

The Design Process and Its Research Methods

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Received 2025-04-02; accepted 2025-09-15

Keywords

Architecture, design process, research methods, wooden facades.

Abstract

The article reviews design research methods such as Design Thinking, the Double Diamond approach, the Triple Diamond design process, and the Agile and Waterfall methods, detailing their application in architecture and in designing wooden facades. It analyses and compares these methods to assess their relevance to architecture. Additionally, the article incorporates sustainability principles, emphasising environmentally responsible design practices such as material efficiency, energy conservation, and the use of renewable resources, critical factors in modern architectural projects. It also aligns these approaches with the United Nations Sustainable Development Goals, highlighting how design methods can support global objectives such as climate action, sustainable cities and communities, and responsible consumption and production.

Introduction

In design, similar research methods can complicate the process, requiring designers and architects to choose the most suitable ones for the desired results. This paper explores and compares Design Thinking, the Double Diamond approach, the Triple Diamond design process, Agile and Waterfall methods, analysing the strengths and weaknesses based on Latvian wooden building facades to identify the best approach. Design research methods are crucial for successfully implementing projects, offering a structured and adaptable problem-solving framework. The study hypothesises that appropriate design methods for wooden facades will yield faster, higher-quality, more aesthetic, and more user-responsive outcomes. Specific research methods and tasks were established to achieve this objective.

- Conduct literature research and analysis (method: literature analysis and research).
- Conduct a historical review of design methods (method: literature analysis and research).
- Investigate and compare design methods through examples of Latvian wooden architecture (method: literature analysis and research).
- Study and analyse the benefits, pros, and cons of using design methods in wooden architecture (method: research and analysis).

- Comparison of design methods and tabulation of analysis (method: tabulation of analysis data).
- Collate the information (method: aggregation of analysis data).
- Conclusions (method: aggregation of analysis data).

In architecture, various design methods are employed based on the type of project, the objectives, complexity, and parties involved. Design Thinking is widely utilised because it emphasises exploring user needs and fostering empathy. Architects apply this method to better understand a building's users, the environment, and social context through iterative idea generation and prototyping. It facilitates the creation of functional, sustainable, and people-friendly solutions. The Double Diamond method structures the steps of the architectural process – discover, define, develop, and deliver. This framework helps architects organise the process and engage clients. The Triple Diamond approach, particularly in integrating sustainability and social aspects, is increasingly considered in complex architectural projects that must address environmental, social, and economic factors. This strategy promotes a broader perspective and systems thinking. The Agile method, while less traditional in architecture than software, is adopted in projects requiring increased flexibility and team collaboration. For instance, architecture and construction project management utilise iterations inspired by Agile principles, client involvement,

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and rapid adaptation to changing requirements. The Waterfall approach remains a traditional, sequential project management model that is straightforward to manage and comprehend. It is still applied in large, formal construction projects where changes in requirements are limited and the process is well defined. Architectural design has utilised traditional methods such as the Waterfall method and modern, flexible methods like Design Thinking, Double Diamond, and Agile. The choice of method depends on the project's complexity, the level of client involvement, the need for flexibility, and sustainability requirements. However, there is an increasing emphasis on user needs, iteration, and sustainable thinking, aligning with the principles of Design Thinking, Double Diamond, and Triple Diamond, as well as the Agile approach.

Several architects have integrated design thinking into their practice, emphasising a human-centred and iterative approach to problem-solving. Mayank Saxena, Enterprise Architect at ABN AMRO Bank in the Netherlands, for example, discusses how design thinking involves empathising with clients, questioning assumptions, ideating solutions, and rapid prototyping to receive early feedback and improve results [1]. Architect and researcher Audrey Mertens believes that the Design Thinking approach can significantly enhance the interaction between architects and clients, particularly in residential design. She notes that while the principles of Design Thinking can serve as an inspirational framework, they need to be tailored to the needs of architects and the constraints of the sector. Mertens emphasises that user involvement in the design process is crucial to ensure project success and that Design Thinking can help advance architectural practice in this area [2]. Design expert Dan Ramsden states that the Double Diamond approach effectively highlights the importance of defining problems and creating solutions, as well as balancing divergent and convergent thinking in the design process. However, he points out that this model is too general and may convey a misleading impression of the linear nature of the design process, underrepresenting its iterative and multi-layered character [3]. The article "Agile and Architecture: Lessons from the Trains" explains how architects need to adapt to the Agile approach – working iteratively and closely collaborating with teams instead of planning everything at once. The Agile approach promotes flexibility and allows for quick responses to changes, but architects still require a stable structure during construction phases. While architects find this approach beneficial, they stress the importance of combining the Agile's flexibility with the rigour and care necessary in architecture [4]. The Waterfall method is more specific to software development and is rarely used in architecture. However, architects point out that the Waterfall approach may limit the ability to respond swiftly to changes in a project, potentially hindering creative adaptation to users' needs

or technological advances, which is why this method is typically not chosen.

The study's objects are contemporary wooden buildings that have won the Latvian Design Award. Using these examples, the effectiveness and applicability of these methods in designing wooden building facades are analysed and compared. Several articles and books have been written on design research methods, and each is discussed separately. For example, one of the best-known books on Design Thinking is Tim Brown's "Change by Design: How Design Thinking Creates New Alternatives for Business and Society". It explains how Design Thinking solves complex problems, inspiring creativity and innovation in business and society. Brown highlights the role of empathy, the ability to understand and empathise with the end user's needs, and emphasises iterative prototyping as a method to quickly test and refine ideas. The book explores how the designer mediates technology, people, and business, creating new opportunities and value. The key message is that Design Thinking helps to overcome the limitations of traditional thinking by fostering flexible and customer-centric solutions [5]. "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value" by Thomas Lockwood explores how the principles of Design Thinking are integrated into innovation and brand value, and how to improve customer experience. This book explores Design Thinking as a broad approach that solves problems, strengthens brands, and enhances customer experience. The author examines how Design Thinking integrates into innovation processes and is used as a strategic tool to improve a company's competitive edge. He discusses customer engagement methods, idea generation techniques, and prototyping, demonstrating how these practices help create unique and positive customer experiences. The main conclusion is that Design Thinking links innovation and business value, making companies more adaptable to market demands [6].

No books cover the Double Diamond approach; it is mainly compared to other methods. Thomas Lockwood and Edgar Papke's "Innovation by Design" discusses how design research methods, such as the Double Diamond approach, foster organisational innovation. The authors examine design research methods broadly, focusing on the role of the Double Diamond model in promoting innovation within organisations. The book investigates various approaches to structuring design processes, emphasising systematic problem definition and solution development. The Double Diamond approach is portrayed as an effective tool for helping teams transition from understanding the problem to developing concrete solutions while promoting creativity and collaboration. The central message is that such structured methods contribute to designing and cultivating an organisation's broader culture of innovation [7].

Daniel Wahl's "Designing Regenerative Cultures" examines sustainable design via the Triple Diamond methodology, impacting broader systems and fostering eco-friendly solutions. Daniel Wahl's work centres on sustainable and regenerative design philosophy, utilising the Triple Diamond methodology as a tool to tackle global environmental and social challenges. The author broadens the framework of traditional design models to incorporate systems thinking and regenerative principles, which foster environmentally friendly solutions and enhance society. The key message is that the Triple Diamond methodology facilitates a shift from mere product or project thinking to broader cultural and systems transformation [8]. Ken Webster's "The Circular Economy: A Wealth of Flows" connects the Triple Diamond approach to the circular economy principles. He illustrates how design methods based on the Triple Diamond approach foster innovation that allows products and services to function according to natural cycles, reducing waste and maximising resource efficiency. Webster concludes that the Triple Diamond approach offers a structured framework for assisting in designing products and systems that are both economically and environmentally friendly, while also creating additional social value [9].

Mike Cohn's book, "Agile Estimating and Planning", explores planning and estimating using the Agile approach. The book is a practical guide to Agile project planning and costing. It provides concrete tools, techniques, and principles for Agile teams to plan iterations, prioritise tasks, and forecast work scope, enhancing efficiency and scalability. The key message is that effective Agile planning allows teams to respond quickly to change while maintaining high quality and productivity [10]. "Agile Software Development: Principles, Patterns, and Practices", written by Robert C. Martin and Micah Martini, offers theoretical and practical insights into the Agile development, emphasising key principles and programming patterns. The authors examine Agile principles, architectural patterns, and best practices in detail, focusing on how these elements are applied in real teams. The key message is that Agile principles foster close collaboration, swift feedback, and continuous improvement, making software development more agile and efficient [11].

The Waterfall approach is discussed in software engineering books. Roger S. Pressman's book "Software Engineering: A Practitioner's Approach" is among the most authoritative resources for programmers; it explains the fundamentals of the Waterfall model within software engineering. The author outlines the model's sequential phases – requirements analysis, design, development, testing, and implementation – and discusses its advantages, such as clarity and controllability. However, Pressman also recognises the model's limitations, including a lack of flexibility and the

challenges of adapting to changing requirements as the project progresses [12]. Winston W. Royce's article "The Waterfall Model and Its Impact on Software Development" details the model, its principles, and its advantages and drawbacks. He emphasises the structured nature of the model, which allows for a clear distinction between project phases and effective resource management. At the same time, Royce acknowledges that the sequential nature of the model can create problems when a project needs changes and rapid adjustments are required. The key insight is that Waterfall is well-suited to well-defined models [13].

The available literature does not address the use of these methods in architecture; therefore, this article is an essential addition to the research and analysis of design research methods for use in other fields. The work analyses the facades of wooden buildings because the visible part of the building determines the external visual aesthetics.

I. Design Thinking

Design Thinking is a non-linear process for generating creative alternatives using anthropological techniques focused on human behaviour and needs (see Fig. 1). It identifies problems, co-creates solutions, prototypes, tests, and continuously improves based on user input. Design Thinking combines problem-solving with a user-centred approach and iterative activities that address users' concerns, desires, and habits. User research tests and refines assumptions and develops innovative strategies [14].



Fig. 1. The main stages of the Design Thinking method [15].

Design Thinking is a collaborative, experimental process crucial for prototyping and testing ideas with users. It merges a human-centred approach with creative solution development and analytical decision-making. Initially, from design, this interdisciplinary process can apply to various work fields. It is significant in developing products and services, particularly in addressing complex, undefined, and evolving issues affecting many people [14].

Design Thinking emerged in the 1960s as engineers and designers focused on user needs. In the 1990s, IDEO, led by David Kelley, structured itself around empathy, experimentation, and iteration. Stanford University advanced its application in business and education [16].

The first stage involves qualitative research to identify user needs through surveys and interviews. This data leads to a clear definition of the design challenge. Brainstorming generates ideas and establishes evaluation criteria before voting. Based on user feedback, prototyping, testing, and refining follow [17].

The challenge should focus on user needs, based on research. The design process defines the challenge through user research, setting Design Thinking apart from other methods [18].

Researchers have highlighted issues in scientific articles, including a case study on the Historic Centre of Riga (HCR) that addresses the little-explored “loss of liveability” in historic city centres [19]. The authors share insights on various design methods for analysing the facades of historic wooden residential buildings and contemporary projects. They suggest these examples may aid architects and urban planners in understanding the “loss of liveability” phenomenon using the theories discussed.

Examples

1. Ogre Central Library

The library is a modern, multifunctional community centre (see Fig. 2). Designed by PBR, Valdis Onkelis, and Rūdis Rubenis, it won a Design Award in 2021 [20].



Fig. 2. Ogre Central Library [20].

The facade of the library was designed using the Design Thinking method:

1. *User needs and environmental research:* Library visitors, staff, and the public are surveyed to assess the facade's impression and its reflection of modern and functional aesthetics within the city's historic context and local cultural values [21].
2. *Identification of the main problems:* Main issues for facade design include accessibility, visual identity, technological development, and energy efficiency. Key aesthetic, functional, and sustainable objectives are established.

3. *Functional and emotional requirements:* The facade should be aesthetic and functional, allowing sunlight into the interior while promoting sustainability and energy efficiency. Various concepts for the facade's tonality, rhythm, shape, and composition are proposed.
4. *Prototyping:* Sketches and 3D models effectively visualise facade variations. After selecting the best ideas, detailed prototypes or visualisations, including digital models, material samples, and physical mock-ups, are created. This stage assesses the facade's energy efficiency, material reactions to climate, and maintenance requirements.
5. *Testing:* Prototypes or plans are shown to the public or users before final implementation. Feedback on design, functionality, and impact is gathered for improvements. Adjustments are made to ensure the facade meets users' criteria and needs.

2. Wooden Office Building in Lizums

An energy-efficient, sustainable timber office building for a significant Vidzeme company combines administrative and catering functions, providing a comfortable meeting place and contemporary accent to the factory complex visible from the road (see Fig. 3). Designed by MADE Architects Mīkēlis Putrāms, Linda Krūmiņa, Māra Starka, Kristis Lūkins, Jēkabs Slava, and Patrīcija Lidere. Design Award 2023 [22].



Fig. 3. Wooden office building in Lizums [22].

The facade of the office building was designed using the Design Thinking method:

1. *User needs and environmental research:* The building's facade serves the function and aesthetics, enhancing the working environment. Interviews and surveys of employees and visitors are needed to gauge preferences for natural light, integration with surroundings, and material choices. Evaluating local architectural style, climate, and landscape is essential. It is vital to assess how the facade can blend into the local landscape while reflecting the sustainability of a wooden office building [23].

2. *Identification of the main problems:* It is crucial to define key issues in facade design. The facade must be sustainable, energy-efficient, visually appealing, and functional. Challenges include maintaining the facade and protecting wood from moisture and UV rays.
3. *Functional and emotional requirements:* The facade must be durable, energy efficient, and visually attractive to create a comfortable, inviting workspace.
4. *Prototyping:* Facade prototypes are created with various wood finishes and architectural solutions to determine which withstands the local climate. They assess durability, moisture treatment, ventilation, and light transmission. Additionally, they test modern technologies such as solar panels, which integrate into the wooden facade design.
5. *Testing:* Prototypes are shown to users and the local community for feedback on design and functionality. The testing phase assesses the emotional impact of the architectural facade and its alignment with user and public expectations. Feedback analysis leads to necessary improvements. Adjustments enhance performance if the facade lacks protection from external factors or disrupts ventilation.

II. Double Diamond Approach

The Double Diamond approach illustrates the design and innovation process. It outlines the steps of any design project, irrespective of methods or tools. Developed by the British Design Council in 2005, it is a popular model for understanding the creative design phases. The technique features two diamonds: one for exploring and defining a problem and the other for focusing ideas into a concrete product or experience, each with two stages (see Fig. 4):

- 1) discover (problem search, user needs identification, research);
- 2) define (define the problem based on the knowledge gained);
- 3) develop (turning a problem solution into a product);
- 4) supply (testing and production of the final product).

The Double Diamond approach emphasises the importance of divergent thinking, encouraging designers to explore various options before arriving at a single solution [24].

The Double Diamond method is critical for several reasons:

1. The method provides a clear structure for the Design Thinking process, helping teams and individuals stay focused and organised.
2. It encourages divergent thinking. The first diamond focuses on generating various ideas and solutions that encourage divergent thinking and creativity.
3. The second diamond focuses on refining and implementing the chosen solution, encouraging convergent thinking and practical problem-solving.
4. The method is based on a user-centred design approach, which puts users' needs and requirements at the centre of the design process.
5. The Double Diamond method is a flexible and adaptable framework tailored to projects and teams' needs and requirements [25].

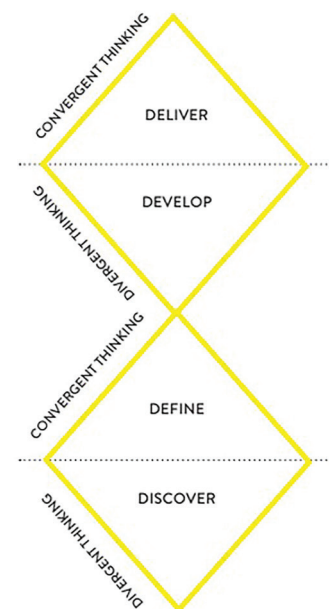


Fig. 4. Stages of the Double Diamond approach [24].

In the early 2000s, the Design Council studied successful design projects in various sectors. It identified a four-step design process organised into two “diamonds” cycles: discovering and defining the problem, then developing and implementing solutions. This Double Diamond process captures a broad understanding of the problem and a focused selection of solutions [26].

Examples

1. "W" house

This building merges Nordic insularity with Scandinavian fusion, creating a contemporary Latvian space (see Fig. 5). Designed by "Space in" Ltd, Normunds Kagainis, Mikus Hercs, Matīss Šteinerts. Design Award 2023 [27].



Fig. 5. "W" house [27].

The facade of the house was designed using the Double Diamond approach:

1. *Understanding the client's needs and wishes:* First, interview the homeowners to understand their wishes for the facade.
2. *Analysis of climatic and environmental factors:* To choose suitable wood and treatments, consider Latvia's climate, including humidity, temperature fluctuations, and wind effects.
3. *Study local architectural traditions and trends:* Latvia boasts rich wooden architecture. Designers can study local trends to integrate modern functionality seamlessly into the environment.
4. *Formulating the main problems:* Sustainability of the wooden facade, natural light, privacy, and environmental aesthetics.
5. *Developing different design solutions:* Various facade solutions utilise distinct wood finishing techniques, textures, and shapes. Options include traditional timber boards, modern panel systems, or combinations with materials like glass or metal. Sketches and 3D models visualise potential facades during idea generation.
6. *Prototype testing:* Prototypes visualise the facade's appearance under various weather and lighting conditions, testing wood panel durability and environmental reactions.

2. Villa "Dālija"

Villa "Dālija" draws inspiration from Palladio's Villa la Rotonda and Nordic materials (see Fig. 6). The design emphasises regularity, symmetry, and a four-pitched roof, creating a unique spatial experience. Designed by ĒTER: Dagnija Smilga and Kārlis Bērziņš. Design Award 2021 [28].



Fig. 6. Villa "Dālija" [28].

The facade of the house was designed using the Double Diamond approach:

1. *Understanding the client's needs and wishes:* First, interview the villa owners to grasp their lifestyle and aesthetic preferences. Consider whether they want to preserve natural wood aesthetics with modern elements or need sustainable materials and energy efficiency. Analyse their preferences for privacy, landscape views, and sunlight exposure.
2. *Analysis of climatic and environmental factors:* Latvia's humid, temperate climate affects the longevity and maintenance of wooden facades. An ecological analysis examines materials and facade solutions that resist humidity, temperature changes, and sunlight.
3. *Study local architectural traditions and trends:* Analyse the villa's integration with its surroundings and the desire to preserve or imitate local architecture. This will determine whether the facade should blend into the landscape or stand out as a modern element.
4. *Formulating the main problem:* Combine traditional wood use with modern solutions while preserving wood aesthetics and ensuring the durability and sustainability of facades in Latvia's climate.
5. *Developing different design solutions:* Key design goals include a modern facade harmonising with the landscape and functional objectives like energy efficiency, thermal insulation, and ventilation. Various facade options blend wood with contemporary materials and technologies. Sustainable solutions are integrated into the facade design.

III. Triple Design Process

The Triple Design process consists of three distinct stages:

1. Reveal.
2. Define.
3. Develop.

Each phase represents a stage of the design process essential for successful results. The Triple Design process draws from the Double Diamond method (see Fig. 7). It has evolved, incorporating feedback from practitioners worldwide, becoming a comprehensive and adaptable approach. A key focus in this method is emphasising empathy and user-centeredness, ensuring final solutions are visually appealing, meaningful, and effective [29].

Empathy is central to this process. Designers seek to understand the perspectives of their users, gaining insight into needs and challenges. They collaborate with cross-functional teams –researchers, engineers, marketers, and strategists – to ensure a comprehensive approach. Recognising that the first solution is rarely the best, designers continuously prototype, test, and refine their work. They prioritise the needs and desires of end users, ensuring that the solutions they create are intuitive, accessible, and enjoyable to use [29].

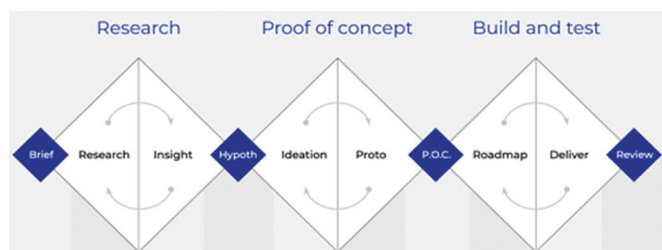


Fig. 7. Stages of the Triple Design process [29].

During the discovery phase, research identifies the problem and establishes priorities. The problem is defined, and goals are clarified to align with outcomes. This includes describing the current situation and considering tasks or requirements. Feedback is essential to ensure clarity between the defining and understanding stages. Goals should be SMART: specific, measurable, achievable, relevant, and time-bound. An action plan is created from the data collected [30]. The Triple Diamond method began to develop in the early 2020s in response to the growing demand for a design approach capable of addressing complex, multi-layered problems such as climate change and social inequality. Such issues often require systematic and strategic solutions that go beyond the conventional Double Diamond structure [31].

Examples

1. Jāņa Market

Jāņa Market is a commercial hub in Sigulda inspired by Latvia's black wooden barns (see Fig. 8), designed by architect Kārlis Bedrītis, artist Andis Gūtmanis, and metal artist Juris Zandersons. Design Award 2019 [32].



Fig. 8. Jāņa Market [32].

The facade of the Market was designed using the Triple Design approach:

1. *User needs research:* Research aims to understand market visitors' and vendors' needs. The wooden building facade is crucial for enhancing the market's atmosphere and promoting community engagement.
2. *Analysis of environmental and climatic factors:* Latvia's cool, wet climate requires wooden facades to withstand precipitation, moisture, and temperature changes. An analysis identifies the best materials and solutions for durability and low maintenance.
3. *Defining key problems:* The wooden facade must ensure sustainability, energy efficiency, and aesthetic appeal while connecting with Jāņa Market's social context. It should be durable against the weather, provide a comfortable indoor climate, and create a harmonious visual image that aligns with the surrounding architecture.
4. *Generating different facade design solutions:* Several facade design options combine wood with elements like glass or metal. Solutions include various wood cladding types –horizontal or vertical boards, classic ornamental patterns, or modern shapes highlighting the market's dynamic nature.
5. *Prototype testing:* Prototypes test facade cladding ideas, examining various wood types and treatments for moisture, sunlight, and temperature response. Tests identify the most durable and sustainable materials, including simulations or installations to evaluate weather resistance.

2. Hotel "Miķelis"

"Miķelis" is a modern 3-star superior hotel with 18 comfortable rooms offering picturesque nature views (see Fig. 9). Designed by Design Bureau A.I.D.E. and architects Jānis Rinkevičs, Elīna Znotēna, Skaidrīte Kassaliete, and Uldis Logins. BK section authors: TrendFor Ltd, Ģirts Vīksne, and Juris Orlovs. Design Award 2017 [33].



Fig. 9. Hotel "Miķelis" [33].

The facade of the hotel was designed using the Triple Design approach:

1. *User needs research:* The focus is on understanding the hotel guests' needs. An analysis determines the types of guests visiting and how their needs influence the facade design.
2. *Analysis of environmental and climatic factors:* In Latvia's humid climate, it is essential to know suitable wood treatment methods and how facades can guard against precipitation, moisture, and temperature changes. This includes choosing weather-resistant materials and exploring ventilation systems.
3. *Defining key problems:* The wooden facade should ensure durability and visual appeal, especially against moisture and temperature changes. Additionally, balancing natural materials with modern technologies, such as energy efficiency, is essential.
4. *Generating different facade design solutions:* Setting goals defines aesthetic priorities, indicating whether the facade emphasises nature or modernity. Various design options blend wood treatments, considering material durability against external factors. Glass or metal elements are also integrated for a modern look.
5. *Prototype creation:* Facade prototypes test materials and solutions practically. For instance, tests assess the facade's performance against precipitation and temperature changes.

IV. Agile Approach

In 2001, 17 people met in the Wasatch Mountains, Utah, to express dissatisfaction with software development. They created the Agile Manifesto, changing the software development paradigm. The Agile methodology offers a cost-effective alternative based on four core principles outlined in the Manifesto (see Fig. 10):

1. Individuals and interactions over processes and tools.
2. Working software over comprehensive documentation.
3. Customer collaboration over contract negotiation.
4. Responding to change over following a plan.

Managers and designers collaborate throughout the project. For effective teamwork, managers must understand the role of design in product success. Continuous communication is key in Agile design. One Agile principle emphasises that face-to-face conversations are the best way to share information within the product team. Agile design teams should be multifunctional. The goal is rapid design and delivery, so the product team should continue making incremental rather than significant, one-time changes [34].

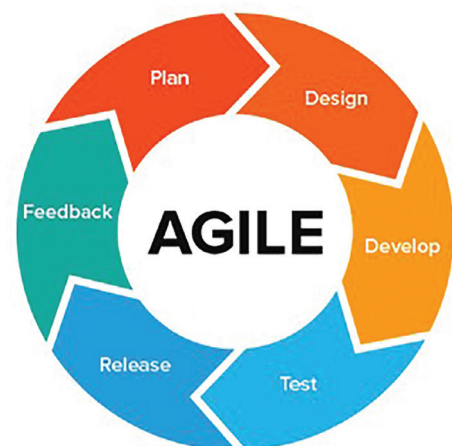


Fig. 10. Stages of Agile approach [35].

The Agile process prioritises customer satisfaction by focusing on individual tasks through multiple iterations. Modularisation is crucial, as Agile is iterative and requires time constraints. It aims to minimise risks and achieve objectives efficiently. Agile allows flexibility in adapting processes to address emerging risks and enables real-time changes to requirements. Effective communication within the development team is vital due to the modular nature of Agile. Ultimately, customer satisfaction overrides technology and processes [36].

Examples

1. The office building of “Latvijas Valsts meži”

The building’s design reflects Latvia’s forest richness, utilising extensive wood materials for tactile sensations and striking visuals (see Fig. 11). Designed by the Architectural office “5.IELA” Ltd and architect Ija Rudzīte, alongside V. Vītola, O. Barons, L. Balode, L. Vītola, I. Krūzkopa, and M. Pildava. Design Award: 2017 [37].



Fig. 11. The office building of “Latvijas Valsts meži” [37].

The facade of the office building was designed using the Agile approach:

1. *Defining the concept:* The facade concept emerges from the “Latvijas Valsts meži” identity, values, and sustainability principles. This phase considers primary materials, symbolising the organisation’s link to natural resources. A thorough analysis of selected materials focuses on sustainability, including local wood use, thermal treatment, and weather durability. Various materials and technologies are tested to identify those that meet visual and functional goals.
2. *Adapting to clients’ needs:* Feedback is gathered from clients and stakeholders. For instance, Latvijas Valsts meži might want to emphasise biodiversity by integrating plants into the facade. These desires are incorporated and adjusted in the next cycle.
3. *User and client involvement:* The Agile approach prioritises client and user involvement in design, ensuring the facade solution is improved based on actual needs and feedback. It promotes collaboration with architects, engineers, and builders for quick responses to construction challenges and adjustments to facade design.
4. *Flexibility and adaptation to new requirements:* The Agile approach offers flexibility, enabling quick responses to changing requirements. It allows for rapid adjustments to the facade solution using

environmentally friendly materials or technologies. The methodology efficiently addresses challenges by adapting plans and solutions to meet new needs without disrupting the process.

5. *Final result and continuous improvement:* The Agile approach stages projects, resulting in a facade that meets functional and aesthetic goals. Constant feedback and iterations help the facade adapt to the project’s needs.

2. Modular-type building for temporary operations at Carnikava Primary School

This modular building, designed on a limited budget, showcases the architect’s ability to balance the concept, client needs, and builder finances (see Fig. 12). Designed by Architects Aivars Rīts, Ieva Rīta, general designers Belss Ltd, and Ritmus Ltd. Design Award 2020 [38].



Fig. 12. Modular-type buildings for temporary operations at Carnikava Primary School [38].

The facade of the school building was designed using the Agile approach:

1. *Concept definition:* A needs analysis identifies the requirements and goals of Carnikava Primary School, focusing on essential functions and aesthetics. The initial facade concept incorporates the benefits of a modular building, including quick installation and easy relocation, while also considering sustainable materials that meet environmental standards.
2. *Customisation to client’s needs:* Facade prototypes utilise materials like wood and composites, focusing on sustainability and thermal insulation. They are tested and refined to meet client needs.
3. *User and client involvement:* The approach emphasises client and user involvement throughout the design process to ensure the result meets their needs. Regular meetings with school administration, teachers, and students gather feedback on the facade design and functionality.

4. *Flexibility and adaptation to new requirements:* Agile flexibility enables quick change responses. The design can be swiftly adjusted if technical challenges or budget constraints arise.
5. *Final result and continuous improvement:* The Agile approach ensures the final result is functional, appealing, and sustainable. The facade design process considers energy efficiency solutions, including thermal insulation, light-reflecting surfaces, and integrating solar panels to reduce the building's carbon footprint.

V. Waterfall Approach

The Waterfall approach is a widely recognised project management workflow. Each phase of the process goes through five stages sequentially:

1. Requirements.
2. Design.
3. Implementation.
4. Verification.
5. Maintenance.

This methodology originated in Winston Royce's 1970 research on software development (see Fig. 13). Although he never called it the Waterfall method, he established a linear project management system. The Waterfall model allows no flexibility; each phase must be completed before the next. The requirements phase defines the project scope, covering business obligations and user needs. After gathering requirements, designers create solutions in the design phase. Once approved, designs are implemented as developers execute specifications. Quality control ensures a good user experience by checking all use cases. After launch, designers rely on customer feedback to fix issues and release updates. The main advantage of the Waterfall method is its clear project structure [39].

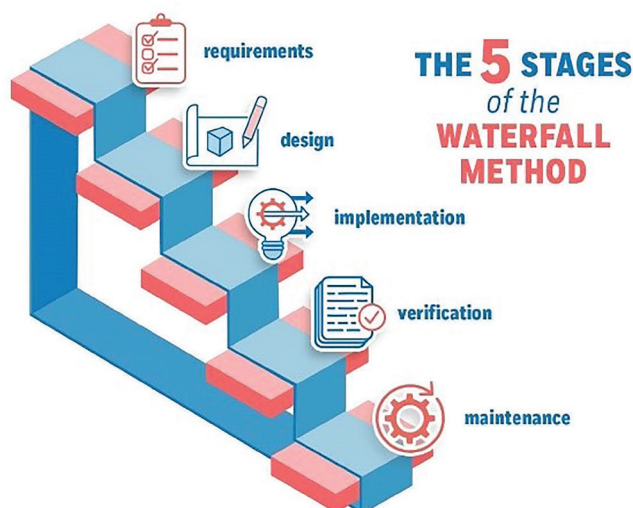


Fig. 13. Stages of the Waterfall approach [40].

Key development requirements are gathered during the analysis phase, helping to define the design and architecture. After determining the requirements, the next phase involves developing the product according to these standards, including implementing all project prerequisites and post-requisites. This encompasses full functionality development, which stakeholders test. Testing strategies are outlined, and various models are checked to ensure compliance with initial requirements. Modifications can then be made based on client preferences.

Advantages of the Waterfall approach:

1. Simple and easy to understand.
2. Clearly defined phases.
3. Easy to structure tasks.
4. The process and results are well documented.
5. It is easy to manage the design process.

Disadvantages of the Waterfall approach:

6. High number of risks and uncertainties.
7. Not suitable for long and ongoing projects.
8. Difficult to manage project phases.
9. Cannot adapt to changes in requirements [40].

Examples

1. Holiday house in Saulkrasti

The project involves constructing a compact holiday cabin in a resort town, focusing on layout, ergonomics, and modern space solutions (see Fig. 14). Designed by architect Mārcis Mežulis. Design Award 2022 [41].

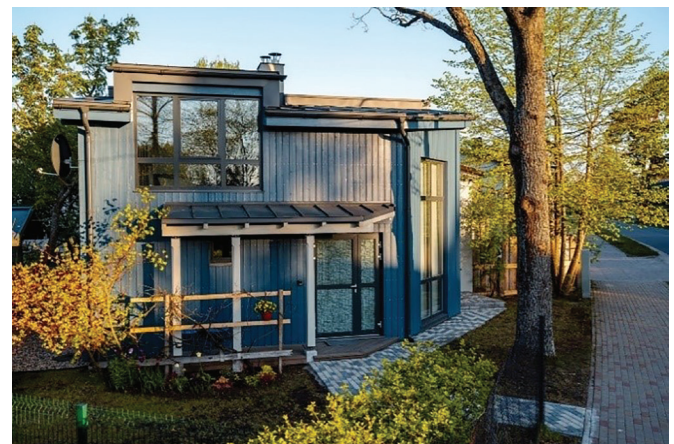


Fig. 14. Holiday houses in Saulkrasti [41].

The facade of the house was designed using the Waterfall approach:

1. *Site research:* Exploring Saulkrasti's landscape informs the design, using wooden materials and organic elements to ensure the cabin blends harmoniously with its environment.
2. *Environmental impact:* Local climate factors like wind, sunlight, and rainfall are analysed to assess their effects on facade design and material choice [42].

3. *Prototype development*: Initial facade prototypes use various woods and finishes, focusing on appearance and functionality.
 4. *Feedback gathering*: Regular meetings held with clients and users for design feedback, incorporating input on functionality.
 5. *Improving the design*: After analysing feedback, design changes include repositioning windows for more natural light and focusing on wooden elements for ventilation.
2. Office building in Āgenskalns
Baložu Street features charming wooden apartments and historic private houses (see Fig. 15), designed by Anda Ārgale. Design Award 2015 [43].



Fig. 15. Office building in Āgenskalns [43].

The facade of the office building was designed using the Waterfall approach:

1. *Site investigation*: The Āgenskalns neighbourhood's character, historic buildings, and environment are assessed, considering design-influencing factors.
2. *Goal setting*: Clear goals are set based on client requirements and user needs to create productive workspaces with a visually appealing facade that fits the neighbourhood.
3. *Prototype development*: Prototypes are created by exploring materials like wood, metal, and glass for a modern, attractive design.
4. *Gathering feedback*: Meetings with potential users to discuss the initial design solution, including suggestions on layout and aesthetics.
5. *Improving the design*: The design has been adjusted based on feedback. For instance, if more natural light is needed, the window size or position is modified to enhance light flow.

VI. Comparative Analysis of Methods

The analysis of the methods set specific evaluation criteria against which all methods were compared by the following criteria.

1. **Main focus**: Every design method has its own central focus, whether it is on problem research, solution creation, project management, or the end user. This criterion helps assess whether the method meets the needs of a particular project.
2. **Project management characteristics**: Project management is crucial in architecture because it ensures control over resources, time, and quality. This criterion allows for a comparison of how well each method integrates project management principles.
3. **Flexibility to design changes**: The building design process often requires adjustments for both client and technical reasons. This criterion evaluates the ability of a method to adapt to these changes without significant project delays or cost increases.
4. **Focus on sustainability**: Sustainability is one of the primary objectives of modern architecture and construction. This criterion assesses how effectively the method integrates sustainability principles into the design process.
5. **Adaptability of project phases**: Architectural projects consist of several phases, from research to implementation. This criterion helps evaluate the flexibility of the method in managing and adapting to the different phases.
6. **Suitability for complex projects**: Most architectural projects are complex, involving many participants, technologies, and requirements. This criterion determines how well a method can handle such complexity.
7. **Focus on the end user**: Understanding and engaging with users' needs is crucial for creating functional and comfortable buildings. This criterion assesses how much the method emphasises the user experience.
8. **Iterative approach**: Iteration enables design improvements based on testing and feedback. This criterion evaluates whether and how the method employs an iterative process that contributes to a better end result.
9. **Importance of feedback**: Ongoing feedback from clients, users, and teams is essential to ensure design quality. This criterion determines how critical this feedback is to the method.
10. **Accuracy of time planning**: Deadlines are established for project completion. This criterion assesses how accurately the method allows for time to be planned and controlled to avoid delays.
11. **Suitability for large projects**: Large architectural projects require specialised management and coordination. This criterion helps understand how well the method can handle the scale of these projects.

TABLE I
Methods Compared Against the Criteria [by the authors]

Criteria	Design Thinking	Double Diamond approach	Triple Design process	Agile approach	Waterfall approach
Main focus	User needs	Problem-solving and sustainability	Problem-solving and sustainability	Quick adaptation and flexibility	Precise planning and defined requirements
Project management characteristics	Iterative, based on empathy and prototyping	Analytical, research-based and transformative	Analytical, research-based and transformative	Iterative, fast approach	Linear, each stage is sequential
Flexibility to design changes	Very high	Medium	Medium to high	Very high	Low
Focus on sustainability	High	Medium High	Extremely high	Medium	Low to medium
Adaptability of project phases	Repeatable and testable	Phases may be repeated as necessary	Phases may be repeated as necessary	Very flexible, continuous change	Phases are sequential and strictly defined
Suitability for complex projects	Medium	Medium	High	Medium to high	High
Focus on the end user	Very high	High	High	Medium to high	Low
Iterative approach	Yes	Yes	Yes	Yes	No
Importance of feedback	Very high	Medium/High	Medium/high	Very high	Less significant
Accuracy of time planning	Difficult to predict, flexible	Difficult to predict	Difficult to predict	Difficult to predict	Well defined
Suitability for large projects	Medium	Medium	High	Medium to high	Very high
Involvement of clients during the project	High	Medium/High	Medium/high	Very high	Less significant
	Good		Average		Bad

Design Thinking through method analysis is a practical research approach for wooden building facades, though it is not ideal for complex projects. Its application is, therefore, limited. Design Thinking produces quality results via idea generation, iteration, and client involvement. Prototyping and testing ensure optimal outcomes, allowing for necessary adjustments at each project stage.

The Double Diamond approach is unsuitable for facade design as it yields sub-optimal results and complications. It lacks a strong focus on sustainability and flexibility for design changes, making it inappropriate for complex projects. Client involvement is unnecessary, leading to a final product that may not meet user needs. Additionally, time planning in the design process can be cumbersome.

The Triple Design process is the second-best method. It has a broader range of applications, is fully user-driven, and is well-suited for large, complex projects. This flexible, iterative approach ensures effective problem-solving.

The Agile approach enables a fast design process that quickly yields results and allows flexibility. However, it is unsuitable for large, complex projects requiring sustainability, customer needs, and an iterative approach. The Agile approach works best for projects needing early, specific changes.

The Waterfall approach is unsuitable for facade design as it lacks focus on the end user and their needs. Its clearly defined phases are sequential and do not allow for flexibility in earlier stages, which is vital in architecture. Although non-iterative and sustainability-focused, this method is suitable for large projects with fixed standards and no anticipated changes.

Design Thinking and the Triple Design process yield the best design results and quality. Following the steps of each method sequentially is crucial. While applicable to wooden building facades, each method poses different challenges, speeds, qualities, and outcomes.

CONCLUSIONS

1. The design methods help architects explore new strategies for timber building facades in the private sector. Using these methods allows architects to innovate and meet changing industry demands, ensuring competitive and sustainable design solutions.
2. Design Thinking, the Double Diamond and Triple Design approaches support sustainable solution development by focusing on user needs. They enable the creation of visually appealing facades that blend smoothly into the environment. Using these methods leads to designs that are environmentally conscious and aligned with user expectations, enhancing acceptance and long-term performance.
3. The Agile approach is highly flexible, enabling quick adaptation to changing requirements and budgets. However, it may not be suitable for large, regulated projects, as wooden building design often involves specific criteria and regulations. Agile should be reserved for smaller, dynamic projects where rapid adjustments are critical, while larger projects may require more structured methods.
4. Design Thinking promotes innovation and personalised solutions by incorporating sustainability and natural materials based on user and societal needs. It supports longer design phases necessary for testing and improvements. For projects that focus on customisation and sustainability, this method provides the best framework, as long as timelines and budgets allow for extended iterations.
5. All methods need careful evaluation to prevent resource waste, enhance perception, and ensure consistent visual results. Selecting and reviewing methods thoroughly at each stage is crucial to optimise resources and maintain design consistency.
6. Double and Triple Diamond approaches enhance understanding of design contexts through thorough research, especially in urban or sustainable

development environments. The Triple Diamond model highlights sustainability, including an extended initial phase for comprehensive issue analysis, which may demand more resources initially. These methods are especially useful for complex projects in sustainability-sensitive areas, even though they require higher upfront costs and longer time investments.

7. The Agile approach enables quick responses to client needs and changes in construction during a project. It is ideal for projects with dynamic schedules and budgets, though implementing it can be difficult if wooden facades must strictly follow building regulations. Agile improves responsiveness and client satisfaction, but should be balanced with regulatory requirements.
8. The Waterfall approach offers a clear structure that enhances transparency and project management, especially for projects with specific requirements. It is ideal for large, complex projects but provides limited flexibility for changes, since each phase is strictly defined. Errors might only be found later if all aspects are not considered during the design phase. This method is suitable when predictability and control are important, but it requires thorough early planning to prevent issues later.
9. The choice of methods depends on project goals, circumstances, resources, and complexity. The study's hypothesis is confirmed. Design methods simplify the process, reducing errors and the need for corrections. Research methods help define each step for faster project delivery. Matching the design method to project characteristics ensures efficiency, accuracy, and timely completion.
10. Designing wooden building facades improves quality through precision, durability, and longevity. This involves choosing appropriate materials, ensuring structural integrity, and protecting against environmental factors. A structured approach to material selection and design maintains the long-term value and resilience of the facade.
11. Using design methods that incorporate aesthetics, creating facades that blend well with their surroundings. Analysing user needs ensures the building is functional and tailored to habits. User-centred design combined with aesthetic sensitivity results in facades that improve functionality and environmental integration.
12. Eco-friendly design methods increase energy efficiency, lower carbon emissions, and help buildings adapt to climate change. For wooden facades, focus should be on sustainable sourcing, proper processing, and eco-friendly wood integration. Sustainable practices in sourcing and processing are essential for reducing environmental impact while meeting global climate goals.

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