveys. The case study showed that PLT was suitable for solving the challenges in Numansgors. Therefore, the Numansgors project was used to **validate** the Activity Kit. Practical suggestions for Numansgors were generated.

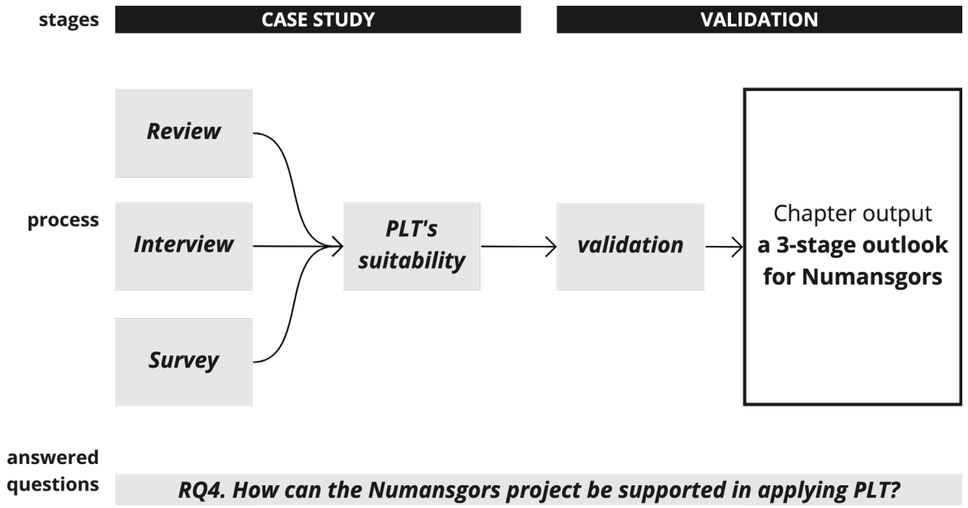


figure 6.1
Chapter 6 overview

6.1 Introduction

To validate the Activity Kit, I wanted to use the Numansgors project as an example. Before this validation, it was necessary to confirm the suitability of PLT in solving Numansgors' challenges. Therefore, a case study was set up.

6.1.1 Case Study

The objective of the case study was to confirm the suitability of PLT in Numansgors. At the beginning, a brief review of the project background (6.2) was performed to introduce the global challenges in housing renovation, the Numansgors context and the main stakeholders in the Numansgors project. Next, a series of field research on two main stakeholders, including interviews of GORS2025 (6.3) and surveys of residents (6.4) were conducted to gain a deeper understanding of their needs, expectations, and values.

Finally, these research insights were synthesised and used to prove PLT's suitability in Numansgors (6.5).

6.1.2 Validate Activity Kit

Based on the case study results, it was confirmed that the problems met in Numansgors could be supported by using PLT. Therefore, the Numansgors project could be taken as an example to validate the Activity Kit (Chapter 6.6). This validation process at the same time was also expected to generate practical implications for Numansgors.

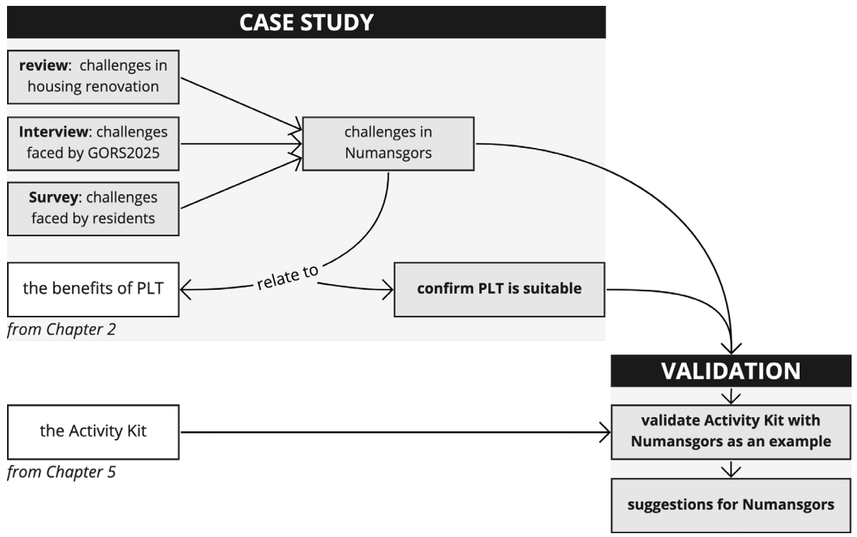


figure 6.2
from case study to the validation of Activity Kit

6.2 Background

To understand the background and the commonly faced challenges in housing renovation, a brief review on the housing renovation domain was performed. Later on, the specific context and main stakeholders of Numansgors were also introduced.

6.2.1 Housing Renovation

Housing renovation, also known as housing upgrading, refurbishment, or retrofitting, is one of the most efficient ways to boost building energy efficiency (Jowkar et al., 2022). Furthermore, it has the potential to improve residents' living experience, resulting in favorable social, health, and economical outcomes (Klink, 2014; Acolin & Green, 2017). Due to the late adoption of energy efficiency rules in the Netherlands, many ancient housing stocks built before 1975 have low energy quality (Jong et al., 2005). As a result, housing rehabilitation is a valuable chance to enhance sustainability in the Netherlands efficiently due to the comparatively low cost plus high added value, the large quantity of old housing, and the necessary accessible technical solutions (Trecodome, 2008).

Housing renovation has been progressing in recent years. However, the total rate of sustainable renovation in the EU remains low. According to (European Commission, 2020), only 1% of the houses in EU are renovated annually, and only 0.2% have implemented a renovation that reduces energy consumption by more than 60%. **The low renovation rate can mainly be attributed to the complexity of housing renovation.** On one hand, renovation is complex (Wilson et al., 2015; Risholt & Berker, 2013; Grecchi, 2022) since much technical or financial knowledge needs to be communiated during this process (Jowkar et al., 2022; Y. Wang et al., 2022). On the other hand, various stakeholders need to be engaged (Hasselkuß et al., 2016; Gomes et al., 2018), which also adds to its complexity. **Especially, the effective participation of homeowners** — who are the final decision-makers and end users of the renovation output — has been acknowledged as one of the most important factors in facilitating housing renovation (Czischke, 2017; Y. Wang et al., 2022; Fruhmann & Knittel, 2016; Hauge et al., 2019; Wang et al., 2016). In the Netherlands, any renovation decision on a joint land or requiring collective investments requires the agreement of more than 70% of the occupants (Ham et al., 2009). However, this ratio is often hard to achieve (Jowkar et al., 2022) due to occupants' various motivations caused by their divergent socio-economic backgrounds (de Oliveira Fernandes et al., 2021; van Geenhuizen, 2018).

Another factor contributing to the slow pace of house renovation is the **tension between individual requirements and communal interests**. When locals feel their private rights or autonomy are being violated, conflicts and even polarization might result (Swyngedouw, 2014).

Therefore, **housing renovation for sustainability as an emergent domain, still requires extensive knowledge exchange and experience accumulation**, which is also part of the reason for Numansgors stakeholders to seek technological possibilities, managerial insights and successful cases or experiences from academia and students.

6.2.2 Numansgors Project

Numansgors is a village located on the water, close to Rotterdam, which was in the 1980s built by the architectural bureau Van der Broek & Bakema as a luxury holiday destination. In 2013, it began to offer permanent residence. The park consists of 201 houses, each with a parking space and a berth. In addition, there are shared facilities and activities which are managed by the Association of Homeowners (VvE).

To meet contemporary energy requirements, **GORS2025**, an initiative including 4 volunteers, hence was set up with the aim to make Numansgors more sustainable and maintaining its aesthetics. In this process, housing renovation, which entails the engagement of homeowners, is required (Czischke, 2017).

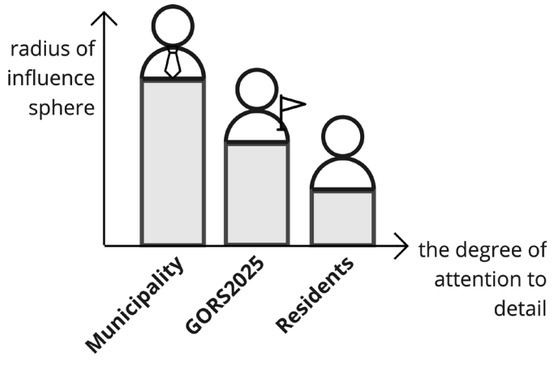


figure 6.3
three stakeholders in the Numansgors project, with their influence sphere and care to details

6.2.3 Numansgors Stakeholders

The Numansgors project mainly involves three stakeholders, namely GORS2025, residents, and the local municipality.

The goal of GORS2025 is improving sustainability by 2030 and achieving fossil-free by 2040. These ambitions are in line with the objectives of the municipality of Hoeksche Waard. Although GORS2025 members are also local residents, they act as the activity facilitators and hence have a larger sphere of impact. GORS2025 members hope to avoid aesthetic fragmentation of the whole park, which is a more overarching concern than individual residents' concerns regarding their own households. In addition, GORS2025 members look for collective measures that can enable opportunities for technologies such as heat storage.

The residents are the end users of the renovation projects in Numansgors. They are the stakeholders with most concerns to the possible impact of changes on their daily practices. At the same time, they have the least impact on decision-making for the whole location. According to GORS2025, the residents have divided expectations on how to take measures because of their diverse socio-financial interests and needs for autonomy.

The local municipality of Hoeksche Waard has the largest impact over the area among the three stakeholders, while has the least attention to residents' detailed needs. The municipality decides on the sustainability vision for Numansdorp in response to the requirements given by higher-level municipalities. The municipality is also involved in the projects in other locations nearby.

These three main stakeholders exert different levels of impact in Numansgors and show different levels of concern to life details. An overview of three stakeholders can be seen in figure 6.3.

6.3 Interview GORS2025

The first phase of the field research involved interviewing the GORS2025. The initial goal of this interview was to have an overview of the situation and to understand the role and values of GORS2025 members. After the development of the Activity Kit, the data analysis focused on the needs and difficulties met by the committee, which might also be good reasons to apply a new methodology — PLT.

6.3.1 Method

Three semi-structured one-on-one interviews were conducted. To avoid losing key information which seemed beyond my preset scope, I used semi-structured interviews that allowed the interviewee to freely explore emerging topics of interest throughout the process. The questions and procedure were formulated along a timeline suggested in the Make Toolkits by (Sanders & Stappers, 2012). Beginning with the present experiences, via past memories, finalising with expectations of the future, this timeline allowed participants to gradually reveal and express their tacit and latent knowledge (Sanders & Stappers, 2012).

The participants were three members of the GORS2025 approached by direct contact with the help of WUR science shop. Each interview lasted around 60 minutes. The processes were audio recorded and transcribed for analysis.

6.3.2 Procedure

The interviews took place at the home of each participant to settle the participants in a comfortable and relaxed state. In the beginning, participants were sensitised to share what they like or dislike about their neighbourhood. The main activity involved three sections of questions, respectively inquiring about the present, the past and the expected situations (figure 6.4).

The Present

First, the current situation of the Numangors project was inquired about. Questions involved how the Numansgor project was planned, and in which stage were they at that moment etc.

The Past

Later on, participants were interviewed about the history of related renovation projects/activities in Numansgors. The focus was especially on a solar panel project initiated during 2016-2017. Questions involved how was the process and how was the results etc. This section aimed to find out participants' underlying preferences by comparing the past to the present. This also helped me confirm that recurring problems and proven practices had already existed in Numansgors, which showed potential to be translated into a pattern language.

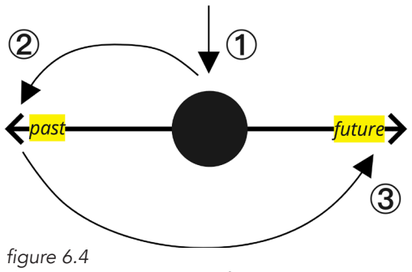


figure 6.4
the interview progresses from
① the present situation
② via recalling the past,
③ ends with expressing future expectations
adapted from Convivial Toolbox figure #3.10
(Sanders & Stappers, 2012)

The Future

Last, participants were asked about their dreams and expectations for the future. Questions involved what outcomes were aimed for and what was expected from involving uni-students etc.

6.3.3 Analysis

After the interviews, the audio data was transcribed into texts. Then a round of coding was performed to analyse the transcriptions. The coding took place before the Activity Kit is structured. Therefore, without an intentional direction at that stage, an inductive coding approach was taken to explore the materials in more detail. After the Activity Kit had been structured, the codes from the first round of analysis were clustered and the insights related to the committee's purpose were retrieved in the transcription (Christians & Carey, 1989). The clustering process ended up with the findings in the following section.

6.3.4 Findings

The beliefs and needs of GORS2025 members were summarised through analysis. An overview can be seen in figure 6.6.

Two Beliefs

First, the committee members shared the belief that the Numansgors project would be a long term process. At the moment of interview, their goal was to have all homeowners improve their individual home insulations. After that, the committee hoped homeowners could wait for the results from researchers about whether a collective approach or individual approach would be better for them.

Second, as homeowners themselves, committee members also believed that every decision should be made by residents without being forced. This was not in line with some residents' (biased) opinion that "VvE doesn't respect the private sphere", which reflects a **communication failure** between the two stakeholders.

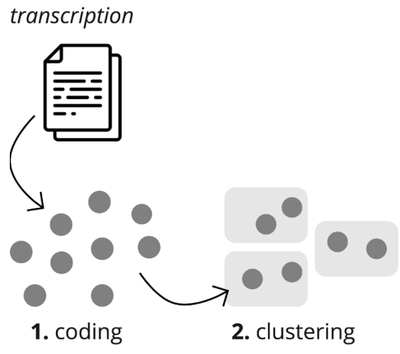


figure 6.5
the process of analysing interviews

Three Needs

In addition, three themes informing the committee's needs were summarised. First, the committee was looking for new **technical possibilities** that were available to help achieve carbon neutrality, either collectively or individually. Second, the committee wanted to gain insights about local residents' needs and opinions on the project and on the committee to better **support residents** in their own actions. Third, the committee hoped to **maintain the consistency** of Numansgors in terms of aesthetics.

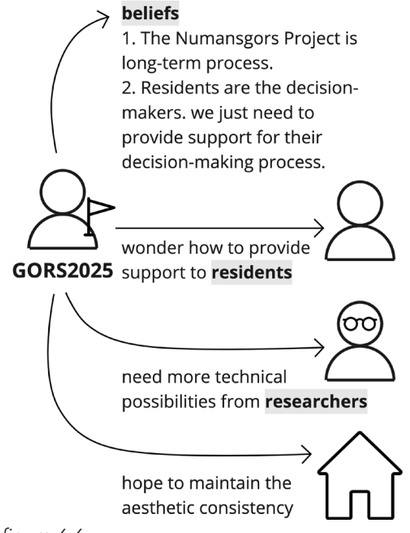


figure 6.6
an overview of GORS2025 opinions

6.4 Survey Residents

The second phase of field research involved a questionnaire for residents. Based on the insights from interviewing GORS2025, the residents are the most important decision-makers in the Numansgors project. In the analysis of questionnaire responses, the focus was on what were residents' needs that might be better addressed with PLT.

6.4.1 Background

At the initiation stage of promoting energy neutrality, data on the current energy consumption in Numansgors was required. Although GORS2025 members had been interviewed, they were not representative enough as residents since they were assumed more positive and active in making sustainability changes.

In addition, an overview of residents' opinions towards renovation for sustainability was needed. Besides, as an information meeting had been organised on 24th March, GORS2025 members would like to know residents' opinions on the meeting hence to improve their work.

Therefore, to learn about the consumption data and residents' opinions, a survey was considered an appropriate approach. The other students involved in the Numansgors project was also seeking relevant information from residents. To avoid disturbing the homeowners twice, the other students' questions were combined in the same questionnaire.

6.4.2 Method

The fundamental objective of the questionnaire was to investigate homeowners' needs, on the scales of both individual buildings and the neighbourhood. The inquired needs were not limited to renovation for sustainability, but encouraged residents to express their needs of any kind.

The questionnaires were available both online and via hard copy versions. The paper version was distributed via mailboxes. The online version can be accessed via the QR code printed on the paper version and was also distributed among homeowners through chats with the help of the GORS2025.

The questionnaire was designed in English and later translated into Dutch to seek a higher response rate. The GORS2025 members and my 3rd party tutor Zoë both helped in proofreading the Dutch version questionnaire.

The questionnaire involved 8 sections of questions:

1. *basic information about household*
2. *consumption and facilities*
3. *need for improvement*
4. *need for information*
5. *values for sustainability*
6. *collective or individual*
7. *feedback on the information meeting on 24th March*
8. *suggestions to the VvE*

There are in total 201 houses in Numangors, with some houses owned by the same households. At last 24 paper questionnaires with answers are received, containing one duplicate. 25 online responses are received, containing two duplicates. In total, 46 effective responses were collected for analysis. This number was not sufficient to provide a statistically valid overview of the energy consumption in Numansgors according to the suggestion by (Israel, 1992), but could provide qualitative insights on residents' needs and expectations.

6.4.3 Analysis

When analysing the questionnaire responses, the Activity Kit was already taking shape. Since the Activity Kit suggests ***considering the purposes first***, a specific focus of the analysis was on the responses that reflect residents' purposes.

Textual answers were analysed by coding. The answers were scanned through and coded in an inductive approach. Related codes were clustered and summarised into several themes.

Some multiselection question responses were presented with a pie chart to show respondents' opinions overview. While it needs to be noted that the number of collected responses was not large enough to represent the whole Numansgors population.

6.4.4 Findings

Through the questionnaires, important findings about residents' needs and expectations were summarised. Table 6.1 provides an overview of these findings.

	findings
Autonomy & Community	*1. Residents need autonomy in making decisions.* *2. Residents think more other forms of collective measures are achievable.*
Need for Information	***1. Information Type*** *Financial information, technical information, progress and expected outcomes of Aquathermie*
	2. Information Format *In addition to website, neighbourhood talk and newspapers, information meeting was also regarded as informative*
	3. Autonomy in Accessing Information *Disparity in knowledge needs annoyed some residents if they would waste time on something already known*
	3. Information Justice *Unbiased information presentation enhance residents' trust in GORS2025. Residents also want more information from the municipality.*

table 6.1
an overview of questionnaire findings

The questionnaire findings are detailed as follows.

Autonomy & Community

Each household was unique in its needs and expectations, hence required autonomy in making their own decisions. This has reconfirmed that a "fit-for-all" vision would compromise the nuanced and detailed life practices of individual homes (Palmieri et al., 2021). Some respondents expressed a strong determination to be independent:

> *Geen collectieve renovaties. Het is mijn eigen huis en ikzelf bepaal wat er met mijn huis gebeurd.*
> *(No collective renovations. It is my own house and I decide what happens to my house.)*

Although some homeowners disliked the idea of a collective heat storage system, other forms of collective measures remained possible. For example, Collectively purchasing and Sharing knowledge/personal experiences were two most agreed on measures by the questionnaire respondents that could leverage the value of a community.

Information Need

Information was considered the most important resource needed for decision-making by residents. More specifically, residents had requirements on the types of information, the format of information, their autonomy in accessing information, and information justice.

Important information for homeowners mainly fell into two types, namely financial information and technical information. Residents' needs for these two types of information can be seen in diagram 6.1.

Financial information — including subsidy and expected price of the collective heat storage — were the most urgently needed information by homeowners. Residents in Numansgors specifically needed information about subsidy because the subsidies in Netherlands had been promoted much in recent years, to increase residents' adoption of energy-saving measures including solar panel and heat pump etc. However, whether the subsidies could be obtained depended on various factors, such as whether the measure was performed by a recognised installer etc. Some residents also recognised this in questionnaires:

> *... deze moeten door een erkend installateur worden gedaan. Als je het zelf doet krijg je geen subsidie helaas.*
> *(... these must be done by a recognized installer. If you do it yourself you will not receive a subsidy unfortunately.)*

Technical information was also important in informing good decision-making. This partly confirmed the insights from (Ebrahimigharehbaghi et al., 2020) that finding technical solutions is the main transaction cost (non-monetary costs) barrier. According to (Ebrahimigharehbaghi et al., 2020), current main sources of technical information for homeowners in sustainability renovations are "construction stores/Do It Yourself (DIY), installations and maintenance companies". According to (Jager, 2006), information meetings and social networks on motivating consumer adoption are also identified as exerting positive effects in decreasing the barriers to PV adoption in the Netherlands.

Another important information for residents was whether the expected benefits of a measure could be realised. Before knowing this information, the residents might have a preference on either collective or individual measure, but would not make the final decision. If the expected benefits could not be realised, the residents might change their decisions (figure 6.7). For collective measures, financial benefits were the expected benefit for most residents (65.22%). For individual measures, many respondents thought that an individual measure permitted higher independence (56.52%) and a faster execution (50.00%). Financial benefits were still considered important by some respondents (30.43%).

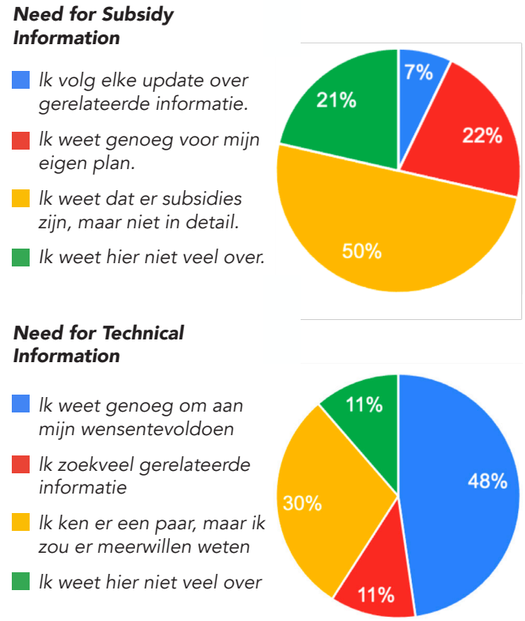


diagram 6.1
residents' responses on their needs for subsidy and technological information

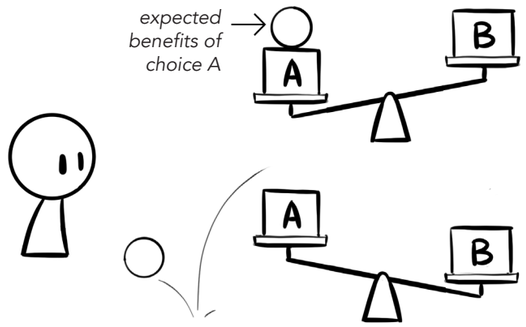


figure 6.7
resident's choice might change if the benefits they expected cannot be achieved,

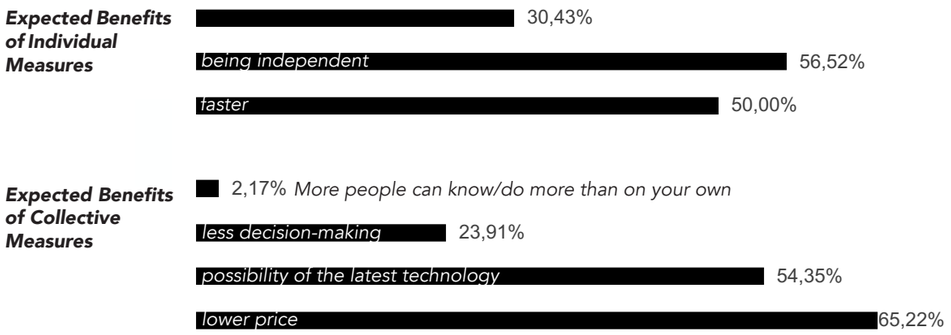


diagram 6.2
respondents' expected benefits of collective measure and individual measure

Information Source

The top three popular sources of information among residents were websites (including governmental websites), communication with fellow residents, and newspapers. The information meeting organised on 24th was also a good form of information exchange. 43.48% of the questionnaire respondents joined the information meeting on the 24th. In addition, two participants suggest giving presentations in a house with a same style with the ones in Numansgors:

> *Presentaties in eenzelfde huisstijl van het Numansgors ...*
> *(Presentations in the same house style of the Numansgors)*

> *Een model woning inrichten*
> *(Furnishing a model home)*

Autonomy in Accessing Information

Individuals had diverging information needs. However, these disparities had not been addressed enough. Due to finance restrictions and need for efficiency, customised consultation could not be achieved and the exchanging information in Numansgors was still same-for-all.

During the information meeting on 24th March, when a lecturer introduced insulation solutions, one participant commented that the presentation had no difference from the information provided by his energy consultants. As can be expected, spending the whole evening on the information already known could be frustrating (figure 6.8).

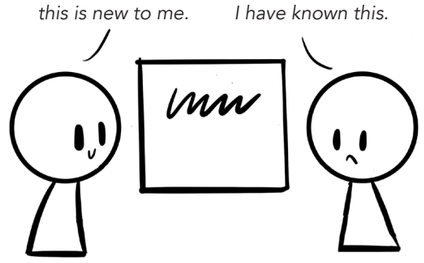


figure 6.8
some participants with more knowledge feel the information meeting was redundant

This disparity in information need was also reflected in questionnaire responses. Among the 20 respondents who attended the meeting, most thought the information meeting was satisfying (40%) or very satisfying (20%). Still 25% respondents felt it neutral and 15% thought it was unsatisfying. Main reasons mentioned for the negative feedback included "too much basic knowledge"(4 responses), or "information about collective measure (Aquathermie) was not sufficient" (2 responses):

> *Te veel basale informatie ...*
> *(Too much basic information ...)*

> *Veel tijd nodig voor zaken die al bekend zijn*
> *(Needs a lot of time for things that are already known)*

A proper way to deal with the divided information needs could improve residents' experiences on accessing information.

Information Justice

Unbiased information sharing during the information meeting on 24th was considered an advantage by respondents. Participants felt they were not forced to take collective measures.

> *Alle facetten werden belicht. Niet alleen collectieve oplossingen maar ook individuele.*
> *(All facets were highlighted. Not only collective solutions but also individual ones.)*

The residents also wished to align with other stakeholders such as the municipality.

> *Inzicht in het beleid en tijdpad van de gemeente en inzicht in de bereidheid van de bewoners om te werken aan collectieve oplossiongen*
> *(need insight into the policy and timetable of the municipality and insight into the willingness of residents to work on collective solutions)*

If collective measures would be taken, respondents hoped to be kept informed of the project progress. Several respondents hoped to receive a regular newsletter for it.

6.5 Case Study Conclusion

The findings from previous research were synthesised into research conclusions. Later, these conclusions were related to the benefits of PLT to conclude on the suitability of PLT in Numansgors.

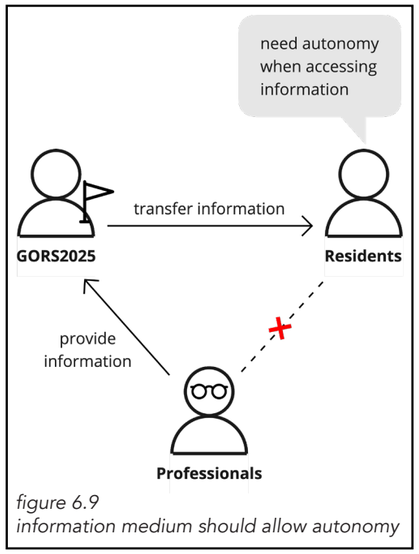


figure 6.9
information medium should allow autonomy

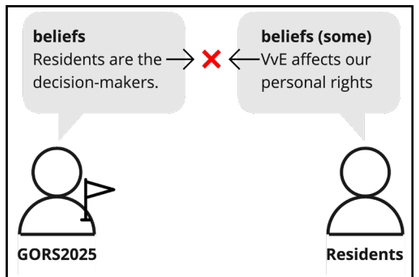


figure 6.10
values should be better communicated

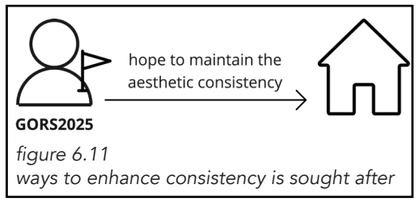


figure 6.11
ways to enhance consistency is sought after

6.5.1 Research Conclusions

Based on the desk research and the field research, the challenges faced in Numansgors fell into two categories:

(1) Ineffective Communication

First off, GORS2025 wanted to learn about technical and financial information from professionals, and transfer it to the residents to support their decision-making process. Although the information meeting allowed GORS2025 to share knowledge, it did not permit enough autonomy for residents. Therefore, an information medium allowing residents to access with autonomy is needed.

Besides, some residents thought GORS2025 would disturb their private rights, although GORS2025 shared the belief that residents had the freedom to make decisions. This could be attributed to the lack of communication over values, which also concurred the findings by (Swyngedouw, 2014). Chances for value exchanging are needed.

In addition, the justice of information was valued by residents.

(2) Difficulty in Maintaining Consistency

Last but not least, without coordination between individual residents, the aesthetic consistency expected by GORS2025 would be hard to achieve. A method to promote the coordination between individual residents' choice is needed.

6.5.2 Suitability of PLT

Based on the research insights, it can be seen that **if there is a pattern language** for the Numansgors project, both the GORS2025 and individual residents can benefit from it.

First, with the benefit to promote ***knowledge management***, the pattern language can serve as a knowledge medium which allows users the autonomy to access only needed information.

Second, a pattern language can assist promoting ***consistency*** for Numansgors. If all residents refer to the same pattern language provided by GORS2025, they hence will use the same pattern when meeting the same problem. In such a way, the residents can take the same approach and maintain Numansgors consistent.

Third, although a pattern language does not directly support value exchanging, it permits the chance of doing so. On one hand, it can improve information justice ***if it is developed in a "bottom-up" approach***. On the other hand, the activity of ***Aligning Stakeholders — one activity recommended in the Activity Kit — can be performed*** to open up the conversation between all stakeholders, which might help with value exchanging. Besides, if a better practice to align residents and GORS2025 could be found out, it can be written into a new pattern and curated into the pattern language for improving Numansgors sustainability.

To demonstrate this suitability more concretely, I give examples on this light yellow background. Suppose here is a pattern language for Numansgors:

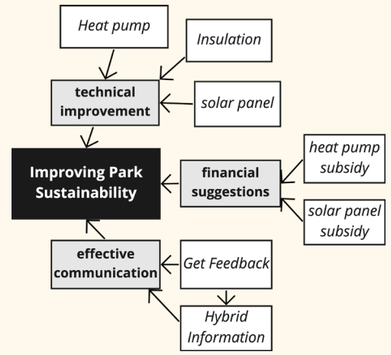


figure 6.12 A pattern language for improving Numansgors sustainability

Corresponding to the three arguments on the left, here are three examples:

1. Access knowledge with autonomy

Tim, a resident in Numansgors, has got solar panels for his house. Therefore, when accessing knowledge from this pattern language, Tim can skip the patterns for solar panel and solar panel subsidy (figure 6.13). However, it is difficult to skip a part of information meeting about solar panel.

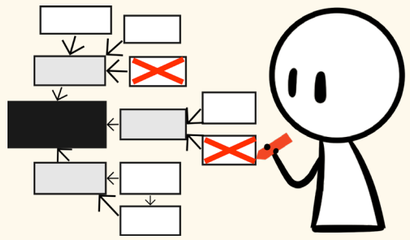


figure 6.13
Tim skips the patterns related to solar panel

2. Achieve Consistency

Amy, Dan and Jane all look for solutions for solar panels. Since they all refer to the same pattern language, they hence would use the same solution from the pattern "Solar Panel" (figure 6.14) and all purchase the black and 140cm solar panels.

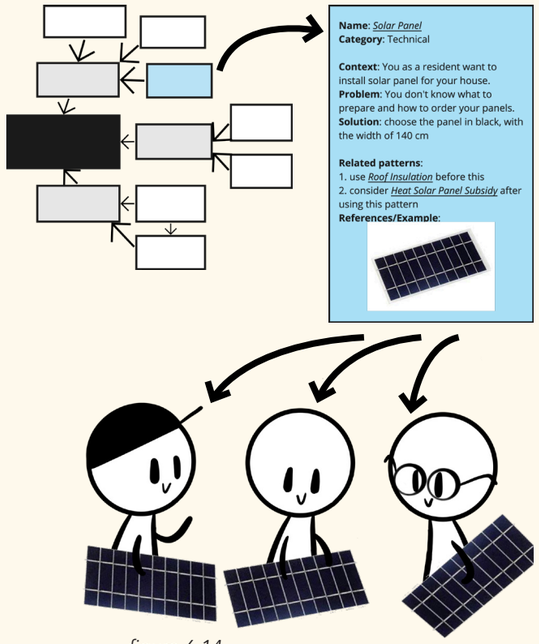


figure 6.14
Residents get the same solar panel based on the same pattern

In fact, the practice of sharing the same solution to maintain consistency has been tried in Numansgors in the solar panel project in 2016-2017, when all the residents were suggested to use the solar panels with the same appearance.

3. Value Communication

Last but not least, if stakeholders perform the "Aligning Stakeholders" activity recommended in the Activity Kit, they will be able to communicate about their underlying values. Even if stakeholders still cannot align, this is still a valuable start for stakeholders.

Besides, if technology can be used to make sure this pattern language is unbiasedly accessible to all residents, residents can have more trust on it, satisfying residents' needs for ***information justice*** (see page 91).

In addition, if a good practice for aligning values is found, a new pattern "aligning values" can be added to the pattern language:

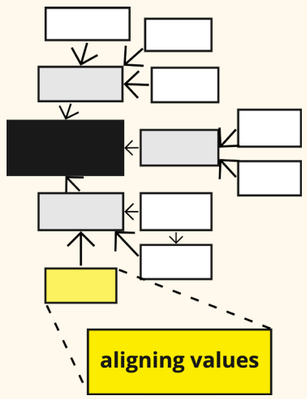


figure 6.15
A new pattern "aligning values" is added to describe the problem and a good practice

This pattern then can be reused in the future.

Although these benefits are achievable, we have to admit that ***there is not yet a ready-to-use pattern language*** for Numansgors. Nevertheless, ***there are already possibilities to start building a pattern language***. This is because, in Numansgors, some good practices — such as the successful renovations of individual homes, and the good communication approaches tried by GORS2025 — already exist, and can be made into patterns. ***The sooner these good practices are made into patterns, the sooner the knowledge can be reused by others.***

This pattern language development process is also advantageous for the developers themselves. On one hand, they can help others and feel a sense of engagement. On the other hand, they can iterate on their own patterns through the feedback from others.

From the survey, residents also needed to align with other stakeholders, including the municipality and energy companies (see page 93, Information Justice) to ***have a comprehensive understanding of the situation***. This lack of an overview also existed in other projects aiming for community sustainability (Finidori, 2016). If all individual stakeholders can externalise their knowledge into patterns, a shared overview can be generated by connecting all the patterns into a complete pattern language.

Again, in this light yellow text box, how the benefits of "reusing knowledge", "iterating knowledge", and "creating a shared overview" can be achieved, is demonstrated in the following examples.

1. Reuse Knowledge

For example, the GORS2025 can write a pattern about how to organise an information meeting providing both in-person and online entries. Reading this pattern, the committee in another location can reuse this knowledge and organise their own hybrid meetings.

2. Iterate Knowledge

At the same time, the committee in another location can provide feedback for GORS2025 on this pattern. In such a way, GORS2025 can iterate and continuously improve their communication approach.

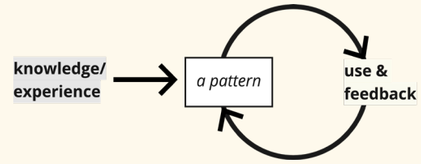


figure 6.16
a pattern can be iterated through use

3. Create a Shared Overview

The municipality can write what they know into patterns to share knowledge with residents. In the same way, residents can write down their confusion on a pattern template (filling only the "problem" part), so the municipality and GORS2025 can provide more targeted support by completing the pattern.

Although the pattern language development process can be initiated by any stakeholder, ***the municipality*** — with larger influence on more projects in the same domain — ***is the best candidate to initiate and maintain the pattern language.***

In addition, researchers can also contribute to the development process by adapting patterns from other domains.

6.5.3 Conclusion

As learned from the literature review in Chapter 2, PLT is a design methodology that have supported the participation of end users in many domains such as urban planning (Alexander, 1975) and policy-making for collective dwellings (Palmieri et al., 2021).

Based on the field research, the challenges faced by the Numansgors project have been identified. These challenges are solvable by using PLT, as demonstrated in the examples. Therefore, the potential of using PLT to support the Numansgors project has been confirmed.

6.6 Validate the Activity Kit

Since the Numansgors project can be supported by PLT, it can be taken as an example to validate the Activity Kit. This validation involved two steps. First, since there were three main stakeholders in Numansgors, the purpose of each stakeholder was taken into account. Second, as the recommended activities for each stakeholders were closely related, a joint outlook was formulated to synthesise them. The two steps are detailed respectively in Section 6.6.1 and Section 6.6.2.

In addition, this validation process already generated practical suggestions for Numansgors.

6.6.1 Use PLT Individually

Informed by the Activity Kit, before answering what activities should be performed, the actual purpose for each stakeholder to use PLT needs to be considered (see Section 5.6.2). In other words, what was expected by each stakeholder from using a pattern language or developing a pattern language?

Based on the insights from the case study, the purposes of individual stakeholders to use PLT can be corresponded to the purposes in Activity Kit as follows.

The GORS2025 can use the pattern language as a toolkit to support all residents in making their own decisions, which can also help maintain the aesthetic consistency of Numansgors (purpose 3).

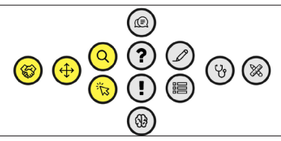
	Purpose	Specific User	Recommended Activities
3	To create a toolkit for participatory (design) project.	facilitating a participatory project	

figure 6.17
purpose 3 and its recommended activities

The residents can find solutions to the problems they met from the pattern language and use them to make decisions for their own homes (purpose 2).

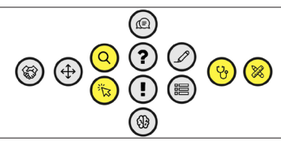
	Purpose	Specific User	Recommended Activities
2	Looking for reusable solutions/measurements to diagnose or make decisions for the current situation.	practitioners	

figure 6.18
purpose 2 and its recommended activities

In addition, the municipality and researchers can initiate and maintain the pattern language for "making Numansgors more sustainable" (purpose 8).

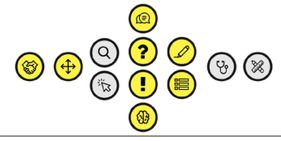
	Purpose	Specific User	Recommended Activities
8	To build an ever-growing knowledge database for a domain.	Stakeholders that facilitate multiple projects in a same domain	

figure 6.19
purpose 8 and its recommended activities

In the Activity Kit, users can find an ***activity icon map*** for each purpose. In this activity icon map, the yellow coded icons represent the recommended activities. While the grey ones are not specifically recommended, they may be organised by another stakeholder and require the participation of the user too.

6.6.2 Use PLT Collectively

However, individual stakeholders should not carry out the activities in isolation.

First, the activities repeatedly required by multiple stakeholders make more sense to be performed together once. For example, GORS2025 and the municipality both need the Aligning and Choosing Approach activities, and it would be better to perform these activities together for once without disturbing relevant stakeholders twice. ***Second, some activities need the participation of other stakeholders.*** For example, when the municipality organise Problem Sharing activity etc., residents and GORS2025 need to attend and contribute. ***Third, some of the activities need to be performed in sequence.*** For example, iteration activities require the existence of a ready-to-use pattern language, hence cannot be performed until at least some patterns have been created through Developing PL activities.

Therefore, to show how the activities can be collectively carried out in Numansgors, an overview involving **three stages** was formulated. The three stages were defined in terms of the state of the pattern language. In the first stage, the development direction of the pattern language can be determined. In the second stage, the pattern language will be piecemeal developed. Finally, in the third stage, the pattern language can be used by practitioners. As discussed before, since the pattern language can be continuously iterated on when being used in practice, the second stage does not end but will continue along with the third stage (figure 6.20).

In the following pages, the three stages and the activities recommended in each stage are introduced in more detail.

figure 6.20
The three stages to use PLT in Numansgors.

Stage 1

Initiate the pattern language

As mentioned before, there has not been a ready-to-use pattern language. To develop a pattern language, the first stage aims to set up a basic structure for the pattern language, in preparation of stage two.

The three main activities recommended in this stage are, (1) Aligning Stakeholders, (2) Choosing Approach, and (3) Interview/ Focus groups or Problem Sharing, because these activities can help make decisions on what the pattern language will be like.

To start with, as discussed in 5.4.1, to elicit the concealed values of stakeholders in preparation for Choosing Approach, the ***Aligning Stakeholders*** activity is recommended. As this activity is recommended for both the municipality and GORS2025 (figure 6.17 & 6.19), it can be organised by these two parties together. The other stakeholder — residents — should be invited to participate. As can be imagined, involving all residents in this activity is almost impossible in reality. Therefore, public votings or questionnaire (as in 6.4 Survey Residents) can be applied to achieve the same goal. In this activity, participants

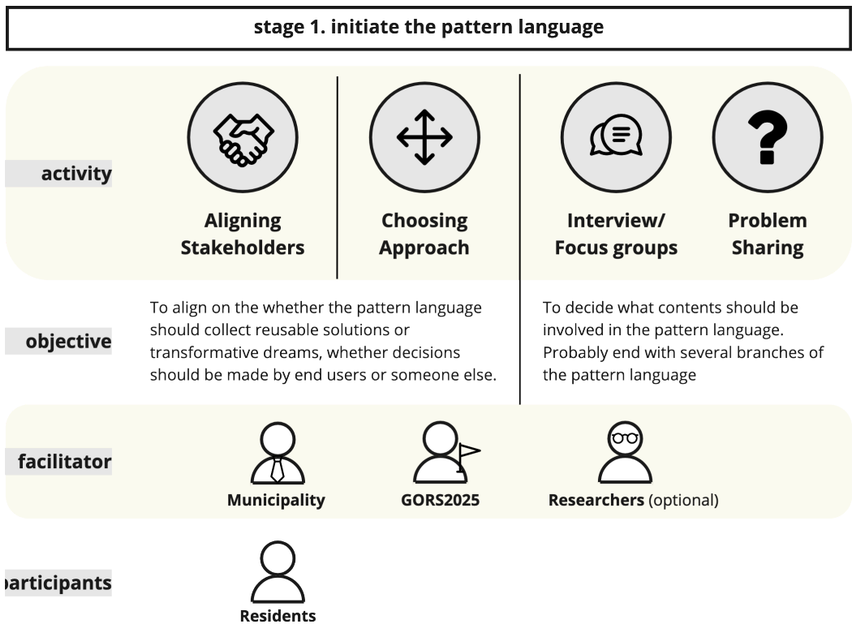


figure 6.21
an overview of the recommended activities in Stage 1

can decide whether a bottom-up or top-down approach, and whether seeking transformation or reusing good solutions is more important for them.

Next, based on the values identified in the Aligning activity, stakeholders can perform the ***Choosing Approach*** activity. The decisions such as where the pattern language will be sourced from, who will be the users of this pattern language etc. — can be made in this activity. A route starting from the short-term approach, via an achievable midterm approach, and ending up at an ideal long-term approach can be delineated on the Navigation Panel.

Besides, to help decide what contents should be involved in the pattern language, ***Interview/Focus groups*** or ***Problem Sharing*** are recommended activities in this stage. These activities can help the pattern language developers gain a general idea on what types of patterns might be included.

In this light yellow text box, the process of Stage 1 in the Numansgors project — including the three activities of ***Aligning Stakeholders***, ***Choosing Approach***, and ***Interview/Focus groups or Problem Sharing*** — is presented below.

1. Aligning Stakeholders

From the previous research, it had been known that GORS2025 and residents both agreed that the decisions should be made by residents themselves, which signifies the value of ***social justice***. As the goal at the time was to "promote immediate changes" in Numansgors rather than transforming the housing industry (which might be a future goal), the value of ***reusable solutions*** turns more important than seeking transformation.

2. Choosing Approach

In a short term, the committee and residents hoped to find reusable good practices. The patterns should come from existing good practices in Numansgors or in other similar locations. The residents should be the initiators of their own home projects. Therefore, the approach to use PLT in the short-term should be "bottom-up" and "decision-making".

While in a long term, new technologies were expected for the housing renovation domain. The approach hence gradually inclines towards "vision-making". The short-term towards long-term route can be visualised as in figure 6.23.

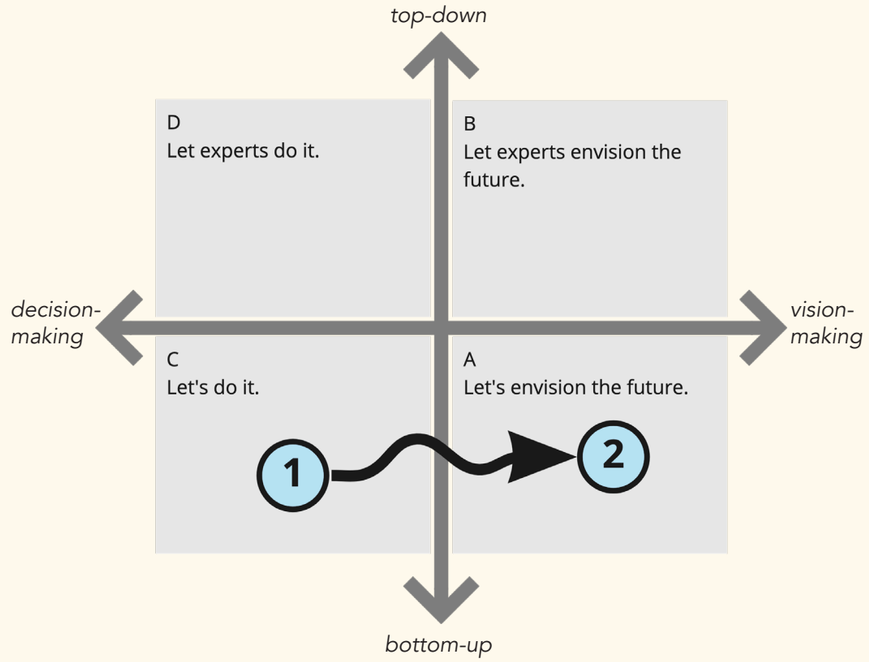


figure 6.22
the route from short-term approach (1) to long-term approach (2) drawn in the Navigation Panel

3. Interview/Focus groups or Problem Sharing

Through the interviews, it was learned that GORS2025 was continuously looking for effective communication approaches to understand residents' needs. Besides, through questionnaires, technology information and subsidy information were reported important by many residents. Therefore, the pattern language for improving sustainability in Numansgors should include patterns for communication, technical knowledge and financial knowledge, as shown in figure 6.23. The three categories are not set in stone, but can act as the entry point for the next stage. If other issues can be identified in future, more branches can be added to this structure.

figure 6.23
a structure including three types of patterns required for this pattern language

Stage 2

Develop the Pattern Language

Based on the primary structure defined in the last stage, the pattern language could be developed piecemeal. As learned from the field research, some good practices — such as the successful renovation of some individual homes, and the communication approaches tried by GORS2025 — already existed, and hence can be made into patterns. In addition, the patterns in other pattern languages can also be adapted and curated to the pattern language for Numansgors. Accordingly, there are the two ways of developing the pattern language:

First, through the Problem Sharing activity in Stage 1, recurring problems encountered by stakeholders have be identified and documented. According to these problems, other stakeholders can share related knowledge and experience through the ***Experience Sharing*** activity.

If there are similar projects going on in other locations, the problem sharing and experience sharing can be organised accross locations by the municipalities. In such a way, knowledge can be circulated within more projects and better boosts information-exchanging efficiency.

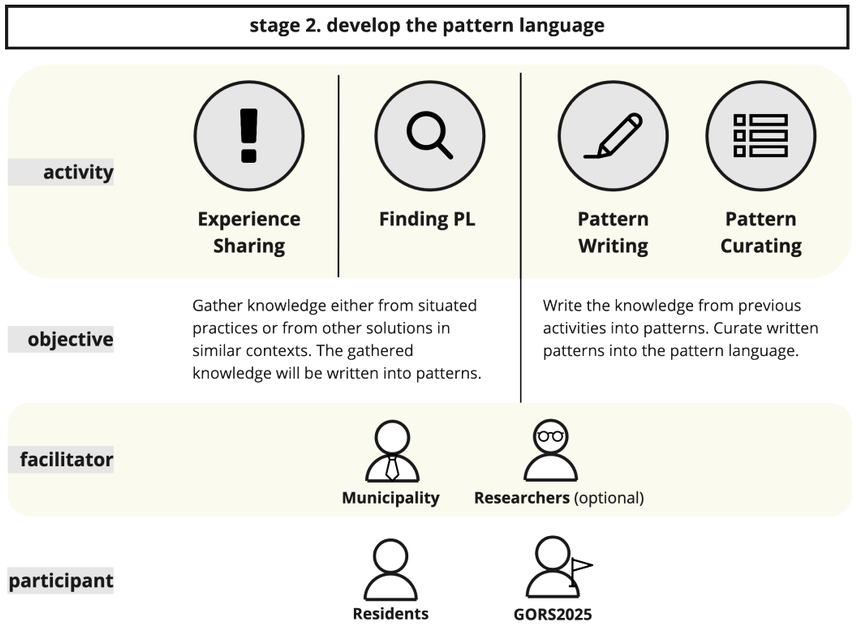


figure 6.24
an overview of the recommended activities in Stage 2

Second, some patterns can be adapted from other pattern languages or solutions. Practitioners or researchers can conduct ***Finding Patterns*** activity to look for usable patterns. The more similar the context in the found pattern language to Numansgors, the more suitable it is for adaptation.

Finally, the knowledge gained in above two ways can be written into formatted patterns in the ***Pattern Writing*** activity. When more individual patterns like these have been written, the connections between them can be found to formulate a complete pattern language in the ***Pattern Curating*** activity.

In this stage, the Brainstorm/Prototyping activity would not be performed in the Numansgors project, because that activity is more suitable for a vision-making approach. While Numansgors has been decided to take a decision-making approach in the Stage 1.

figure 6.25
a resident with experience (right) can externalise the experience into patterns, to support an inexperienced resident (left)

Following Stage 1, a sample process of Stage 2 in the Numansgors project — including the three activities of ***Experience Sharing***, ***Finding Patterns***, and ***Pattern Writing & Curating*** — is presented below on this light yellow background.

4. Experience Sharing

For example, in Numansgors, some residents have problems with planning their roof insulation, such as "which type of insulation suits Numansgors roof structure?" Regarding this question, a resident who had already renovated the roof may have experience to share. He/she then can share this knowledge in the ***Experience Sharing*** activity organised by GORS2025. Then this piece of knowledge can be discussed and documented into a pattern format later.

Another example is that, the VvE of another neighbourhood plans to organise an information meeting among residents. As many residents are on a holiday, they are not able to join in person. Since in Numansgors, GORS2025 has organised a hybrid (both online and offline) information meeting successfully, they can share this experience in an ***Experience Sharing*** activity to provide inspiration for other neighbourhoods.

5. Finding Patterns

Take the topic of "technical renovation solutions" as an example, through a primary search on the internet, I found this piece of words providing suggestions on a "heat pump" solution for houses in Netherlands:

> *"[Is your house built] Before 2000? Most likely, your house is suitable for a hybrid heat pump. Although there are exceptions. Is your house hardly insulated at all? First, start insulating. Are you not sure if your house is suitable? You can test it by controlling the water temperature to 70 degrees Celsius during the whole of the winter. You set the temperature in the hot water boiler. If the result of this test is that you feel comfortable all winter, your house is suitable." — adapted from https://settledownsupport.nl/heat-pump-netherlands/ (2022)*

In this paragraph, the author presented a pattern of preparing for a heat pump. It can be adapted to the target pattern language because it is set in the Netherlands context for a house built before 2000, which is also the case in Numansgors.

There might be another pattern better than this, but it can be applied at least temporarily and be iterated on in the future.

6. Pattern Writing & Curating

The knowledge about hybrid information meeting and preparing the insulation for heat pump can be respectively written into the patterns, as in figure 6.26 and figure 6.27.

The current pattern language for improving park sustainability consisting the patterns mentioned above can be visualised as in figure 6.28.

Name: *Hybrid Information Meeting*
Category: Communication

Context: You as a VvE member plan to organise information meeting among residents.
Problem: Some residents might not be able to join in person.
Solution: You can organise a hybrid meeting through Google Meeting to increase the attendance.

Related patterns:
1. use *Get Feedback* first to make sure you know enough persons prefer to join online
2. consider *Suitable place for Hybrid Meeting* & *Handle Online Q&A* later
References/Example: In Numansgors, a hybrid information meeting was organised and gained good feedback.

figure 6.26
the pattern "Hybrid Information Meeting"

Name: *Confirm Insulation Quality*
Category: Technical

Context: You as a resident plan to install a heat pump. You have been advised to make sure the insulation of your house is good enough.
Problem: You don't know how to confirm the insulation quality of your house.
Solution: You set the temperature in the hot water boiler to 70 degrees Celsius during the whole of the winter. If you feel comfortable all winter, the insulation quality of your house is suitable to consider a heat pump.

Related patterns:
1. use *Roof Insulation, Wall Insulation* and *Floor Insulation* if the insulation quality is not good enough
2. consider *Heat Pump* if the insulation quality is not good enough
References/Example: https://settledownsupport.nl/heat-pump-netherlands/

figure 6.27
the pattern "Confirm Insulation Quality"

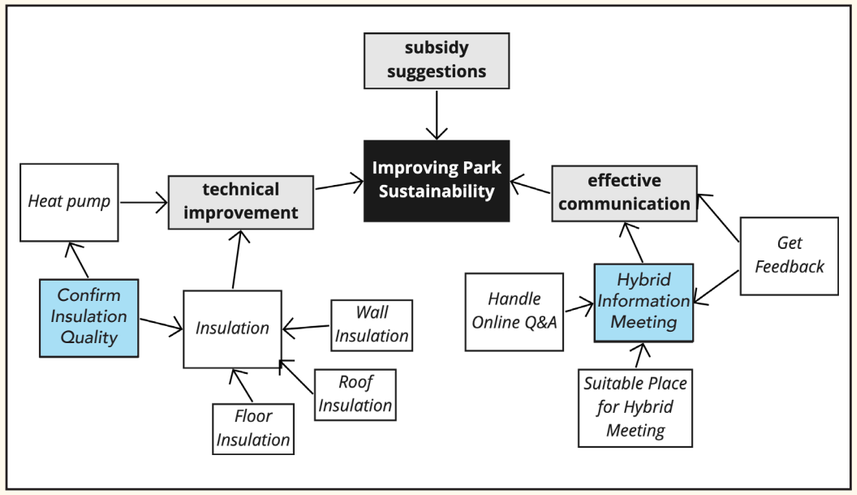


figure 6.28
part of the pattern language. The patterns in figure 6.26 & 6.27 are highlighted in blue

Stage 3

Using the Pattern Language

Finally, as the pattern language grows, the committee and the residents can make use of it for the Numansgors project and individual homes. The pattern language does not have to be fully complete to put into use. In fact, individual patterns can already be helpful, although the connections between patterns can make it even more powerful.

To use the pattern language, practitioners need to first perform ***Selecting Patterns*** activity. In this activity, users select the patterns that are relevant to their own projects as a project-pattern language (henceforth abbreviated into "project-PL").

Then users can use the project-PL for ***Diagnosing*** and ***Designing/Deciding*** activities for the problems they meet.

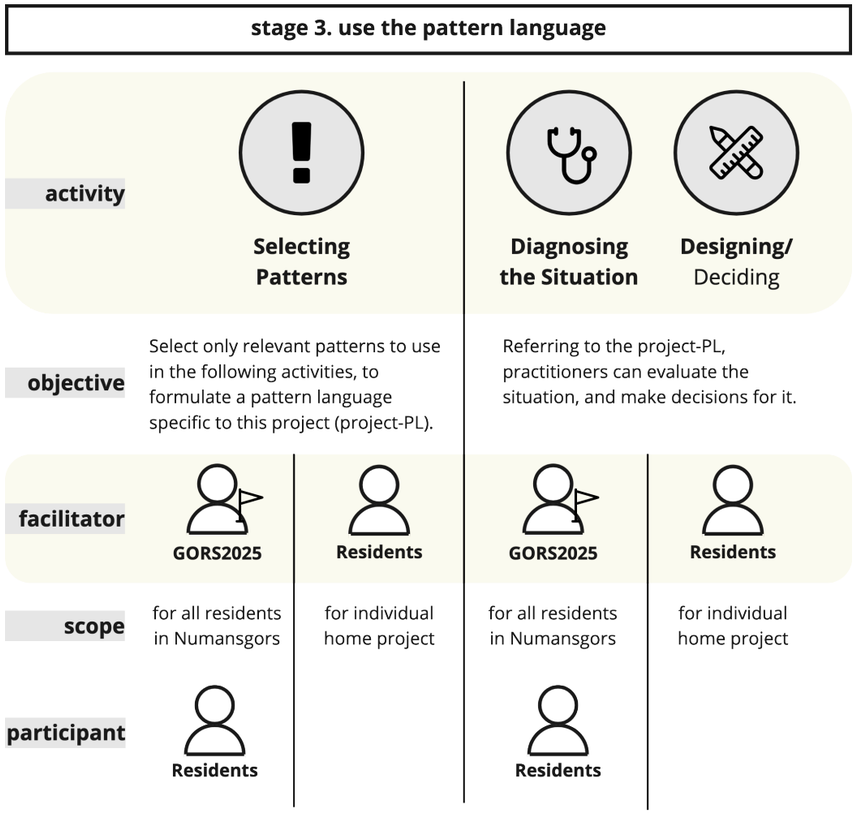


figure 6.29
an overview of the recommended activities in Stage 3

Following the Stage 1 and Stage 2, the process of Stage 3 in the Numansgors project — including ***Selecting Patterns*** and ***Diagnosing & Designing/Deciding*** — is presented below on this light yellow background.

7. Selecting Patterns

For example, a resident in Numansgors wants to use the pattern language for his own house. As he does not organise communication with other residents, he only selects the patterns about subsidy and technology. In addition, as he had already got subsidy for solar panels, the pattern about subsidy for solar panels can also be excluded. In this way, he ends with a project-PL specifically for his house.

In a different neighbourhood, Park N, the VvE also wants to use the pattern language. Therefore, the VvE members together select the patterns applicable in their neighbourhood. They excluded the patterns about solar panel and relevant subsidy because all homes in Park N already had installed panels. In this way, a project-PL specifically for Park N is ready. Afterwards, the residents in Park N can conduct another round of selecting to gain a smaller project-PL specific for their own houses.

8. Diagnosing & Designing/Deciding

Continuing with the example above, the VvE of Park N can use the patterns in their project-PL to evaluate and make decisions. When they encounter a situation same as in the pattern "Hybrid Information Meeting", they can then apply the solution in this pattern.

Same, the residents can evaluate and make decisions for their houses with their home project-PL. According to the pattern of "Confirming Insulation Quality", a resident can evaluate the insulation of her house. After finding the insulation of her house was not good enough, she can navigate to the patterns of Wall Insulation, Roof Insulation, and Floor Insulation accordingly.

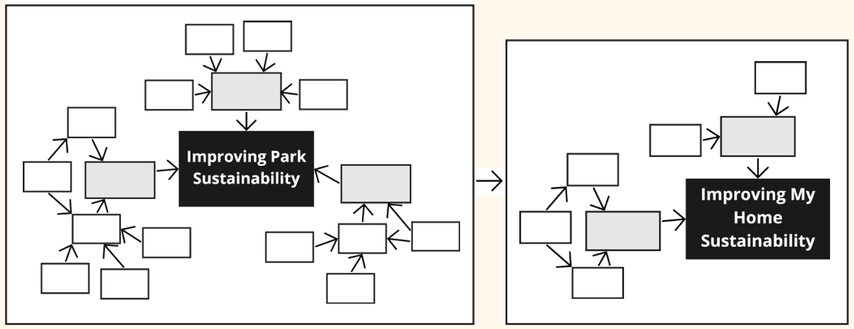


figure 6.30
selecting part of the pattern language into a project-specific pattern language

The three-stage overview and corresponding state of the pattern language can be seen in this figure:

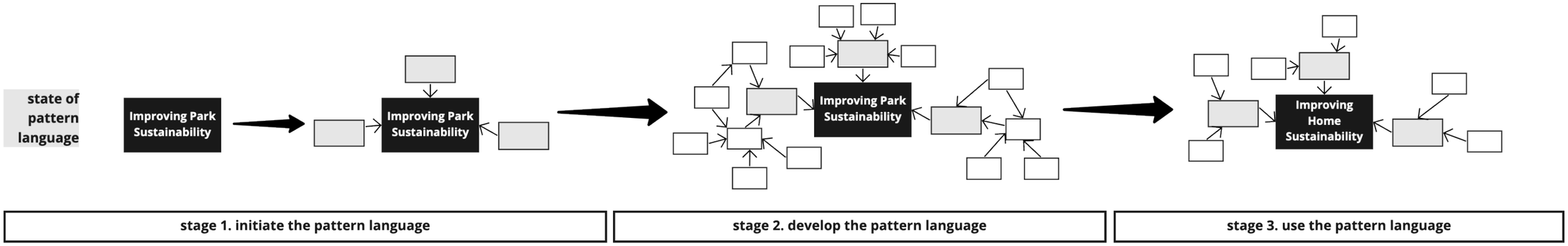


figure 6.31
an overview of the three stages, corresponding to the states of the pattern language

6.7 Reflection

In general, the validation process can show that the Activity Kit can lead to a favourable choice of approach to applying PLT in Numansgors. Additionally, I have the following reflection on this validation process, documentation and its impact on Numansgors.

6.7.1 Validation

Due to the limitation of the project timeframe, this case study and validation of Activity Kit was conducted by myself instead of by Numansgors stakeholders. In a real project setting, the stakeholders would be the ones who reflect on their purposes (possibly through research) and use the Activity Kit. A recommendation is to test the Activity Kit with practitioners in real world to examine its validity in depth.

Besides, as I have been quite familiar with the Activity Kit, more fresh insights on it are required for a more comprehensive evaluation. The evaluation of the Activity Kit is planned out of the frame of this graduation project.

6.7.2 Activity Kit

In the validation process, it was found that a pattern language can be gradually developed and then put into use through three stages. A complete view of the three stages and corresponding states of the pattern language have been presented in figure 6.31. However, as I reflected on my use of the Activity Kit, I found that ***the Activity Kit fit well for individual practitioners but still require further development if it is used for a complex project like the Numansgors project***, which involves multiple stakeholders. Therefore, after Individual stakeholders' purposes are considered respectively, an extra action was performed when using the Activity Kit:

> *Combining the purposes of individual stakeholders into an overview.*

However, no reminder was provided on this extra step. It is recommended to consider how to facilitate a collective use of the Activity Kit.

In addition, although the activities in the Activity Kit are presented in a recommended sequence, practitioners may need to modify this sequence according to their own needs. Another reminder need to be provided that the recommended sequence is not set-in-stone, but allows flexible arrangements.

6.7.3 Towards Practice in Numansgors

As the case study and the validation process have been finished and as this validation process already generated practical suggestions for Numansgors, these insights can be shared with Numansgors stakeholders. A working prototype of the pattern language can already be set up.

Besides, the appropriate format of the pattern language and what other contents should be included can be researched in the future.

6.8 Summary

Answers to Research Question (4)
How can the Numansgors project be supported in applying PLT?

1. The purposes to use PLT in the Numansgors project correspond to the needs of three main stakeholders.

   a. Residents can use single patterns to diagnose and make decisions for their own homes.

   b. GORS2025 can provide the pattern language as a toolkit for residents to use.

   c. Local municipalities with the influence in a range of projects, can help initiate and maintain the pattern language. This pattern language can be used by more similar projects across locations.

2. A series of activities for these three purposes can been picked from the Activity Kit. As some activities are duplicate, requiring the participation of other stakeholders, or need to be performed in sequence, an overview of them was formulated. This overview involves three stages:

   a. initiating the pattern language
   b. developing the pattern language
   c. using the pattern language

IDEATION (A)

Consider what can Pattern Language Theory (PLT) do for your fish. How would you use it?

Breaking a problem down into several smaller problems

Finishing Essay for Read a book

Motivation | Time | Pressure

Motivational coach

Time management tricks?

External person to commit with

A concrete deadline

Someone in the same situation

IDEATION (B)

Now refer to **page 4** and continue to consider or reflect on your stinky fish.

Pattern language for finishing an assignment with no deadline

Motivation | Time | Pressure

I see now that I could do different things to create Motivation, Time and Pressure

IDEATION (C)

Now refer to **pages 5-11** and continue to consider or reflect on your stinky fish.

I SO STINKY !!!!

Write here

- Current recruitment process
- Design my own portfolio website for job hunting
- How to embark on phase 2

I SO STINKY !!!!

Write here

+ Running form is getting worse but I am trying more!!
+ Read a book

Conclusion

The last chapter of the report introduces the implications and limitations of this project, as well as recommendations for future work. Finally, this chapter ends with a personal reflection on this research project.

7.1 Project Implication

In general, this project contributes to more effective applications of PLT on a global level, and has also transformed this univeral implication into more situated local implication for Numansgors.

7.1.1 Link to Previous Studies

At the beginning of the project, in order to consider how to use PLT in Numansgors, I have read many cases of using PLT. However, I found that there are a lot of differences in the approaches of these cases, but there is a lack of explanation of the causes of these differences. This makes it difficult for me to learn from these cases and formulate an approach that is really suitable for Numansgors. I believe other practitioners have encountered the same issue but also fail to find support. Actually, this has been confirmed in the workshops and in my communication with the other participants.

To rationalise the different approaches to use PLT, existing literature cannot provide much support. Most studies repeat on the advantages of pattern language, but have these advantages actually been achieved in practice? What ways of using PLT can better bring about these advantages? Research on such issues is very limited.

There are some studies that have found that an inappropriate approach to using Pattern Language Theory can defect its effectiveness. For example, (Wania & Atwood, 2009; Abraham, 2011) both believed that the use of pattern language in the HCI field or interaction design had wrongly focused on providing solutions instead of promoting communication, making the value of Pattern Language Theory not fully exerted. However, although the problem has been agreed on, the solutions they have provided are quite general. In addition, these studies only focused on a specific domain, while a more global or universal guidance is lacking.

This project concentrates on how to distinguish and choose PLT approaches, which is a supplement to the previous research Based on the problems they raised about "approaches", this project provides a more objective perspective for distinguishing different APPROACHes, and puts forward more practical suggestions for choosing appropriate Approach. And these suggestions are suitable for more fields.

7.1.2 Academic Implication

In the first place, this research provides a new lens to differentiate various approaches to using PLT, in terms of both external manifestations and internal reasons. This lens has been concretised into three tools, the Approach Axes, Navigation Panel, and the Approach Detail Table, which can support practitioners to make wiser choices on PLT approaches and support researchers in examining past PLT projects.

Researchers can use the tools to examine a past PLT project in whether the internal reasons are in line with its external manifestations. If not aligned, then the effectiveness of PLT is in doubt in this project. How may this project be performed in an approach that more honestly reflect practitioners' values and needs can then be investigated.

7.1.3 Practical Implication

Practitioners can use the tools concretised from theoretical findings to choose an appropriate approach that is in line with their internal reasons, and then perform this approach by replicating its external manifestations. If the current situations restrict practitioners from taking the ideal approach immediately, practitioners can also use these tools to plan a long-term outlook — starting with the current achievable approach, via a feasible transition approach, and ending at the ideal approach.

Next, this research devised the Activity Kit to incorporate these tools into specific activities. The Activity Kit, as practical guidance, leads practitioners to consider their project purposes, select activities according to purposes, and finally perform the activities. It permits practitioners with a more deliberated and effective plan before taking action, and hence allows better use of PLT.

7.1.4 Implication for Numansgors

In addition, the case study in Chapter 6 has proven the suitability of PLT for the Numansgors project. A dedicated pattern language for Numansgors shows the potential to act as the knowledge medium between residents and GORS2025, allow residents the autonomy in accessing information and making decisions, and allow the possibility to maintain aesthetic consistency between individuals. Moreover, the project can act as a catalyst for more similar projects across locations, if the development and use of the pattern language can be facilitated by the municipalities.

Taking the Numansgors project as an example to validate the Activity Kit, this project generates insights on the appropriate approach to using PLT in Numansgors. A three-stage outlook is created, foreseeing the initiation, development and practical use of a pattern language. By performing the activities suggested in the Activity Kit, a basic structure of the pattern language and some problems that deserve new patterns have been generated. The process of collecting problems and solutions from residents into patterns has been initiated through an exercise in Numansgors. Although the effectiveness of this ongoing process and its implications still await long-term observation and evaluation, the theoretical outputs of this research have been proven to have practical value.

7.2 Limitations

This research has tried to address a pragmatic issue — taking an appropriate approach to make best use of PLT — that had been reported in previous studies, although this may be a start rather than a final solution.

First of all, I hope the recommendations given by the study are informative globally for diverse domains, but on the other hand I am also concerned about whether the conclusions are too general if being used in specific areas. Tests and evaluations should be performed on the applicability of these results in different disciplines.

In addition, this project moves back and forth not only between practice and theory, but also between general cases and more specific contexts (Numansgors). These transitions inevitably bring limitations to this project. For example, the workshops (Chapter 3) were performed to seek inspiration on how the tools can be used achieved intriguing insights. However, the invited participants were limited to the design field. To make the results more universally applicable, participants and projects from various disciplines should be involved, not only in the workshops but also in the evaluation or validation of the project output.

Another major limitation of this project is that the Activity Kit has not been completed and extensively evaluated. This is because, the Activity Kit mainly provide support for differentiating and deciding on the PLT approach (due to project scope), but does not provide much support for executing PLT. Without really carrying out PLT, it hence becomes difficult to evaluate whether the Activity Kit has supported practitioners in using PLT effectively. Although PLT has started to be applied in Numansgors project, the evaluation of end results cannot be achieved within this graduation project timeframe.

This graduation project mainly focuses on the development of a document, yet a complete use case or evaluation of the document among real stakeholders is lacking. Currently, the example of Numansgors is performed by myself by synthesising the insights gained from field research and case study. Understanding how real practitioners with different backgrounds perceive and use the Activity Kit in their projects can better enhance its validation. It would be informative for future research to involve real practitioners in evaluating and iterating on this Activity Kit.

7.3 Future Work

The new lens for differentiating PLT approaches have been transformed into practical tools in this project. How might this new lens contribute to the PLT in theory requires more researchers to investigate.

As discussed before, although the structure of the main output — the Activity Kit — has been set up, due to the project scope, not all parts of this structure has been addressed. Especially the contents of executing PLT still await further development. Future studies can complement the document by developing more tools for supporting activity execution. In addition, to complement the evaluation of Activity Kit, future work is expected to provide the Activity Kit for more projects from diverse domains.

Regarding the case study of the Numansgors project, to focus on my project scope, much information from the Numansgors field research data has been idled. I hope the other data which I have also shared with the other students involved in the Numansgors project can be treated carefully and also brings more insights.

Actually having a pattern language initiated in Numansgors is one of the most exciting achievements of this project. Since the Numansgors project is long-term and is still in its infant stage, research on the needs of stakeholders has only focused on the decision-making stage of the community improvements. This example should be completed by following up on the Numansgors project in future stages of the community transformation. More purposes for using PLT might be found and help enrich the three-stage overview developed in Chapter 6.

Besides, as discussed before, the pattern language initiated in Numansgors also has the potential to inform more other projects across locations. How can other neighbourhoods get involved in the collective development and use of this pattern language deserves investigation.

In addition, the user experience of contributing to and using the pattern language can be studied in future research. In Numansgors, a paper prototype of the pattern language was set up for the presumption that some residents were not fond of digital platforms. However, how may this paper pattern language be useful for neighbourhood in other locations, or what a better format of the pattern language could be deserves further investigation.

7.4 Reflection

The original plan for this graduation has been greatly varied when being executed, as the field research requires the coordinated involvement of multiple stakeholders and as findings from literature had led me to something more theoretical. However, this unexpected changes led me to many interesting insights and surprises too. I initiated with “plain” desk research and began to become creative in analysing the literature, such as the "deconstruction" and "reconstruction" processes. Although these approaches are not fined enough and still see space for improvement, I have enjoyed the process of the expected-to-be boring and tiring literature review.

The process of switching between practical cases and theoretical findings was also difficult but informative to me. How I distill theoretical insights from numerous real-world cases, and how I translate the theoretical findings into something practical to use, were also new learnings for me.

Another important learning is the thinking mode of "integrative literature review". An integrative literature review is essentially a way of disassembling a large number of solutions and finding the patterns in them. Since this graduation project, I found myself using this thinking mode more often in daily life. This makes me truly feel that research is not only about changing the world, but also improving my own thinking ability.

Through this project, I also found research is not a predictable and linear process. It sometimes makes me struggle, as when I found something new but I cannot predict what it means or what outcomes it will bring about. Sometimes, the contents that I have deemed useless even became important after some while (such as the eight purposes from Chapter 2). These learnings also concurred with the wisdom of PLT, that answer does not always follow the problem right away. In research, one may have to wait for an answer to show up after a long time of incubation.

Communicating my work with other parties — involving the participants in workshops, supervisory teams and the stakeholders in Numansgors —has been the greatest challenge for me. The theoretical nature of my research approach is part of the reason, but more importantly, I indeed lack training in writing effectively. As I sometimes thought I was being concise, I am actually skipping important argumentations and making sentences difficult to read. Luckily with the support of my supervisors, I finally understood my issues and am gradually improving on it.

References

A. (2022, May 10). Heat pump in the Netherlands. Settle Down Support. Retrieved June 21, 2022, from https://settledownsupport.nl/heat-pump-netherlands/

Abraham, S. G. (2011). Evaluating the Impact of a Pattern Structure on Communicating Interaction Design Advice. ProQuest LLC. 789 East Eisenhower Parkway, PO Box 1346, Ann Arbor, MI 48106.

Ahmed, S., & Asraf, R. M. (2018). The workshop as a qualitative research approach: lessons learnt from a "critical thinking through writing" workshop. The Turkish Online Journal of Design, Art and Communication, 2018, 1504-1510.

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., & Angel, S. (1977). A pattern language: Towns, buildings, construction. New York: Oxford University Press.

Alexander, C., Silverstein, M., Angel, S., Ishikawa, S., & Abrams, D. (1975). The Oregon Experiment (Vol. 3). Center for Environmental Struc.

Alexander, C. (1977). A pattern language: towns, buildings, construction. Oxford university press.

Alexander, C. (1979). The timeless way of building (Vol. 1). New york: Oxford university press.

Ali, A. S., & Alias, A. (2010). Designer's attributes in refurbishment projects: case study in Malaysia.

Amaral, G., Sales, T. P., Guizzardi, G., Almeida, J. P. A., & Porello, D. (2020, November). Modeling trust in enterprise architecture: A pattern language for archimate. In IFIP Working Conference on The Practice of Enterprise Modeling (pp. 73-89). Springer, Cham.

Arcaini, P., Mirandola, R., Riccobene, E., & Scandurra, P. (2020). MSL: A pattern language for engineering self-adaptive systems. Journal of Systems and Software, 164, 110558.

Arnold, I. (2022). Enterprise Architecture Function-A Pattern Language for Planning, Design and Execution (pp. 1-521). Springer.

Athavankar, U., Khambete, P., Roy, D., Chaudhary, S., Kimbahune, S., Doke, P., & Devkar, S. (2014, December). Multidisciplinary Team Dynamics in Service Design-The Facilitating Role of Pattern Language. In Proceedings of the India HCI 2014 Conference on Human Computer Interaction (pp. 16-25).

Athavankar, U., Khambete, P., Doke, P., Kimbahune, S., Devkar, S., Roy, D., & Chaudhary, S. (2014, December). Exploring Cards for Patterns to Support Pattern Language Comprehension and Application in Service Design. In Proceedings of the India HCI 2014 Conference on Human Computer Interaction (pp. 112-115).

Banno, Y., Kaneko, T., & Iba, T. (2019, July). A proposal of modular-structured pattern language: based on pattern language for end of life care. In Proceedings of the 24th European

Conference on Pattern Languages of Programs (pp. 1-6).

Bayle, E., Bellamy, R., Casaday, G., Erickson, T., Fincher, S., Grinter, B., ... & Thomas, J. (1998). Putting it all together: towards a pattern language for interaction design: A CHI 97 workshop. ACM SIGCHI Bulletin, 30(1), 17-23.

Behold and Beware, Design Toolkits - School of Design and Creative Technologies - The University of Texas at Austin. (n.d.). College of Fine Arts - University of Texas at Austin. Retrieved June 14, 2022, from https://designcreativetech.utexas.edu/behold-and-beware-design-toolkits

Birukou, A. (2010, July). A survey of existing approaches for pattern search and selection. In Proceedings of the 15th European Conference on Pattern Languages of Programs (pp. 1-13).

Borchers, J. (2000). A pattern approach to interaction design. Proceedings of the DIS 2000 International Conference on Designing Interactive Systems, New York. 369-378.

Borchers, J. O. (2008). A pattern approach to interaction design. In Cognition, Communication and Interaction (pp. 114-131). Springer, London.

Bravo, G., Pardalis, G., Mahapatra, K., & Mainali, B. (2019). Physical vs. aesthetic renovations: Learning from Swedish house owners. Buildings, 9(1), 12.

Bridi, M. E., Soliman-Junior, J., Granja, A. D., Tzortzopoulos, P., Gomes, V., & Kowaltowski, D. C. C. K. (2022). Living Labs in Social Housing Upgrades: Process, Challenges and Recommendations. Sustainability, 14(5), 2595.

Bukovszki, V., Dóci, G., & Reith, A. (2021). Coding engines in participatory social housing design—a case to revisit pattern languages. Sustainability, 13(6), 3367.

Cambridge Dictionary. (2022, April 13). Let, let's - English Grammar Today - a reference to written and spoken English grammar and usage - Cambridge Dictionary. https://dictionary.cambridge.org/grammar/british-grammar/let-let-s

Christians, C. G., & Carey, J. W. (1989). The logic and aims of qualitative research. Research methods in mass communication, 354–374.

Chen, C. T., Cheng, Y. C., & Hsieh, C. Y. (2007). Towards a pattern language approach to establishing personal authoring environments in e-learning. Web-based Education.

Coplien, J. O., & Alexander, A. W. O. (1996). Software patterns.

Coplien, J. & Schmidt, D., 1995. Pattern Languages of Program Design. Addison-Wesley, Reading MA., USA.

Creswell, J. W., & Poth, C. N. (2017). Qualitative Inquiry and Research Design (international Student Edition).: Choosing Among Five Approaches. Sage Publications.

Czischke, D. (2018). Collaborative housing and housing providers: towards an analytical framework of multi-stakeholder collaboration in housing co-production. International Journal of housing policy, 18(1), 55-81.

Dawes, M. J., & Ostwald, M. J. (2017). Christopher Alexander's A Pattern Language: analysing, mapping and classifying the critical response. City, Territory and Architecture, 4(1), 1-14.

de Oliveira Fernandes, M. A., Keijzer, E., van Leeuwen, S., Kuindersma, P., Melo, L., Hinkema, M., & Gutierrez, K. G. (2021). Material-versus energy-related impacts: Analysing environmental trade-offs in building retrofit scenarios in the Netherlands. Energy and Buildings, 231, 110650.

De Vreede, T., Steele, L., De Vreede, G. J., & Briggs, R. (2020, January). Leadlets: towards a pattern language for leadership development of human and AI agents. In Proceedings of the 53rd Hawaii international conference on system sciences.

Dearden, A., Finlay, J., Allgar, E., & McManus, B. (2002). Using pattern languages in participatory design. In Proceedings of the participatory design conference (PDC 2002) (pp. 104-113).

Dearden, A., Finlay, J., Allgar, L., & McManus, B. (2002, April). Evaluating pattern languages in participatory design. In CHI'02 extended abstracts on Human factors in computing systems (pp. 664-665).

De Vreede, T., Steele, L., De Vreede, G. J., & Briggs, R. (2020, January). Leadlets: towards a pattern language for leadership development of human and AI agents. In Proceedings of the 53rd Hawaii international conference on system sciences.

Ebrahimigharehbaghi, S., Qian, Q. K., Meijer, F. M., & Visscher, H. J. (2020). Transaction costs as a barrier in the renovation decision-making process: A study of homeowners in the Netherlands. Energy and Buildings, 215, 109849.

Eglin, R. (2020). Capturing a community's vision as a pattern language: Case study of the Mooiplaas community in Great Kei Municipality, South Africa. Town and Regional Planning, 76, 29-41.

European Commission. (2020). A Renovation Wave for Europe—Greening Our Buildings, Creating Jobs, Improving Lives. _Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions_.

Experiences -- A Pattern Language for User Interface Design. (n.d.). Experiences -- A Pattern Language for User Interface Design. http://www.maplefish.com/todd/papers/Experiences.html

Fassbinder, A., Barbosa, E. F., & Magoulas, G. D. (2017, October). Towards an educational design pattern language for massive open online courses (MOOCs). In Proceedings of the 24th Conference on Pattern Languages of Programs (pp. 1-17).

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. International journal of qualitative methods, 5(1), 80-92.

Finidori, H. 2014 a. An ecology of transformative action awaiting to be discovered. Spanda Journal V/1: 5 – 14.

Finidori, H. 2016. Patterns that connect: Exploring the potential of patterns and pattern languages in systemic interventions towards realizing sustainable futures. Advanced Author Paper presented at the 60th Annual Meeting of the International Society for the Systems Sciences "Realizing Sustainable Futures." University of Colorado, July 23– 30.

Fruhmann, C., & Knittel, N. (2016). Community energy projects: Europe's pioneering task. Climate Policy Info Hub, 3.

Gamma, E., Helm, R., Johnson, R., and Vlissides J., 1995. Design Patterns: Elements of Reusable Object-Oriented Software. Addison-W esley, Reading, MA., USA.

Golden, E., John, B. E., & Bass, L. (2005a). Quality vs. quantity: Comparing evaluation methods in a usability-Focused Software architecture modification task. Proceedings of the 4th International Symposium on Empirical Software Engineering, Noosa Heads, Australia.

Gomes, V., Saade, M., Lima, B., & Silva, M. (2018). Exploring lifecycle energy and greenhouse gas emissions of a case study with ambitious energy compensation goals in a cooling-dominated climate. Energy and Buildings, 173, 302-314.

Gonçalves, R. D., & Hayashi, A. (2021). A pattern language for social field shifts: cultivating embodied and perceptual capacities of social groups through aesthetics, and social field archetypes. Journal of Awareness-Based Systems Change, 1(1), 35-57.

Goodyear, P., de Laat, M., & Lally, V. (2006). Using pattern languages to mediate theory–praxis conversations in design for networked learning. ALT-J, 14(3), 211-223.

Granlund, Å., Lafrenière, D., & Carr, D. A. (2001, August). A pattern-supported approach to the user interface design process. In Proceedings of HCI International 2001 9th International Conference on Human-Computer Interaction (pp. 282-286).

Guerra-Santin, O., Boess, S., Konstantinou, T., Herrera, N. R., Klein, T., & Silvester, S. (2017). Designing for residents: Building monitoring and co-creation in social housing renovation in the Netherlands. Energy research & social science, 32, 164-179.

Ham, M., de Bruijn, D. M. P., Vos, S. J. H., Weijers, K. A. M., & Straver, M. C. W. (2009). Smart Solar Housing Renovation.

Hasselkuß, M., Baedeker, C., & Liedtke, C. (2017). Social practices as a main focus in living lab research. In Living Labs (pp. 23-34). Springer, Cham.

Hauge, Å. L., Hanssen, G. S., & Flyen, C. (2018). Multilevel networks for climate change adaptation–what works?. International Journal of Climate Change Strategies and Management.z

Hübscher, C., Pauwels, S. L., Roth, S. P., Bargas-Avila, J. A., & Opwis, K. (2011). The organization of interaction design pattern languages alongside the design process. Interacting with Computers, 23(3), 189-201.

Iba, T. (2014). Using pattern languages as media for mining, analysing, and visualising experiences. International Journal of Organisational Design and Engineering 4, 3(3-4), 278-301.

Iba, T., Masai, M., Abe, Y., & Kosaka, Y. (2020, July). Patterns for Building Customer Relationships in a Pattern Language for Value-Creation Marketing. In Proceedings of the European Conference on Pattern Languages of Programs 2020 (pp. 1-12).

Iba, H., & Iba, T. (2019, July). A pattern language for improving foreign language skills when studying abroad. In Proceedings of the 24th European Conference on Pattern Languages of Programs (pp. 1-9).

Iba, T., & Isaku, T. (2016, October). A pattern language for creating pattern languages: 364 patterns for pattern mining, writing, and symbolizing. In Proceedings of the 23rd Conference on Pattern Languages of Programs (pp. 1-63).

Inmark, E. M. F. (2010). Concept and methodology of Interactive Workshops. PRO-IDEAL PLUS project.

Israel, G.D., 1992. The evidence of extension program impact. Program evaluation and organizational development. In: IFAS, University of Florida, PEOD-5.

Jager, W. (2006). Stimulating the diffusion of photovoltaic systems: A behavioural perspective. Energy Policy, 34(14), 1935-1943.

Jiang, W., & Qian, X. (2022). Fragmented Property Rights and Residents' Participation in Renovation of Old Communities: Comparative Case Studies in Haikou, China. Lex Localis - Journal of Local Self-Government, 20(1), 259–277. https://doi.org/10.4335/20.1.259-277(2022)

Johnston, E., & Hicks, D. (2004). Speaking in teams: Motivating a pattern language for collaboration. Interdisciplinary Description of Complex Systems: INDECS, 2(2), 136-143.

Jowkar, M., Temeljotov-Salaj, A., Lindkvist, C. M., & Støre-Valen, M. (2022). Sustainable building renovation in residential buildings: barriers and potential motivations in Norwegian culture. Construction management and economics, 40(3), 161-172.

Kamari, A., Jensen, S. R., Corrao, R., & Kirkegaard, P. H. (2017, June). Towards a holistic methodology in sustainable

retrofitting: Theory, Implementation and Applications. In WSBE 2017 (World Sustainable Built Environment) conference, Hong Kong, China (pp. 702-708).

Kamada, A., Munakata, K., Kamada, M., Ichinose, T., & Iba, T. (2019). Promoting and Supporting Biodiversity Conservation Activities with the Pattern Language Approach: A Pattern Language for Collaborative Activities for Biodiversity Conservation. In Collaborative Innovation Networks (pp. 201-213). Springer, Cham.

Kennedy, A. (2005). Models of continuing professional development: A framework for analysis. Journal of in-service education, 31(2), 235-250.

Kent Beck and Ward Cunningham. Using pattern languages for object-oriented programs. Technical report, Tek- tronix, Inc., 1987. Presented at the OOPSLA-87 Workshop on Specification and Design for Object-Oriented Pro- gramming.

Kerr, N., & Winskel, M. (2020). Household investment in home energy retrofit: A review of the evidence on effective public policy design for privately owned homes. Renewable and Sustainable Energy Reviews, 123, 109778.

Kersten, W. C., Crul, M. R. M., Geelen, D. V., Meijer, S. A., & Franken, V. (2015). Engaging beneficiaries of sustainable renovation–exploration of design-led participatory approaches. Journal of Cleaner Production, 106, 690-699.

Khambete, P. (2013). Designing desirable service experience: a pattern language framework for designing touch point ecosystems. Indian Institute of Technology Bombay, 972.

Khambete, P., Athavankar, U., Doke, P., Shinde, R., Roy, D., Devkar, S., ... & Chaudhary, S. (2015). a case study in participatory service design for rural healthcare system in India using a pattern language. In ICoRD'15–Research into Design Across Boundaries Volume 1 (pp. 3-13). Springer, New Delhi.

Khambete, P., Roy, D., & Devkar, S. (2015, December). Validation of a service design pattern language as an effective framework for multidisciplinary design. In Proceedings of the 7th International Conference on HCI, IndiaHCI 2015 (pp. 1-9).

Knote, R., Söllner, M., & Leimeister, J. M. (2018). Towards a pattern language for smart personal assistants. In Conference on Pattern Languages of Programs (PLoP).

Knutsson, O., & Ramberg, R. (2018). Teachers' Collaborative Pattern Language Design. Designs for Learning, 10(1), 1-17.

Köppe, C., Manns, M. L., & Middelkoop, R. (2019). The pattern language of incremental grading. In Proceedings of the 25th Conference on Pattern Languages of Programs, PLoP (Vol. 18, pp. 1-17).

Köppe, C., Nørgård, R. T., & Pedersen, A. Y. (2017, March). Towards a pattern language for hybrid education. In Proceedings of the VikingPLoP 2017 Conference on Pattern Languages of Program (pp. 1-17).

Kuenkel, P. 2017. A pattern approach to stewarding sustainability transformation: How the 17 SDGs can become a starting point for transformative change. Collective Leadership Studies 5. Potsdam: Collective Leadership Institute.

Kumar, A., Chani, P. S., & Deoliya, R. (2014). Green retrofit potential in existing research laboratories and demonstration of energy efficient and sustainable technologies: case study. Int. J. Sci. Eng. Technol. Res, 3(3), 400-405.

Law, N. W. Y., Li, L., Herrera, L. F., Chan, A., & Pong, T. C. (2017). A pattern language based learning design studio for an analytics informed inter-professional design community. Interaction Design and Architecture (s).

Lindkvist, C., Karlsson, A., Sørnes, K., & Wyckmans, A. (2014). Barriers and challenges in nZEB projects in Sweden and Norway. Energy Procedia, 58, 199-206.

Liu, G., Li, X., Tan, Y., & Zhang, G. (2020). Building green retrofit in China: Policies, barriers and recommendations. Energy Policy, 139, 111356.

May, D., & Taylor, P. (2003). Knowledge management with patterns. Communications of the ACM, 46(7), 94-99.

Mehaffy, M. W. (2007). Notes on the genesis of wholes: Christopher Alexander and his continuing influence. Urban Design International, 12(1), 41-49.

Meszaros, D. J., & Doble, J. (1997, October). G. A pattern language for pattern writing. In Proceedings of International Conference on Pattern languages of program design (1997) (Vol. 131, p. 164).

Moftakhar, N. (2013). Sustainable design pattern language for CSUN's student housing (Doctoral dissertation, California State University, Northridge).

Moore, R. (2017). (un) Finished: Pattern Language for Human-Centric Architectural Evolution (Doctoral dissertation).

Moore, G. T., Piwoni, J. L., & Kennedy, D. (1989). DESIGNING CHILD CARE CENTERS USING THE CHILDREN'S ENVIRONMENTS'PATTERN LANGUAGE: THE NORTHERN MICHIGAN UNIVERSITY CHILDREN'S CENTER. Children's Environments Quarterly, 54-63.

Mor, Y., & Winters, N. (2008). Participatory Design in Open Education: A Workshop Model for Developing a Pattern Language. Journal of Interactive Media in Education.

Myhren, J. A., Heier, J., Hugosson, M., & Zhang, X. (2020). The perception of Swedish housing owner's on the strategies to increase the rate of energy efficient refurbishment of multi-family buildings. Intelligent Buildings

International, 12(3), 153-168.
Noble, J. (1998, November). Towards a pattern language for object oriented design. In Proceedings Technology of Object-Oriented Languages. TOOLS 28 (Cat. No. 98TB100271) (pp. 2-13). IEEE.
Olhoff, A., & Christensen, J. M. (2018). Emissions gap report 2018. UNEP DTU Partnership: Copenhagen, Denmark.
Ortega-Arjona, J. L. (2010). Patterns for parallel software design. John Wiley & Sons.
Palmieri, T., Huybrechts, L., & Devisch, O. (2021). Co-producing, curating and reconfiguring dwelling patterns: A design anthropological approach for sustainable dwelling futures in residential suburbs. Design Studies, 74, 101011.
Pan, Y., & Stolterman, E. (2013). Pattern language and HCI: expectations and experiences. In CHI'13 Extended Abstracts on Human Factors in Computing Systems (pp. 1989-1998).
Park, S. (2021). A Pattern Language for Class Responsibility Assignment for Business Applications. International Journal of Advanced Computer Science and Applications, 12(10).
Pinho, D., & Aguiar, A. (2020, July). The AgilECo Pattern Language: Physical Environment. In Proceedings of the European Conference on Pattern Languages of Programs 2020 (pp. 1-9).
Pollmann, K., & Ziegler, D. (2021). A pattern approach to comprehensible and pleasant human–robot interaction. Multimodal Technologies and Interaction, 5(9), 49.
Porter, Ronald, James O. Coplien, and Tiffany Winn. "Sequences as a Basis for Pattern Language Composition." Science of Computer Programming (Elsevier) 56, no. 1 (2005): 231--249.
Reinfurt, L., Falkenthal, M., & Leymann, F. (2020). Where to begin: on pattern language entry points. SICS Software-Intensive Cyber-Physical Systems, 35(1), 127-139.
Ricaud, L., Thibon, M., Marseault, L., & Chotte, J. L. (2021). Pattern languages as a design tool to tackle "wicked problems" in sustainability science. GAIA-Ecological Perspectives for Science and Society, 30(4), 237-242.
Rising, L. (1997). The road, Christopher Alexander, and good software design. Object Magazine, 7, 46-50.
Sales, T. P., Roelens, B., Poels, G., Guizzardi, G., Guarino, N., & Mylopoulos, J. (2019, June). A pattern language for value modeling in ArchiMate. In International Conference on Advanced Information Systems Engineering (pp. 230-245). Springer, Cham.
Salingaros, N. A. (2000). The structure of pattern languages. ARQ: Architectural Research Quarterly, 4(2), 149-162.
Sanders, E. B. N., & Stappers, P. J. (2012). Convivial toolbox: Generative research for the front end of design. Bis.
Schümmer, Till, and Stephan Lukosch. Patterns for Computer-Mediated Interaction. Chichester, West Sussex: John Wiley & Sons Ltd, 2007.
Schuler, D. (2008). Liberating voices: A pattern language for communication revolution. MIT Press.
Snyder, H. Literature Review as a Research Methodology: An Overview and Guidelines. J. Bus. Res. 2019, 104, 333–339. [CrossRef]
Stark, W., & Schümmer, T. A Performative Pattern Language.
Statistics Explained. (n.d.). Eurostat. Retrieved April 27, 2022, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Main_Page
Sterner, C. S. (2008). A Sustainable Pattern Language: A Comprehensive Approach to Sustainable Design (Doctoral dissertation, University of Cincinnati).
Stinky Fish. (n.d.). Hyper Island Toolbox. Retrieved May 3, 2022, from https://toolbox.hyperisland.com/stinky-fish-13d9ce8d-e64f-4085-8a06-8d212c627788
Streimikiene, D., Lekavičius, V., Baležentis, T., Kyriakopoulos, G. L., & Abrhám, J. (2020). Climate change mitigation policies targeting households and addressing energy poverty in European Union. Energies, 13(13), 3389.
Swyngedouw, E. (2014). Where is the political? Insurgent mobilisations and the incipient "return of the political". Space and polity, 18(2), 122-136.
te Brömmelstroet, M., Nello-Deakin, S., Quillien, J., & Bhattacharya, I. (2021). Towards a pattern language for cycling environments: merging variables and narratives. Applied Mobilities, 6(1), 35-53.
te Duits, N. (2022). Flourishing Foodvalley: Pattern language as a co-design method to approach the transition towards circular agricultural systems in a hybrid landscape.
Thomas, V., Alexander, S., & Mathias, K. (2020, November). Towards an empirically based gamification pattern language using machine learning techniques. In 2020 IEEE 32nd Conference on Software Engineering Education and Training (CSEE&T) (pp. 1-4). IEEE.
Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. Human resource development review, 4(3), 356-367.
User, G. (2021, September 3). Design Thinking Bootleg. Stanford d.School. https://dschool.stanford.edu/resources/design-thinking-bootleg
Vaishnavi, V.K. (2007). Design Science Research Methods and Patterns: Innovating Information and Communication Technology (1st ed.). Auerbach Publications. https://doi.org/10.1201/9781420059335

Van der Merwe, C. G. (1996) The comparative law of apartment ownership, Scottish Law and Practice Quarterly, 1(3), pp. 205-216.
van de Vijver, F. J. R., & Leung, K. (1997). Methods and data analysis for cross-

cultural research. Thousand Oaks, CA: Sage.
van Geenhuizen, M. (2018). A framework for the evaluation of living labs as boundary spanners in innovation. Environment and Planning C: Politics and Space, 36(7), 1280–1298. https://doi.org/10.1177/2399654417753623
Van Welie, M. Van der Veer G.,(2003). Pattern languages in interaction design: structure and organization. In Proc. of IFIP TC13 Int. Conf. on Human-Computer Interaction INTERACT'2003 (pp. 1-5).
Wahl, D. C., & Baxter, S. (2008). The designer's role in facilitating sustainable solutions. Design issues, 24(2), 72-83.
Wania, C. E., & Atwood, M. E. (2009, May). Pattern languages in the wild: exploring pattern languages in the laboratory and in the real world. In Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology (pp. 1-15).
Wang, A., Hu, Y., Li, L., & Liu, B. (2016). Group decision making model of urban renewal based on sustainable development: public participation perspective. Procedia Engineering, 145, 1509-1517.
Wang, Y., & Green, K. E. (2019, March). A pattern-based, design framework for designing collaborative environments. In Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction (pp. 595-604).
Wang, Y., Qu, K., Chen, X., Gan, G., & Riffat, S. (2022). An innovative retrofit Motivation-Objective-Criteria (MOC) approach integrating homeowners' engagement to unlocking low-energy retrofit in residential buildings. Energy and Buildings, 259, 111834.
Watson, C. (2011). Patterns in Post-Occupancy Evaluation. Enhancing Building Performance, 75.
Wikipedia contributors. (2022, March 23). Pattern language. Wikipedia. https://en.wikipedia.org/wiki/Pattern_language#Simple_example_of_a_pattern
Wirth, W., & S. Kolb. (2004). Designs and methods of comparative political communication research. In F. Esser & B. Pfetsch (Eds), Comparing political communication: Theories, cases, and challenges (pp. 87–111). New York: Cambridge University Press.
Wohlin, C. Guidelines for Snowballing in Systematic Literature Studies and a Replication in Software Engineering. In Proceedings
of the 18th International Conference on Evaluation and Assessment in Software Engineering—EASE 14, London, UK, 13–14 May
2014; ACM Press: London, UK, 2014; pp. 1–10.
Xue, Y., Temeljotov-Salaj, A., Engebø, A., & Lohne, J. (2020). Multi-sector partnerships in the urban development context: A scoping review. Journal of Cleaner Production, 268, 122291.
Yin, C. & Qian, X. (2020) The spatial production of simulacrascape in urban China: Economic function, local identity and cultural authenticity, Cities, 104, 102806.
Zavadskas, E.K., Kaklauskas, A., and Gulbinas, A., 2004. Multiple criteria decision support web based system for building refurbishment. Journal of civil engineering and management, 10, 77–85.