P2ENDURE
PLUG & PLAY BUILDING RENOVATION

Set-up of an e-Marketplace (in Synergy with existing e-Marketplaces in E2B PPP)

Deliverable Report D2.5

Deliverable D2.5, issue date on 31 August 2017

P2ENDURE
Plug-and-Play product and process innovation for Energy-efficient building deep renovation

This research project has received funding from the European Union's Programme H2020-EE-2016-PPP under Grant Agreement no 7723391.

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Colophon

This research project has received funding from the European Union's Programme H2020-EE-2016-PPP under Grant Agreement no 723391.

Publishable executive summary

The findings documented in this deliverable are relevant for the development of the demonstrator of the e–Marketplace. P2Endure offers a holistic solution differing from competitors. The draft of the platform is designed to collect and filter information based on BIM models in order to support the buying, prefabrication and making processes related to building components for deep retrofitting.
Furthermore the involvement of different stakeholders is organised at an easy–to-handle level and the efficient and effective communication about projects' details is realised. The realisation and production of the operating platform including the involvement of important stakeholders as the building supply industry is not foreseen in P2Endure. Nevertheless, the analysis of applicable business models shows promising opportunities for a later start-up business. This is following current multi-channel distribution ideas discussed currently with growing acceptance in the building supply industry.

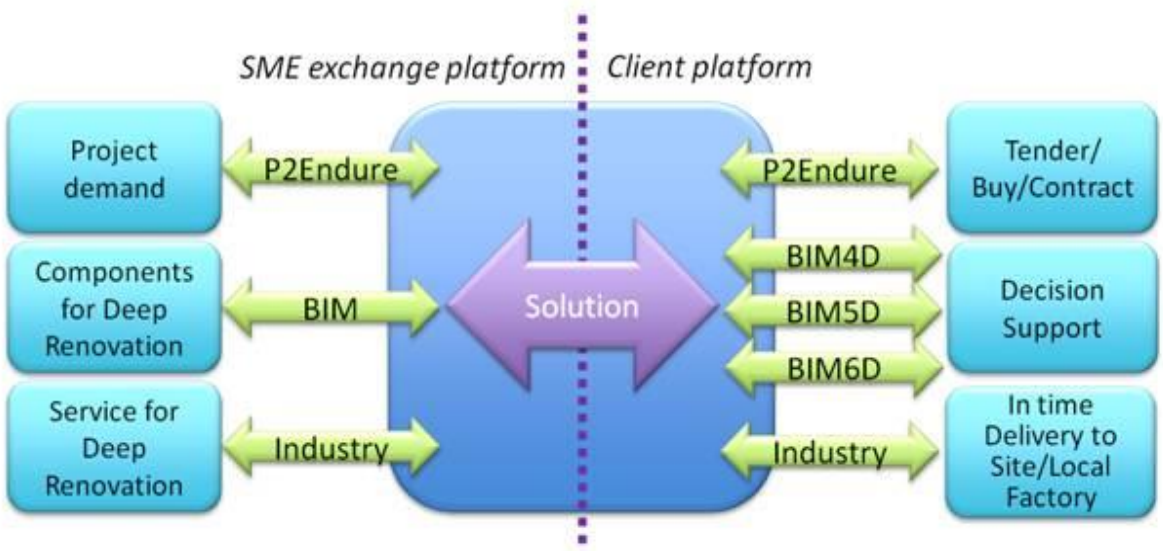

Figure 1: scheme P2Endure e-Marketplace, ©3L

Nevertheless the added value of the P2Endure e-Marketplace for different stakeholders from real estate developers, designers, engineers, building owners to construction companies is the key to a successful and sustainable implementation. The USP of the platform is the holistic offer including the preparation of a localised pre-fabrication from the perspective of the above mentioned members of the group of stakeholders.

Chapter 2 - ***Analysis of the Existing Platforms*** summarises the generic scope of the deliverable giving an insight in current developments in market diffusion strategies of the construction

market developed or demanded by the building supply industry. It contains the idealistic benefits survey of a BIM based platform for all stakeholders. The vision is the 'Building Amazon' a holistic platform operating in the field of building supply and retrofitting. The demonstrators' values and its benefits for all market partners are described. This section introduces e-Marketplaces and its functionalities in general, the difference between e-Marketplace and e-commerce, and reasons for their late adoption in the construction industry. Additionally, chapter 2 offers an overview of the initiatives undertaken in EU projects aiming at fostering the transition to e-Marketplaces at many levels and in several industries. Such initiatives include PaaSport, MOBiNET, WaterInnEU, AppHub, AutoMat, and Proficient. Lastly, section 2 identifies possible e-Marketplace models that could be suitable to the needs of P2Endure.

Chapter 3 - ***Expected Functionality Of The e-Marketplace*** is focusing on the impact and interaction of the P2Endure platform created by stakeholder needs. The interaction is organised from two different sides following the client and the SME driven demands. The partners from the building supply industry are involved in service and logistics. The current demand of the single project is identified by the precise project data and the qualified identification of needed components by filtering of BIM data.
The platform allows tendering, buying and contracting on basis of the available information. It gives a decision support for the client based on time, costs and facility management aspects and helps to organise the site logistics including pre-fabrication at the local factory.

Chapter 4 is giving an insight on the BIM based holistic and systemic approach. The P2Endure e-Marketplace is characterized by the integration of different components into one system. Six steps were shown for describing the system. First, the user loads his 'as is BIM' model into the front-end display of the P2Endure e-Marketplaces. In the second step, this model is presented in the front end of the e-Marketplaces. In addition to the 'as is BIM' model the user is also shown the energy and thermal data of his model. The e-Marketplace products which can be used for the renovation are also shown in the front-end display. In the third step, the user can add these products to his 'as is BIM' model. In the subsequent process step a new calculation of the thermal and energy data is carried out. The parameters of the selected products are added to the original 'as is BIM' model data (process step 5). Finally, the calculated data are displayed again in the front-end of the P2Endure e-Marketplaces. Using these data, the user can easily identify the thermal and energetic potential (and cost savings) of the renovation.
The P2Endure e-Marketplace with the integrated parametric modeller offers the user the possibility to calculate his renovation project energetically. The result of the calculation reflects a comparison of the existing values and the new values.
For this purpose, product solutions are made available within the e-Marketplaces. As already indicated (chapter 4.1.3), these individual products must be described as precisely as possible

by the manufacturers. This information includes, for example, product prices, design parameters and (where applicable) maintenance values. Without the description of the products, they cannot be implemented in the P2Endure e-Marketplace.

Chapter 5 introduces the local factory organization integrating the P2Endure 4M approach as part of the e-Marketplace. A generic four step implementation plan is elaborated that can be adapted according to the district characteristics and defined requirements for the production of specific PnP solutions. Furthermore, this section gives an insight in the potential value and sustainability aspects that are achieved by local factory concept integration.

List of acronyms and abbreviations

B2B	Business-to-Business
B2C	Business-to-Consumer
BIM	Building Information Model
CO_2	Carbon Dioxide
CRM	Customer Relationship Management
CSO	Collective Self-Organized
EEB	Energy Efficient Buildings
e-Marketplace	electronic marketplace
ERP	Enterprise Resource Planning
EU	European Union
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information and Communications Technology
IDRP	Innovative deep renovation product
IFC	Industry Foundation Classes
JiT	Just in Time
KPI	Key Performance Indicator
LCA	Life Cycle Analysis
LCC	Life Cycle Cost
MEP	Mechanical, Electrical and Plumbing
OEM	Original Equipment Manufacturer
PM	Project Management
PnP	Plug and Play
RLLL	Real Life Learning Lab
R&D	Research and Development
SEA	Search Engine Advertisement
SEO	Search Engine Optimisation
SME	Small Medium Enterprise
USP	Unique selling proposition
4M	Mapping, Modelling, Making, Monitoring

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1. Introduction

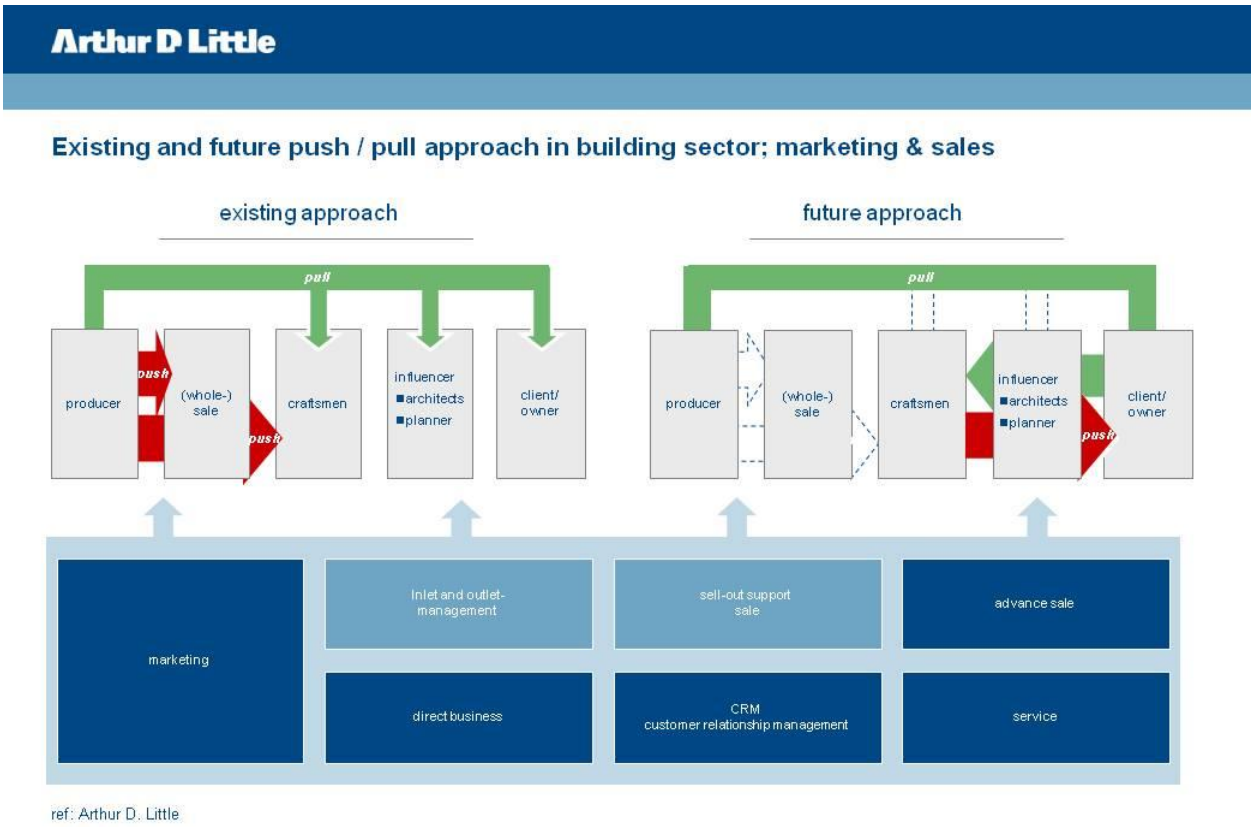

Figure 2: existing and future approach in building sector

The building supply industry was following a single distribution channel for decades successfully. The basic idea was to deliver products via a wholesale and not directly to the client. The building supply industry profited from the wholesale and the craftsmen consulted the client in the product application. The industry was not concentrated that much on sale activities as focused communication is a minimum requirement looking for end clients. A good basis for communication is BIM application in order to steer and monitor project development processes and the objective of the parametric modeller is to ease the use of data for P2Endure.

Nowadays the 'younger' client (18-40 years following a survey worked out by OC&C strategy consultants) is interested in product features and qualities that enable him to make decisions and create a demand on adjusting diffusion strategies:

- Other partners as wholesale and craftsmen are continuously losing their decision making competence and influence;

- The building supply industry has to develop more client oriented advertisement and sales support which is realised by intensive use and development of online services;
- Focusing on the P2Endure targeted deep renovation market the complexity of the offer in terms of the technical demand, the composition of the holistic offer expected by the client and total warranties obligations is quite big and there is a need for creating a fixed network of partners involved. They have to be organised and supported at the highest level of efficiency and effectiveness.

As Prof. Dr. Tobias Kollmann from University of Duisburg states in his lectures about the relevance of e-Marketplace offers the survey of the motivation and the successful implementation of an e-Marketplace offer is directly related to an identified coordination leakage in the regular business model. In terms of deep renovation projects the coordination gap exists in almost all project phases of different extents. If the quality expectation of clients is a benchmark the fixed cost, delivery time and quality delivered as ordered describes the most important issues. There is a lot of improvement potential that might be covered by an enhanced e-Marketplace solution assuring the above mentioned 3 basic quality expectation fields.

Definitely there is a change atmosphere in the market based on the 'grown-up' client demand and at the same time appropriate offers are required that cover the needs of the client to find a holistic solution and no single product offers at different portals. The 'Building Amazon' provides a vision and a working title for this enhanced offer matching with current market needs. The idea is to offer components that enable push marketing as an addition to pull marketing offers and follow the multi-channel distribution concept. E.g. at 'Amazon' you will find almost everything -products- and if they don't have a product at their platform they realise the clients' wish by organising market partners under the umbrella of one brand and one portal. The holistic offer is accepted by the client and leads to a certain price elasticity: Even knowing that single products are expensive there is a tension caused by comfort of operation and warranty and handling features that are well known and accepted. Unfortunately this concept is not working for P2Endure needs. The 'Amazon' sample stands for a horizontal e-Marketplace offer where a large number of products are provided by a large number of suppliers organised at a horizontal hierarchy level. For building products the offer has to cover the whole value chain from designing the solution, identifying the right products for building components, organising the assembly process and realise the solution on site.

A 'Building Amazon' is typically demanding a vertical marketplace structure following another hierarchy and organisation: Vertically organised marketplaces are aiming to provide a branch specific and specialised offer that covers the whole value chain. This is complex but promising in terms of creating the maximum profit out of a single project. To realise a vertical marketplace it is

important to identify a limited number of partners that offer services and products. This definition is definitely in line with the product project matching vision of P2Endure.

The findings documented in this deliverable are relevant for the development of the demonstrator of the e–Marketplace. P2Endure offers a holistic and systemic solution differing from competitors.
The draft of the platform is designed to collect and filter information based on BIM models in order to support the buying, prefabrication and making processes related to building components for deep retrofitting and to run and monitor energy consumption scenarios and life cycle surveys at the same time.

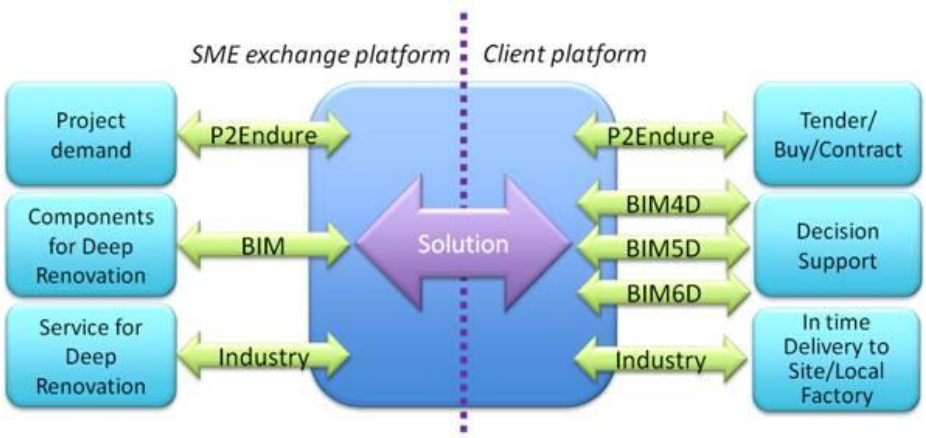

Figure 1: scheme P2Endure e-Marketplace, ©3L

Furthermore, the involvement of different stakeholders is organised at an easy-to-handle level and the efficient and effective communication about projects' details is implemented. The realisation and production of the operating platform including the involvement of important stakeholders as the building supply industry is not foreseen in P2Endure but the analysis of applicable business models shows promising opportunities for a later start-up business that is following current multi-channel distribution ideas discussed currently with growing acceptance in the building supply industry.

The business model idea developed contributes to a multi-channel distribution concept that is slowly adapted by the conservative building industry. The offering part of the market is related to service and product stakeholders that provide single solutions as e.g. architects and component developers. The demanding part is the client asking for holistic offers and turnkey like structures. Especially the demand part has to be served at a higher level compared with competitors in order to raise the acceptance and the frequency of use. This frequency of use combined with frequency of closings and other business and buying related activities allows running the P2Endure e-Marketplace in the build-up and running phase. Nevertheless there is a huge variety of e-Marketplace platforms that has already been developed in EU funded projects and synergies with existing e-Marketplaces in

E2B PPP are looked for. The following ***Chapter 2 Analysis Of Existing Platforms*** will analyse functionalities and possible synergies. ***Chapter 3 Expected Functionality Of The e-Marketplace*** focuses on the application and the demand of the stakeholders. ***Chapter 4 P2Endure e-Marketplace: Mode Of Operation*** is describing the technical operation of the parametric modeller. ***Chapter 5 Making Process Integration Following The 4M Approach*** outlines the localised prefabrication process generated by the help of the parametric modeller. ***Chapter 6 Development Of A Business Model Concept*** illustrates the options how to fund the development and running of the e-Marketplace in principal. This aspect will be developed in detail in WP5 in D5.3 and D5.4 due at M24 and M30 both updated at M48.

2. Analysis of the existing platforms

2.1 Introduction

An online marketplace (or e-Marketplace) is a web-based system that provides information on products or services, encouraging collaboration among trading partners across a selection of industries. Whether all e-Marketplaces are e-commerce, not every e-commerce is e-Marketplace. The most relevant differences between e-Marketplaces and traditional e-commerce models are:

- Unlike traditional e-commerce, e-Marketplaces don't buy any products, taking smaller financial risks achieving economies of scale faster.
- e-Marketplaces gather a greater number of vendors and of product categories than traditional e-commerce websites. This way, it is possible to create more efficient and detailed filter categories to help users in refining their search for products.

e-Marketplaces can be vertical or horizontal, depending on if they operate on a specific industry or among many industries. Therefore, vertical e-Marketplaces are more focused and allow refining users' search easier than horizontal e-Marketplaces. However, within vertical marketplaces it is very hard to find for services that do not fall exactly in a specific industry.

With respect to other industries, the construction industry has been a late adopter of e-Marketplace and e-commerce in general. According to Schonherr et al[1], this resistance to change is due to several factors, including:

- A high degree of fragmentation in the industry, that make communication in the construction process quite complex;
- A relative low level of standardization in the design that makes every project unique.
- An inadequate preparedness of the work force to new technologies.

Nevertheless, Bhutto et al[2] pointed out that the construction industry attitude towards e-commerce is positive and that there is a number of ongoing models and initiatives to bring the construction processes on-line. At the same time, external internet organisations see a huge potential in construction e-Marketplace.

[1] Schonherr, I., Alarcón, L. F., & Maturana, S. (2007). Quantifying the benefits of using e-marketplace in construction companies. Proceedings IGLC-15, July 2007, Michigan, USA

[2] Bhutto, K., Thorpe, T., & Stephenson, P. (2005). E-commerce and the construction industry. Proceedings of the 21st Annual Association of Researchers in Construction Management, 1345-1353.

2.2 e-Marketplace in EU funded projects

Several initiatives undertaken in EU projects aim at fostering the transition to e-Marketplaces at many levels and in several industries. The following section lists some EU projects carrying out such initiatives, which are worth of consideration in the light of the objectives of P2Endure.

FP7 – 605193 – PAASPORT (A Semantically-Enhanced Marketplace Of Interoperable Platform-As-A-Service Offerings For The Deployment And Migration Of Business Applications Of SMEs)

Project description

The 36-month PaaSport project focuses on resolving the application portability issues that exist in the Cloud PaaS market through a flexible and efficient deployment and migration approach. To this end, PaaSport is combining Cloud PaaS technologies with lightweight semantics in order to specify and deliver a thin, non-intrusive Cloud-broker (in the form of a Cloud PaaS Marketplace), to implement the enabling tools and technologies, and to deploy fully operational prototypes. With the support of the participating associations, PaaSport will enable European Cloud vendors to roll out semantically interoperable PaaS offerings leveraging their competitive advantage and the quality of service delivered to their customers, making their offerings more appealing and improving their outreach to potential customers, particularly the European software industry. PaaSport will also facilitate European Software SMEs to deploy business applications on the best-matching Cloud PaaS and to migrate seamlessly these applications on demand. Therefore, PaaSport contributes to aligning and interconnecting heterogeneous PaaS offerings, overcoming the vendor lock-in problem and lowering switching costs. From a business perspective, PaaSport aims at lifting the barriers that cause the vendor lock in problem, thus empowering Cloud customers and Cloud application developers (in particular, European SME Software vendors) and allowing them to choose freely the Cloud PaaS offering that fits to their needs best. PaaSport is expected also to empower the position and encourage the entrance of European SME Cloud vendors, in an emerging market, which is currently dominated by American colossi, such as Google and Amazon. In order to maximize the communities awareness and adoption of the PaaSport results, the PaaSport partners (mainly the participating Software SME Associations) are following a European -wide dissemination strategy. Led by the German ICT Federation BiTMI, the PaaSport consortium consists of twelve (12) partners, from eight (8) EU member states and associated countries, i.e. Germany, Sweden, Latvia, Turkey, Greece and Cyprus.

Weblink: http://enterprise.paasport-project.eu/

***e-Market place description*:** The innovative PaaSport Marketplace Infrastructure for semantically interconnected Cloud PaaS offers and facilitates the publication and advertisement of available Cloud PaaS offerings, the identification and recommendation of the best matching

PaaS offering, and the seamless business application deployment and migration. The PaaSport Marketplace consists of three core components:

1. The PaaSport PaaS Offerings Recommendation Layer (R2.a) that facilitates the discovery, short-listing and recommendation of the most suitable and appropriate PaaS offering (registered at the PaaSport Marketplace), based on the semantic profile of the application to be deployed;
2. The PaaSport Governance and Monitoring Layer (R2.b) that implements the core management functionalities offered by the PaaSport platform, such as the management of the registered PaaS offerings, as well as the monitoring and the lifecycle management of the deployed applications;
3. The PaaSport Persistence and Execution Layer (R2.c) that puts in place the infrastructure that allows the registration of the PaaS offering at the PaaSport Marketplace and the registration of the semantic profiles of the deployed applications.

Moreover, the PaaSport Marketplace Infrastructure integrates a set of configurable and adaptable (to the user's context) front-ends that support seamless interaction of the users with the PaaSport functionalities.

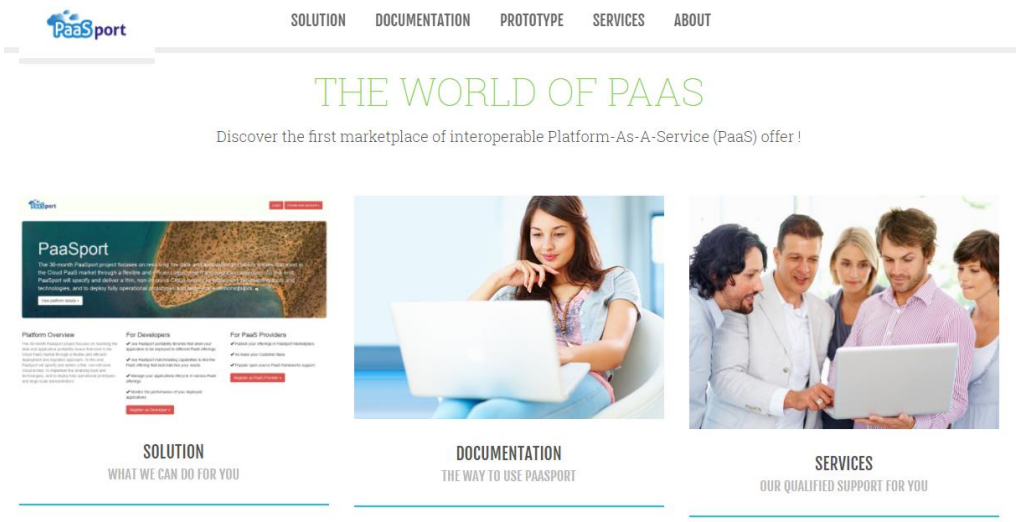

Figure 3: homepage PaaSport

FP7 – 318485 – MOBINET (Europe-Wide Platform for Cooperative Mobility Services)

Project description: MOBiNET will develop, deploy and operate the technical foundations of an open, multi-vendor platform for Europe-wide mobility services. Key MOBiNET innovations address the barriers to cooperative system-enabled service deployment, including the lack of harmonized services; availability of communication means; inaccessibility and incompatibility of transport-related data; fragmentation of end-user subscription; proprietary technologies in user devices; etc. MOBiNET will develop solutions for both business (B2B) users and end (B2C) users (drivers and travelers):

- A comprehensive directory of Europe-wide mobility and transport-related data and services;
- An e-Marketplace as an e-commerce network linking end users, content- and service-providers;
- Single sign-on MOBiNET membership;
- Membership of the MOBiNET B2B Provider Community enables providers to add third-party content and services contract-free to their own products;
- A platform-independent agent on end-user devices, including access to a MOBiNET Service Directory and an intelligent communication & connectivity manager that hosts end-user services;

The project will develop both a service development kit to enable easy creation of MOBiNET user services and a set of uniform reference services suitable for Europe-wide deployment, including "eco-traffic management-as-a-service" and a multimodal traveller assistant. The MOBiNET platform facilities will be hosted as cloud services available to the provider community, and will be operational early during the project. These facilities will be taken up at a group of diverse pilot sites that will validate MOBiNET in trials aimed at learning from operators' and users' experience how to create, deploy and operate services in a Europe-wide platform.

***Weblink*:** http://www.mobinet.eu

***E-market place description*:** MOBiNET offers solutions for business users (B2B and B2C) including a comprehensive directory of mobility and transport-related data and services across Europe and beyond:

- Advertise your business in the Service Directory and get Europe-wide visibility to expand your customer base
- Easily find and access transport & mobility-focused contents and potential business partners across Europe to expand your business.

MOBiNET fosters both horizontally and vertically approach and an e-commerce network linking providers and users of contents and services:

- Sell and purchase travel & transport-related services and data to/from a wider Europe-scale customer base
- Interface with and integrate third party services & data to enhance your service offering
- Benefit from a technology-agnostic & privacy protection framework, data quality assessment & certification features
- Develop new mobility services using the toolkit defined in MOBiNET including the technical components required.

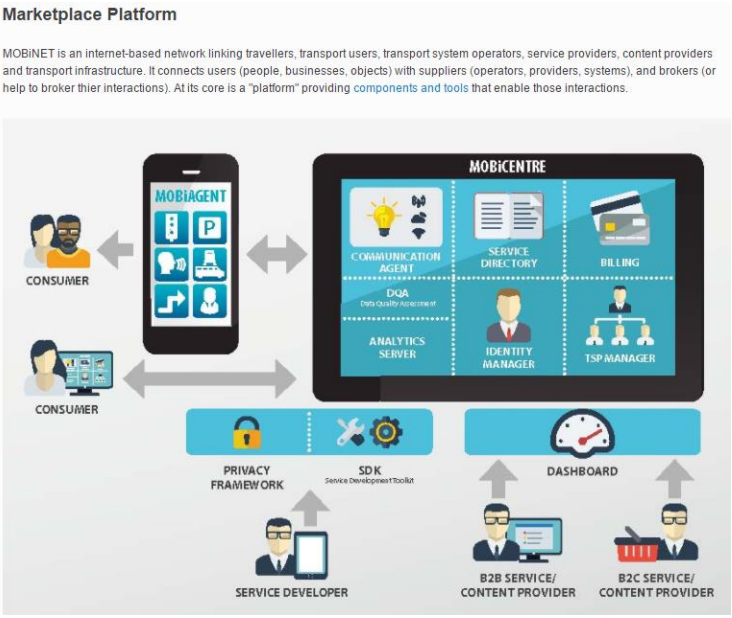

Figure 4: MOBiNET platform

H2020– 641821 – WATERINNEU (Applying European market leadership to river basin networks and spreading of innovation on water ICT models, tools and data)

Project description: WaterInnEU's primary vision is to create a marketplace to enhance the exploitation of EU funded ICT models, tools, protocols and policy briefs related to water and to establish suitable conditions for new market opportunities based on these offerings. WaterInnEU will build upon existing knowledge bases and platforms developed in previous projects but will provide new concepts, connections, and components that are essential for a marketplace to work.

The primary goals can be detailed in five major objectives:

a) Gather the outcomes of previous European funded projects, and contribute to their dissemination and exploitation to be used as an instrument for supporting the implementation of the Water Framework Directive.

b) Assess the level of standardization and interoperability of these outcomes as a mechanism to integrate ICT-based tools, and incorporate open data platforms and generate a palette of interchangeable components that are able to use the water data emerging from the data sharing processes and data models stimulated by initiatives such as the INSPIRE directive.

c) Create the marketplace as a service: a forum formed by water research projects representatives, stakeholders in the water domain, and companies (in particular SMEs), who are capable of moving current products into the market and offer them to, for

example, river basin managers, at different levels. The user segment will mainly benefit from the capability of the water partnerships (e.g. the Global Water Partnership), in bringing together a wide variety of water sector stakeholders and practitioners such as decision makers, public and private users, local, regional and international entities, and multidisciplinary stakeholders.

d) Build an open virtual marketplace that includes the Water Knowledge Portal of projects and research (WISE-RTD), a user feedback facility and a success stories portfolio, additionally to the current tools and policies lists.

Weblink: https://marketplace.waterinneu.org/en

***E-market place description*:** WaterInnEU offers tools, products, services and training on a single website. It is a market led innovation platform that screens the most relevant products and services for River Basin Management and accelerate their uptake.

Figure 5: WaterInnEUMarketplace

H2020– 645096 – APPHUB (AppHub, the European Open Source Marketplace)

Project description: Many software engineering and cloud computing are developed in open source in order to implicitly avoid the curse of the European science paradox 'we are good at science but poor at exploitation' but fail because they lack adequate support and strategy. Open source provides an efficient framework for cooperation and IP management and that makes it indeed a powerful enabler for collaborative innovation. It is wrong however to assume that making the source available automatically attracts contributors and grants immediate market access. Open source as a convenient process is not the same as open source as a business strategy.

The aim of this project is to support the market outreach strategies of EU-supported open source by launching AppHub, the European open source market place. AppHub is a service platform that will help the market to seamlessly identify, position and implement the software outcomes of these projects. The partners that will develop, run and promote AppHub over this two-year project and beyond combine unparalleled expertise in open source community management, EU research projects and a breakthrough technology in software asset management.

***Weblink*:** www.apphub.eu

***E-market place description*:** AppHub helps the market to seamlessly identify, position and implement the software outcomes of your projects. The partners that run and promote AppHub combine unparalleled expertise in open source community management, EU research projects and a breakthrough technology in software asset management. A key objective of AppHub is to foster adoption of open source projects by making them trustworthy, easy to find, and easy to download and run. AppHub provides open source project software as cloud-ready packages that can be executed by a broad range of cloud service providers. The open source software great shopping mall will also help accelerate open source adoption. AppHub provides a distribution channel to facilitate the connection between EU-supported open source projects and their potential markets. AppHub helps develop efficient community support to EU-supported open source projects and open source SMEs in general, but note that, while initially concentrated on EU-supported and open cloud projects, AppHub is open to all open source software.

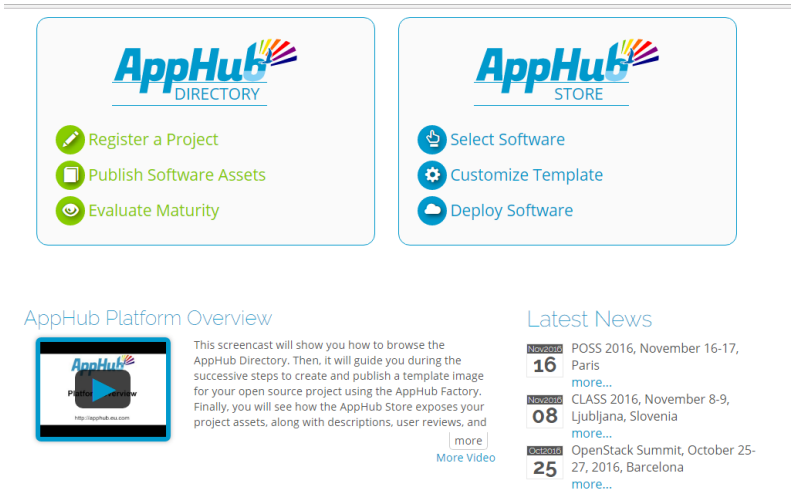

Figure 6: AppHub store

H2020– 644657 – AUTOMAT (Automotive Big Data Marketplace for Innovative Cross-sectorial Vehicle Data Services)

Project description: Inside today's vehicles ~4000 CAN-Bus signals/sec are processed in comparison to very few signals in smart phones and alike. This large amount of continuously gathered vehicle data represents major big data business potentials, not only for the automotive industry but in particular for cross-sectorial industries with interdisciplinary applications. With today's proprietary approaches focusing on bringing services into vehicles and the applied ignorance of customer privacy concerns, this major business potential is still locked because the automotive industry was not yet able to establish an open service ecosystem equivalent to the ones in the smart phone industry.

The core intention of the AutoMat project is to innovate an open ecosystem for Vehicle Big Data, materializing in the form of a cross-border Vehicle Big Data Marketplace that leverages currently unused information gathered from connected vehicles. The interface to the marketplace is derived from a Common Vehicle Information Model that makes mined and anonymous vehicle data from various OEMs accessible to cross-sectorial service providers. With the huge amount of volatile data from vehicles, the AutoMat ecosystem heavily builds upon current trends in Big Data. Exemplary service scenarios, driven by service providers dedicated to generate concrete businesses from the AutoMat ecosystem, are developed in the context of meteorological data based hyper local and extended innovative enterprise service domains.

By defining an open value chain, the proposed AutoMat ecosystem enables and stimulates parties from different sectors to focus on their core businesses and to excel collaboration with other partners. AutoMat therefore may serve as incubator for new business opportunities strengthening Europe's position as provider of innovative cross-sectorial and cross-border Big Data services. An Open Service Contest based upon the AutoMat Big Data ecosystem actively stimulates the latter aspect during the project.

Weblink: www.automat-project.eu

E-MARKET PLACE DESCRIPTION: The AutoMat marketplace is built on the idea of creating an open ecosys-tem for provisioning of manufacturer and service provider independent vehicle data, a single point of data access for service providers via of the marketplace.

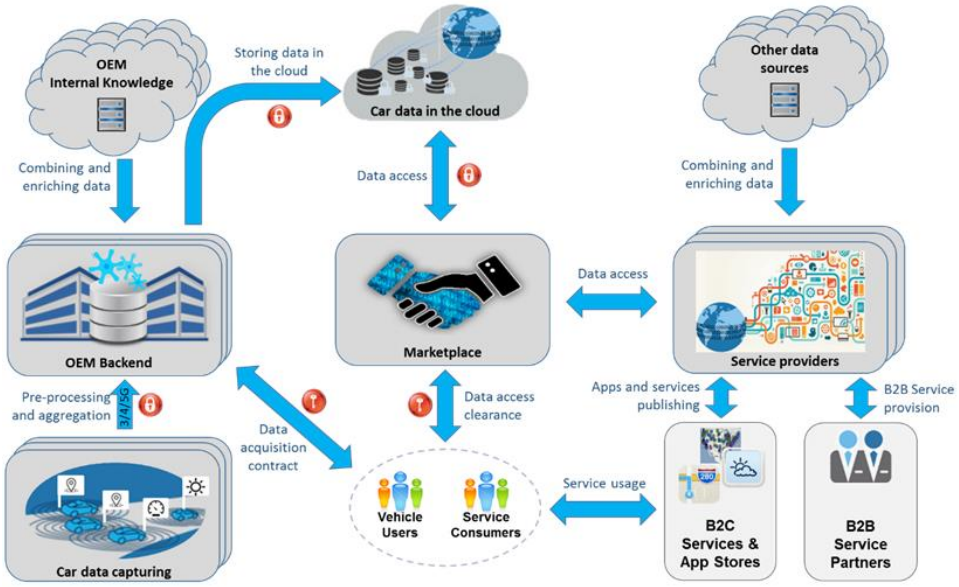

Figure 7: AutoMat scheme

FP7 - 312219 – PROFICIENT (SME network business model for collective self-organised processes in the construction and retrofit of energy-efficient residential districts)

Project description: The subject of the Proficient project funded under the FP7 program 'Energy efficient Buildings' (EeB), is Collective Self-Organized (CSO) housing. In CSO housing, a group of individuals organize themselves to realize their housing project, either newly built or retrofitted. The aim of the Proficient project is to facilitate and promote CSO housing for energy-efficient neighbourhoods, creating new business opportunities for SMEs.

The work in the project is structured according to the needs and offers of three main stakeholders in a CSO process: end users, SMEs and municipalities. The Proficient team has developed a web-based 'CSO housing platform' offering information and tools for each of these three stakeholders.

The three main stakeholders are:

1. End users, which we assume to have organized themselves into a CSO group. With their desire to build or renovate a building, they represent the demand side of a virtual marketplace. For this stakeholder, a number of tools were developed such as organizational instruments (social media forum), a tool offering a first calculation of total cost of ownership of their building, checklists of requirements and financial and regulatory information.
2. A number of SMEs that may include an architect or process facilitator, but that also include SMEs like brick layers, carpenters, and installers that have organized themselves into an SME network like a guild. With their ability to construct or renovate buildings, they represent

the supply side of the virtual marketplace. As a group with all required expertise, the SME network offers an alternative to large construction firms that do not have the flexibility to satisfy the specific needs of a CSO group. For this stakeholder, the CSO housing platform offers an organizational platform as well as a number of organisational models, tailored to the needs of CSO. In addition, an optimized business model for CSO housing was developed, but details are not offered on the CSO housing platform due to its proprietary nature (rem: 3L is the owner of the copy right).

3. A land owner or building owner, often a municipality, offering a plot of land or a building to renovate in a supporting role.

The three stakeholders can meet in a virtual marketplace, where demand and supply can be matched. To facilitate a successful interaction between the stakeholders, the platform offers a number of functionalities, of which the main one is the Configurator, where municipalities can offer plots of land, onto which end users and architects can upload designs of dwellings. They can then assess the look of all dwellings on the plot in the actual environment (taken from GIS-Geographic Information System data). In addition, an EeBB (Energy efficient Buildings Benchmarking) tool is downloadable and an Energy optimizer tool if available to generate an optimal package of energy efficiency measures, e.g. using the IFC output file from a CAD design.

Weblink: http://www.proficient-project.eu/ - (The CSO platform can be found at http://cso.house/)

E-market place description: SMEs are looking for new business opportunities, acting as an alternative to large construction companies. PROFICIENT platform aims to facilitate CSO housing, helping to organize CSOs and SMEs and bring them together in an e-Marketplace PROFICIENT platform is organized according to the CSO housing process and involved stakeholder. In the next process flow, information and tools are provided to help stakeholders in the development of setting up a CSO housing organization, and support them throughout the implementation and operation stage. First selection is between new construction of housing or renovation of resided housing. An analogy with a traditional marketplace, i.e. a physical location where sellers and buyers meet up, bargain and come to a mutual agreement (deal); the e-Marketplace is offering the same function, but on a virtual platform. The principle is that, divided into various stands, merchants and suppliers can offer their products for sale. Therefore, one stand is offering a variety of plots of land for sale by various owners and suppliers. Another stand focuses on sustainable energy solutions. Suppliers are enabled to sign in to the e-Marketplace, by filling out company details, service area, and detailed description of the product or service for sale. Suppliers/merchants also asked if they are willing to participate in a consortium, for offering costumers an integrated solution.

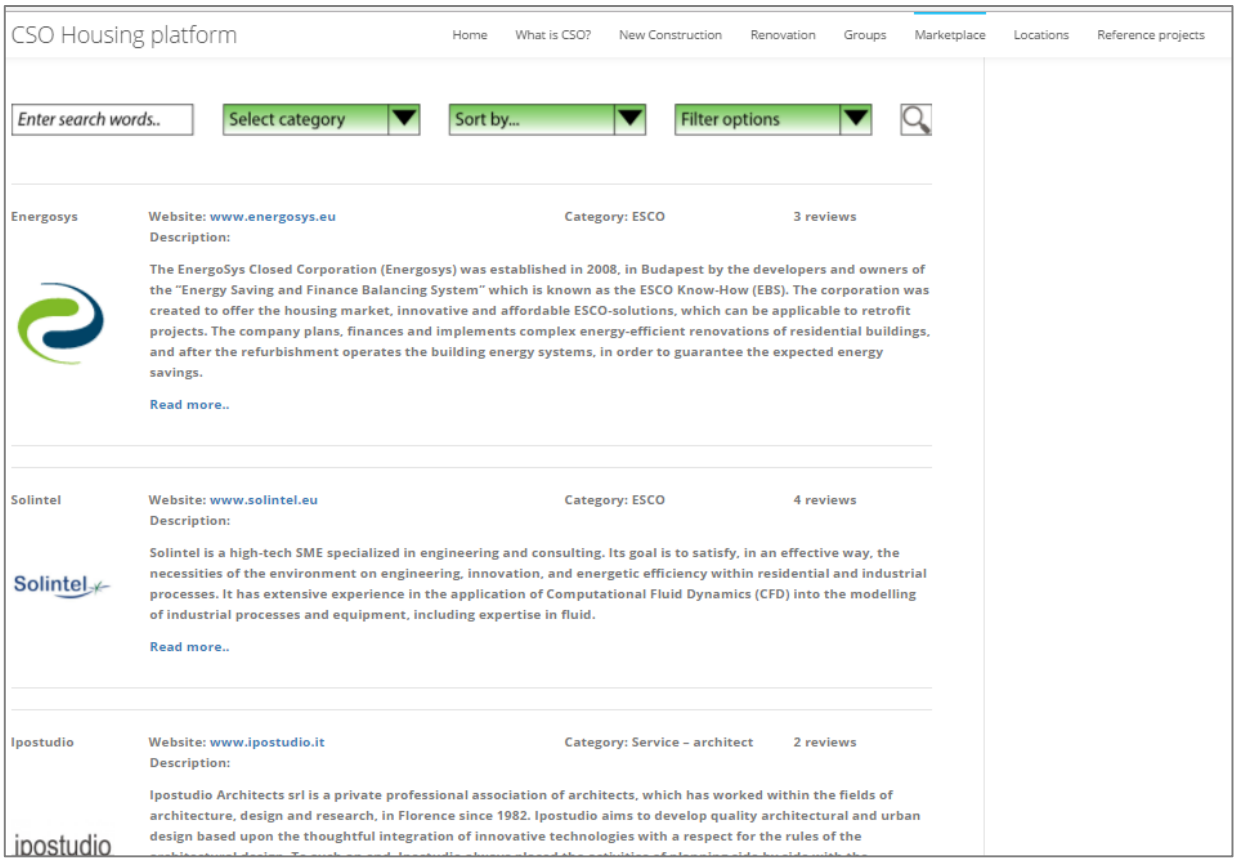

Figure 8: CSO housing platform ‚Proficient'

2.3 Limits and recommendations for P2Endure

As presented in subsection 2.2 a wide array of e-marketplaces have been developed within EU-funded projects, covering the needs of diverse industries. Even if none of the presented platform fits the purposes of P2Endure exactly, there are chances to establish interesting connections with existing platforms. For example, the P2Endure e-marketplace could cooperate with the Proficient platform, where Collective Self-Organized (CSO) housing are virtually put in communication with SMEs to build new / retrofit existing energy-efficient neighbourhoods.

Further recommendations concerning the alternative models for the P2Endure can be summarised as follows:

1. Businesses are collected in a database and organized by categories. Users have the chance to make detailed and refined searches, benefiting from the amount of information stored in the database (e.g. Yellow Pages).

2. Business information is organized following a tree structure. Users have to enter specific information from a drop-down menu and receive possible solutions as a direct output.
3. The Business model idea developed within P2Endure – as described in chapter 6 contributes to a multi-channel distribution draft that is slowly adapted by the conservative building industry. The offering part of the market is related to service and product stakeholders that provide single solutions as e.g. architects, component developers. The demanding part is the client asking for holistic offers and turnkey like structures. Especially the demand part has to be served at a higher level compared with competitors in order to raise the acceptance and the frequency of use. Especially this frequency combined with frequency of closings and businesses allows running the P2Endure e-Marketplace in the build-up and running phase.
4. Additional features covering energy issues and LCC and LCA aspects are supporting the acceptance at client level – as in section 4.

3. Expected functionality of the e-Marketplace

3.1 Description of expected functionalities from the perspective of the applying stakeholders

In addition to the technical development parameters dealt with in Chapter 4 this part is focusing on customer demands that have to be covered by the functionality of the P2Endure e-Marketplace. The objective of the P2Endure platform is to offer a holistic solution for deep renovation projects. The processes behind the platform are based on the 4M approach developed in P2Endure –see explanation under the following headlines. The solution is created involving different stakeholders and data delivering institutions. There is a variety of SMEs involved in the creation of the offer. Fragmented offers of different craftsmen have to be combined for a turnkey solution consisting of products or components provided by the building supply industry and/or joined together at the local factory and supporting services as design and engineering provided by architects and engineers and the building supply industry related to product application. BIM is a core application as creating a standard for data exchange, filtering and communication. The platform is offering a supply chain integration as a support for involved SMEs and an information exchange offer at the same time at the client level. The e-Marketplace includes the parametric BIM modeller. The modeller is implemented and deployed for the demonstration cases. With the application of the modeller -see Chapter 4 for details- parameters of the respective P2Endure products can be added to the existing BIM analysing the difference in performance.

3.2 Features related to energy consumption

Additionally a validation of reduced use of net primary energy lowered embodied energy, reduced renovation cost and time is realised. The replicability and scalability of PnP prefab solutions, the improved indoor environment quality related to the regular BIM model are proofed. It is an end client and customer need that the concept and the proof of reduced disturbances for inhabitants during renovation is taking into account at the same time crating the P2Endure concept for deep renovation.

3.3 The platform concept

Project demand

Mapping is applied in order to collect and store all needed information about the project. The objective is to identify the demand, check the feasibility and promote decision making based on technical and economical and long run performing aspects. The client should be enabled to place a go/no-go decision based on the P2Endure analysis.

Components for Deep Renovation

Modelling is needed to shape the project related to specific needs and identify the products that are combined for the solution. There is an existing selection of P2Endure components that help to ease the deep renovation process as they contain an embedded added value for all stakeholders. Furthermore, they support the modelling activities as they are created as transferable BIM products available in the P2Endure product library. The library will be created with the support of the building supply industry and are easily adaptable at BIM modelling systems of any brand. The user demand for entering the platform is easy to grasp:

A. Create and represent a model in front end and generate and upload an (IFC) data model to the platform,

B. Apply P2Endure PnP prefab solutions and assign components of the library to the model,

C. Receive qualified feedback with a quantified analysis representing the values of the model related to costs, energy consumption and costs, energy costs related to use period,

D. Receive automatically generated report and survey of the above mentioned results comparing original model values with values after P2Endure PnP products' application.

Service for Deep Renovation

The 4M stepwise approach includes Mapping, Modelling, Monitoring and Making. As the diffusion concept of the platform is characterised as a direct sale between building supply industry and contractor the demand for this relationship has changed at several levels. Regularly there is no direct connection between the building supply industry and the company using the product. The balancing is done via the wholesale and just salesmen and consultants of the building supply industry are involved in the so called pre-sale process. This system is changed as the industry is providing the product and the service knowledge needed for the application directly bound with the platform offer. This service consists of technical and economical optimisation of product use and creating the library for their components at the same time. The industry has to be involved in the site preparation and

planning which is an important part of Mapping activities. Modelling has been mentioned already related to library production and in case support of modelling architects and engineers for product application. Regularly Monitoring is out of scope of the supply industry. But as the generation of monitoring information is possible by participating as a product partner in the platform the information of quality in performance time is quite valuable for product innovation and qualification issues of the supplier.

Tender/Buy/Contract

The information exchange offer at the client level aggregates tenders by filtering the BIM model and supports the procurement and the contracting. The stakeholders involved in creating the offer are working simultaneously in order to fulfil the turnkey needs exhaustively. The client profits from direct linked relationships between the performing stakeholders as the working time is shortened and the preciseness is enhanced simultaneously.

Decision support based on a holistic analysis model

In the Modelling phase and based on the tendering results an analysis of a limited number of smart solutions is provided. At least the covered aspects are costs, validation of reduced use of net primary energy, lowered embodied energy and reduced renovation cost and time. This tool is quite important to close the coordination gap and vitalise the platform for a high frequency use. The creation of this added value will be realised by using the results of the parametric modeller. The information embedded in the BIM model will be filtered without any support by the client and the report will be automatically created. It is possible to upgrade the BIM model for other analytics following the scheme below. 4D BIM is covering scheduling, 5D BIM stands for estimating and 6D BIM deals with sustainability aspects. Facility management issues are dealt with in 7D BIM. Monitoring as defined in P2Endure is supported by the as built and as designed overlay of project data covering all performance KPIs.

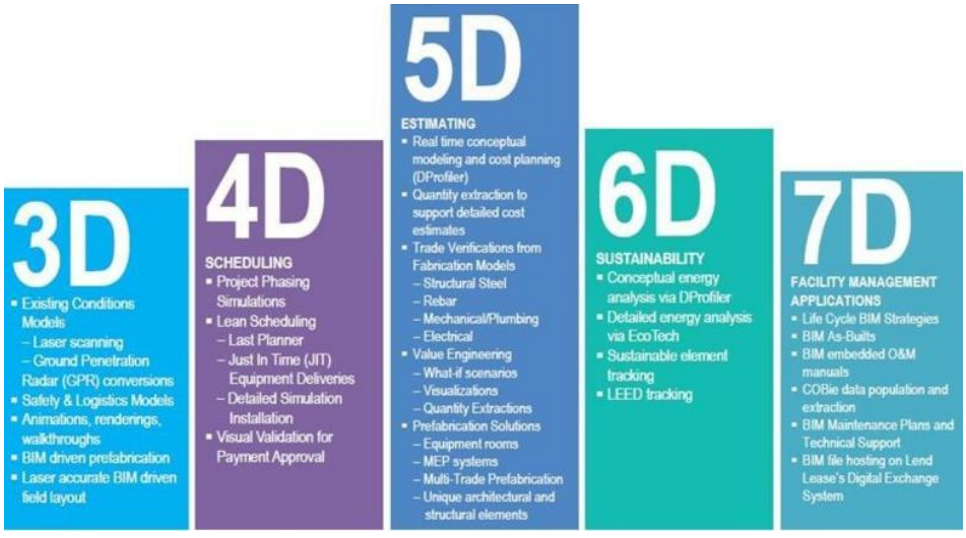

Figure 9: scheme multidimensional planning

In time delivery to site/Local Factory

Step 3 of the 4M approach is Making. The local factory is a tool to reduce the quality assurance efforts on site and reduce the economic risk of providing qualified personnel without arranging a smoothly ongoing production process. Regularly the work on site is demanding and working conditions are quite bad and instable e.g. in terms of weather conditions. The idea of the local factory is to reduce the efforts for a manufacturing process under instable conditions caused by weather and other inconsistencies and pre-fabricate components at the highest extent in sheltered areas near the site. It is unconditionally necessary that the logistics that are needed to realise an in-time-delivery of components and other parts are feasible. The parametric BIM modeller prepares a design for manufacturing and assembly (DfMA). It is important that a virtual company is created including the steering of the prefabrication as a concerted action with the site installing of the components. The product or component delivery in time is quite ambitious but the parametric modeller aims to support the creation of the lean production process.

As the features described above are helping the stakeholders in charge for operating and profiting from the added value of the P2Endure e-Marketplace and parametric modeller at the same time a win-win situation is realised. The ambition of the platform development is to make the most out of the BIM model and generate valuable information for different actions. This information is regularly produced and reproduced in loops for the preparation and the running of construction sites. The functionality description aims at the validation as a map of duties to balance the existing features of the platform against the feasible ones. In fact as the platform is meant to be a demonstrator, the collection of available tools at existing platforms and further available solutions that help to create the mentioned features, will be analysed and combined to realise the maximum value. In the near future, caused by demographic change and missing qualification of personnel, lean management processes have to be adapted by the building industry. The objective is to cover more effective and efficiently the needs of deep renovation sites with fewer workers and based on a higher quality of work. An important aspect is the enhanced motivation of the workers in order to engage them at a higher level. One of the biggest problems to solve is how to overcome the shortage of qualified personnel especially in the complex deep renovation market segment.

The special role of the local factory and its benefits for all stakeholders is showing a perspective, and the exchange of data and other important information is a key factor for a successful implemented future oriented process –see detailed description at Chapter 4. The functionalities urgently needed to close the existing coordination gaps can be handled by the introduction and implementation of the P2Endure e-Marketplace. The technical details are further elaborated in the following chapter.

3.4 e-Marketplace architecture

The P2Endure e-Marketplace is built in a component architecture. This means that the system consists of several components which are connected to one another via interfaces and communicate with one another by the transmission of data. The sequence of the components creates the e-Marketplace process. The system consists of 6 major components ('as is BIM' upload, model presentation, adding the parametrically described products, configuration of the 'as is BIM', calculation of the data, presentation of the calculated data), according to current development. A description of the process sequence is given in chapter 4.1.

Due to the structured, loosely encapsulated architecture pattern of the P2Endure e-Marketplaces, an iterative development of the individual components is possible. Since the components communicate via interfaces, the development can be carried out without any major influence on the system and thus the maintenance of the individual components is easier, as well.

The system of e-Marketplaces works according to the 3-tier client-server architecture. The user receives the necessary information about the interaction with the system via the user interface (front-end) of the e-Marketplace (tier 1). After the user has made his/her inputs via the front-end, the information is processed in the application logic of the system (tier 2). The application logic receives the necessary data for processing the user input via the connected database (tier 3). The source code of the P2Endure e-Marketplaces is published via the online service GitHub. The GitHub system is open source and free of charge.

With its repositories (i.e. directories managed by GIT), GitHub offers the possibility of collaborative and agile collaboration. GitHub also supports the separate development of components within a system. This platform provides optimal conditions for an agile development.

4. P2Endure e-Marketplace: Mode of operation

This section describes the functionality of the marketplaces and passes through the individual process steps of the system. Figure 10 provides an overview of the process flow of the p2Endure e-Marketplaces with the respective process steps. Within these figure the individual process steps are numbered and are explained in the following section.

The P2Endure e-Marketplace supports the "Making process" in the Making- Mapping-Modelling-Monitoring-(4M) process for implementing Plug and Play (PnP) solutions. The e-Marketplace will provide construction supplier and clients with clear information to quickly understand how to implement or duplicate a similar 4M based process on their projects. The core of this information is documentation from the live demonstration projects and the virtual demonstrators. The e-Marketplace will be interfaced with a BIM-oriented procurement/tendering platform that facilitates multi-criteria decision making for optimizing different offers to clients. In the implementation of the deep renovation, this platform will support efficient management of the integrated material with objectives in terms of costs, time and quality issues. The user is given a detailed review of his renovation projects, based on the materials he has selected within the e-Marketplaces.

The P2Endure e-Marketplace will also set up a parametric BIM modeller. This modeller is implemented and deployed for the demonstration cases, presentation of current progress and outcomes of the demonstration cases in e-Marketplace. With the help of the parametric BIM modeller, various design options can be configured, showing the implications of user requirements and design preferences both on energy performance as well as costs (investment and lifecycle costs). Through the parametric modeller the user has the opportunity to customize his/her 'as is BIM' model before starting the renovation process on the building. The close integration of BIM and the parametric modeller enables a participatory design with the entire value chain, involving customers, end-users and all providers. The modeller will allow for the modular combination of the different systems that P2Endure solutions will integrate. This parametric modeller allows quickly developing different renovation alternatives and comparing these alternatives based on their cost and energy-saving potentials.

4.1 Mode of operation

The P2Endure e-Marketplace is characterized by the integration of numerous components that unite into one system. These individual components are shown in figure 10. The individual parts of the system (marked with numbers in the figure) interlock and allow the user to carry out an energetic calculation based on his initial model and the addition of the (P2Endure) structural elements to

the model values. Based on these calculated data, the user can see the expected (energetic, thermal and financial) values and thus plan his renovation work. As shown in figure 10, the system is divided into the following process parts:

1. Upload the 'as is BIM'
2. Presentation of the Model in the front end
3. Configuration of the 'as is BIM' data file for energetic calculation
4. Start calculation of the data
5. Add the parametrically described P2Endure products to the 'as is BIM' model
6. Front end presentation of the (calculated) data.

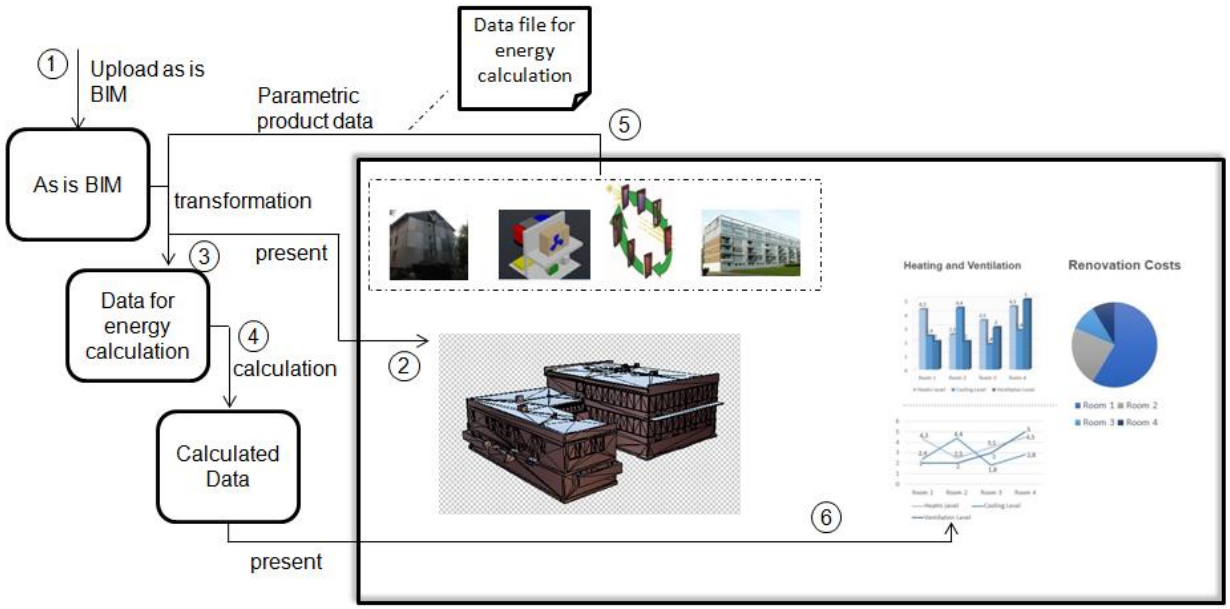

Figure 10: Overview of the P2Endure e-Marketplace

The individual process steps as well as their results and interfaces to the adjacent process parts are explained in detail below.

1. Upload the 'as is BIM'

The start of the e-Marketplace process is the upload of the 'as is BIM' model which is provided by the user. Via an input mask the user can provide the model to the front-end application of the e-Marketplace. This BIM model needs to contain the physical and functional characteristics of the building. This information offers a digital representation of the real facility, including functional systems (HVAC, electrical) and geometrical elements (walls, roof, windows). The model information is the starting point for the later calculation by comparing it with the parameters of the added P2Endure products.

Within this first process step, the 'as is BIM' provided by the user is not yet displayed in the front-end but is merely loaded into the back end of the system. If the model is read in the back end, the further process steps can be connected. The 'as is BIM' is required by the system for the further procedure in two aspects. On the one hand, the BIM model is prepared for representation in the front end. For this purpose, the data format must be converted first. The original 'as is BIM' building data must be converted into a file format which is compatible for display in the front-end application. The presentation of the model is marked with a 2 in the figure 8 and is explained in section 4.1.2. On the other hand, a further data transformation must take place, which is the basis for the creation of the parametric calculation. In figure 10, this is indicated by the number 3. This process step is explained in 4.1.3.

2. Presentation of the model in the front end

The presentation of the model in the front-end (number 2 in Figure 8) occurs after the user has deployed the BIM and the data transformation has been completed successfully in the back end. The transformed data is forwarded to the front-end.

After the first use of the P2Endure e-Marketplace, the system displays the user's output model. The data of the BIM are displayed in a three-dimensional model in the front-end of the P2Endure e-Marketplace. The front-end model representation allows the user to interact with his BIM model. For example, a 360-degree view is possible or can be increased and decreased.

3. Add the parametrically described P2Endure products to the 'as is BIM' model

As shown in Table 1, the products implemented in the P2Endure e-Marketplace are described by parameters. The table describes the parameters of the multifunctional panel, which is used within the P2Endure project. This panel stands, out among other things, for a high insulation performance, as well as a high durability. As can be seen, this panel consists of three layers with two varied materials described by parameters.

	TRC Layer	EPS250	TRC Layer
Conductivity (W/mk)	2	0.034	2
Thickness (cm)	1.40	10	1.4
Emissity	0.9	0.9	0.9
Volumetric mass (kg/m^3)	2400	28	2400
Specific heat	1000	1000	1000
breathability μ	130	130	130

Table 1: Example: Parameters the P2Endure EASEE prefab Multifunctional Panel

The P2Endure product development partners, who are responsible for the innovation of the respective solutions, provide the parametric description of their products. In the final e-Marketplace, all product providers must specify the parameters of their products to make a calculation. A description of the parameters to be transmitted is given in section 4.3. Within the e-Marketplace, the product descriptions are stored in a "technology catalogue" and are available for parametric calculation. In the front-end application, the products are recognizable by clear image representations and by a tabular representation of the properties for the user.

In addition to the parametric modeller, the P2Endure e-Marketplace provides the user with various products that can be used as components for the renovation of the building to be built. Within Figure 8, these products are marked with the number 5.

For the demonstration cases, the products are developed and represented by the respective P2Endure partners. In the final e-Marketplace, each vendor can make his product available to the potential users. These innovative product solutions are a starting point for energetic calculation and, if the user decides to add a new application to his future renovation process. In order for an energetic building simulation to take place, data requirements must be met. For example, the surface content of the windows must be known, the glass properties, or the properties of the installed material. A detailed description of the parameters that are important for the implementation of the products on the e-Marketplace is given in section 4.3. After the user has made his selection and triggers the calculation, the process for energy and cost calculation described in 4.1.4 is started.

4. Configuration of the ‘as is BIM’ data file for energetic calculation

The ‘as is BIM’ model provided in process step 1 is prepared for parametric calculation in the third process step. Since the software program used for the calculation requires a different data format, the ‘as is BIM’ must be converted. This output format must be transformed so that it can be read by the calculation software. In the ideal case, a consistent exchange of information must ideally implement seamless communication under various software, making manual and repeated data input unnecessary.

Since there is no satisfactory "out of the box" solution for the transformation between the data formats, TU Berlin has had to make greater efforts to implement a data conversion. The aim of the transformation concept is to convert the original building geometry into a format that can be read and evaluated by the calculation software using transformation rules. The generated building geometry definition includes the definition of building materials (including glazing) as defined by the original building design. The used calculation software cannot evaluate the complex building information of the output model. This information must be simplified during the transformation. The data transforming concept of the TU Berlin therefore initially presents walls, windows, façades and zones. With the

successful conversion of the data formats, the process 4, the calculation of the energetic data based on the building information, can be initiated. This process section is explained in section 4.1.4.

5. Start calculation of the building data

After the transformation of the data is done, the actual calculation of this data can take place. The main purpose of the simulation is to evaluate the possibilities of design by means of clear criteria. The comparison of different design variants of the structure represents a significant advantage of the energetic simulation. The calculation is done by calculation software. This software is a simulation program for energy analysis and thermal loads of the building. Figure 9 shows the principle of calculation in more detail. After providing the 'as is BIM' by the user, an initial calculation is made based on the existing building data. The calculation of the initial data of the 'as is BIM' is displayed to the user in the front-end. After the user has looked at his model, including the calculated data in the front end of the P2Endure e-Marketplaces and made the selection of the e-Marketplace products, a second calculation takes place. The P2Endure e-Marketplace also allows the user to make a calculation between the 'as is BIM' and products that can be selected on the marketplace. These products are to be found for the user above the representation of his model. In addition to an image representing the respective product, the individual solutions are also characterized by a short, tabular description of the properties. As required, the user can select specific products and integrate them into the subsequent calculation.

The individual products are described by parameters and stored in a product catalogue. These parameters include, among others, material characteristics (thickness, specific heat, breathability and emissivity) and/or compositions of the products (for example, windows with single, double or triple glazing).

As can be seen in figure 11 a calculation between several products and the 'as is BIM' is also possible. Based on the initial values of the 'as is BIM' or the BIM with additional products, the transformation described in 4.1.3 is carried out. The simulation is then realised with the help of the KPIs defined by the TU Berlin for the preparation of the energetic calculation (for example, energy consumption, thermal comfort, CO_2). These parameters are compared with the respective matching parameters of the original data from the 'as is BIM' model. Based on this comparison, for example, calculations on the energy values achieved as well as the resulting energy and renovation costs can be made possible. With the analysis of the data, the next process step, the presentation of the data in the front end, can take place.

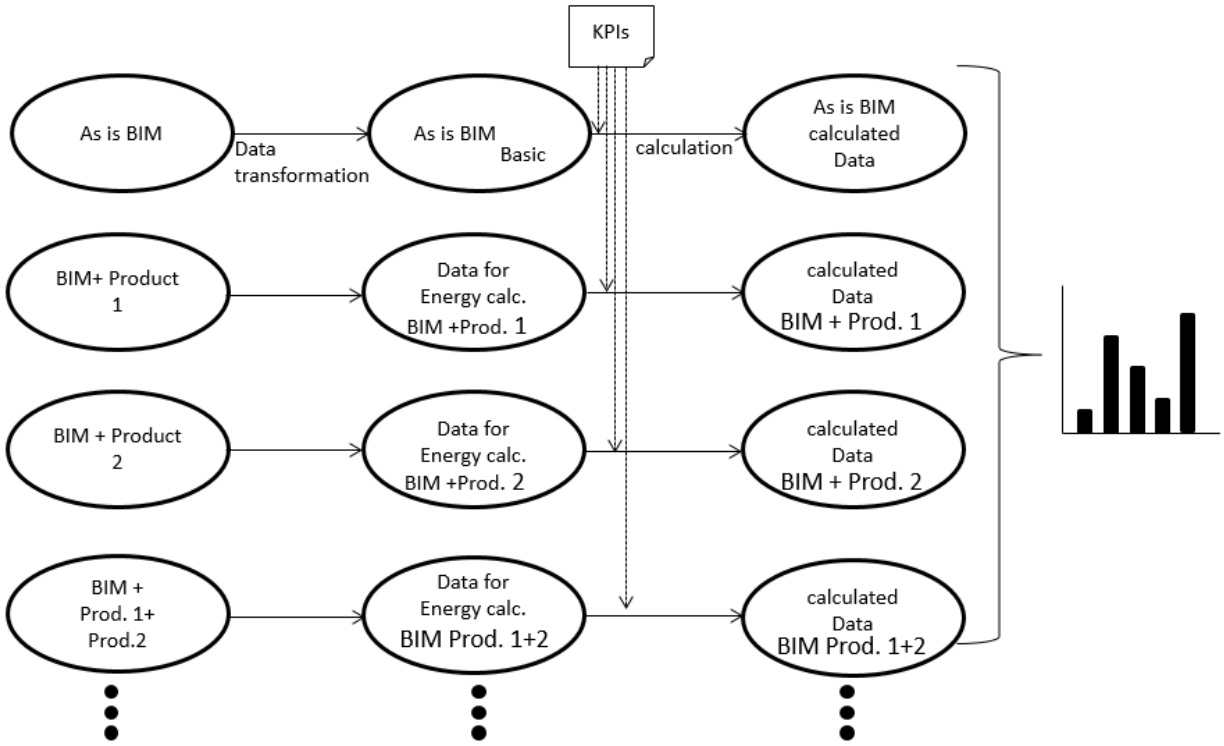

Figure 11: Overview of the energy calculation

6. Front end representation of the calculated data

After the data have been calculated, the representation of this data can be done in the front end (number 6 in figure 10). The visualization of the calculated data is presented to the user by the use of a dynamic, interactive implementation. The output format of the calculated data cannot be used to display this. Therefore, they must first be converted and made compatible for display in the front-end. The presentations include energy (for example, energy savings per year), thermal (for example temperature, CO_2) and monetary balances (for example cost savings per year). By adding or removing the e-Marketplace products to the 'as is BIM' model, the user can get an overview of the resulting values. The values from the output model are always displayed in comparison to the new calculation values with the e-Marketplace products.

4.2 KPIs for the energy calculation

The P2Endure e-Marketplace with the integrated parametric modeller enables the user to do an energetic calculation of his renovation project. This calculation can, on the one hand, be performed on the already existing 'as is BIM' model. On the other hand, the e-Marketplace also offers the user the option to start a calculation of the existing model, including new construction elements that can be selected on the marketplace. The result of the calculation reflects a comparison of the old values and the new values. To make the user more aware of individual products, the essential values are tabulated on the front-end application.

In general, KPIs are used for calculations of energy consumption and thermal properties over a period of time. The KPIs help the user to ensure that the planned designs are efficient in terms of energy and costs and thus provide a powerful feedback.

To demonstrate how the calculator works, the TU Berlin concentrates on four main parameters:

Thermal comfort

Thermal comfort means the comfort of the user under given conditions. The measured factors are, among other things, the temperature in rooms or the heat transfer. If the user is aware of the thermal comfort of the user as a result, the P2Endure e-Marketplace offers the possibility to improve its output values by adding products which influence the thermal room temperature.

Energy consumption

Energy consumption is used to measure the overall energy consumption. This energy consumption can be changed by multiple factors. In the P2Endure e-Marketplace demonstrator there is a variety of products that change the energy budget of a building. In Figure 9, such data calculation is shown as an example.

Via the e-Marketplace, the user can add a new façade, new windows (with different types of glazing) and a new rooftop construction to his existing model. The subsequent calculation shows the savings potentials to the users due to alternative product application and gives information about

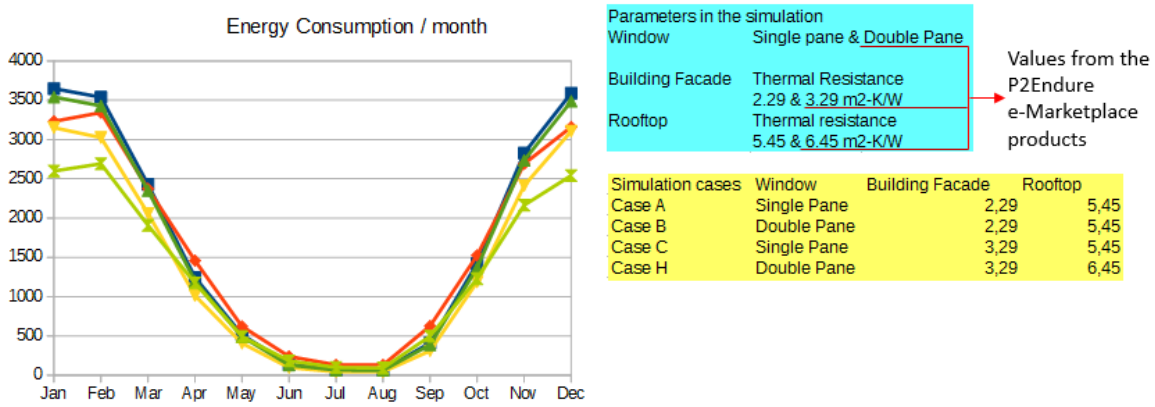

Figure 12: Calculation of the new and the old model parameters

CO_2 Emission

The measurement of CO_2 balances can be used to determine the ventilation quality of the respective room and to define the indoor air quality. This calculation allows the user of the P2Endure e-Marketplace to determine whether his installed ventilation system fulfils the requirements for sufficient air quality. Again, the e-Marketplace offers products that allow a comparison of the values. By comparing the old and new values, a clear statement can be made as to whether the user has to retrofit.

Cost

In addition to the energy and thermal balances, the cost of its renovation is crucial for the user. He would like to make clear statements about the individual renovation cost. In addition to the fixed cost, the long-term development of the costs and the savings potential are also of interest. Based on evaluations of the thermal and energetic values, the P2Endure e-Marketplace provides a cost balance that considers both the investment and the maintenance costs. The user finally gets a comprehensive statement about which inventories are interesting for him.

4.3 Mode of operation for product suppliers

The P2Endure e-Marketplace provides ready-to-implement prefabricated Plug-and-Play (PnP) systems for deep renovation of building envelopes. These innovative solutions can be used to transform non-functional or sub-functional buildings into thermally and energetically improved buildings.

For this purpose, product solutions are made available within the e-Marketplace. As already indicated in section 4.1.3, these individual products must be described as precisely as possible by the manufacturers. This information includes, for example, product prices, design parameters and (where applicable) maintenance values. Without these enhanced descriptions of products they cannot be implemented in the P2Endure e-Marketplace.

Within the previous demo application of the e-Marketplace, among other multifunctional panels, rooftop retrofit solutions, prefab HVAC systems or innovative windows are described. For numerous P2Endure products, the parameters for the description are already available at TU Berlin. A parameter list, which describes the individual components, has been prepared by the manufacturer or product supplier in table 1 from section 4.1.3. A further example is the values listed in table 2 for describing a rooftop retrofit. Since the construction is made up of several components, it is essential that all parts of the system are described.

Table 2: Example: Excerpt from the data sheet describing the P2Endure rooftop retrofit solution

Roof (extended floor)	R value ca. 7 ((m2K)/W) Construction (inside out): Plasterboard (2x 12,5 mm) OSB (wood fibre board) (12mm)
Steel frame construction façade	R value ca. 7 ((m2K)/W) Construction (inside out): Plasterboard (12,5mm) U and C-profiles 100mm, 600 mm
Window frame	Plastic window frames HR++ or triple glass windows
Heat generation	Scenario with no alterations on installation in existing building

The product description of the HVAC system, which is used within the P2Endure project, is also available to the TU Berlin. Table 3 shows the data used for parametric calculation:

Table 3: Example: Data from the HVAC system from the P2Endure project

Air handling	4000 m^3/h
Heating capacity	about 35 kW thermal
Ventilation	3x per hour

If the parameters of the construction elements are dependent on the size of the building, the seller must provide a range of values that vary according to the size of the building. The values of the examples from Tables 2 and 3 are also related to the respective house size. The suppliers of the products will provide TU Berlin with the respective values for calculation of various building sizes.
The UML diagram provided by the TU Berlin for the creation of a BIM can serve as a reference point for the minimal information content necessary for the implementation of the products. It describes the components of a BIM with its attributes. Table 4 shows as an example the attributes required for windows and glazing. These attributes were taken from the UML diagram (see Appendix 3):

Table 4: Example: Attributes for windows and glazing taken from the UML diagram

	Attributes
Window	Height Width
Glazing	Type Solar transmittance Visible transmittance Number of layers

If the description of the elements is complete, the product is included in the P2Endure e-Marketplace product catalogue and displayed in the front-end. The description is used in addition to the parametric calculation as well as the information display of the products in the front-end.

4.4 Conclusion: Innovative character of the P2Endure e-Marketplace

Under the awareness that the P2Endure e-Marketplace is not the only one of its kind on the market, it is particularly important to focus and work out the unique features. The essential characteristic of the e-Marketplace is the conception as a software instrument that will support decision-making based on a life-cycle assessment and life-cycle information. The e-Marketplace will be interfaced with a BIM-oriented procurement/tendering platform that facilitates multi-criteria decision making for optimizing the different offers to clients share and store all relevant material on deep renovation packages, their performances and understanding real energy use and energy costs for consumers after renovation. To realize this, a parametric BIM modeller is implemented. With the aid of this modeller the thermal and energetic calculations can be generated. In order to meet the e-Marketplace's characteristics, more and more products have to be added to the digital product library continuously. This allows the user to access a wide range of products that he can include in his analyses of cost and energy issues.

5. Making process integration following the 4M approach

Where relevant due to the district scale of deep renovation, P2Endure will employ a local factory concept. In case of district-scale retrofits, local factory organization integrating the P2Endure 4M approach is to be integrated as part of the e-Marketplace (figure 15)

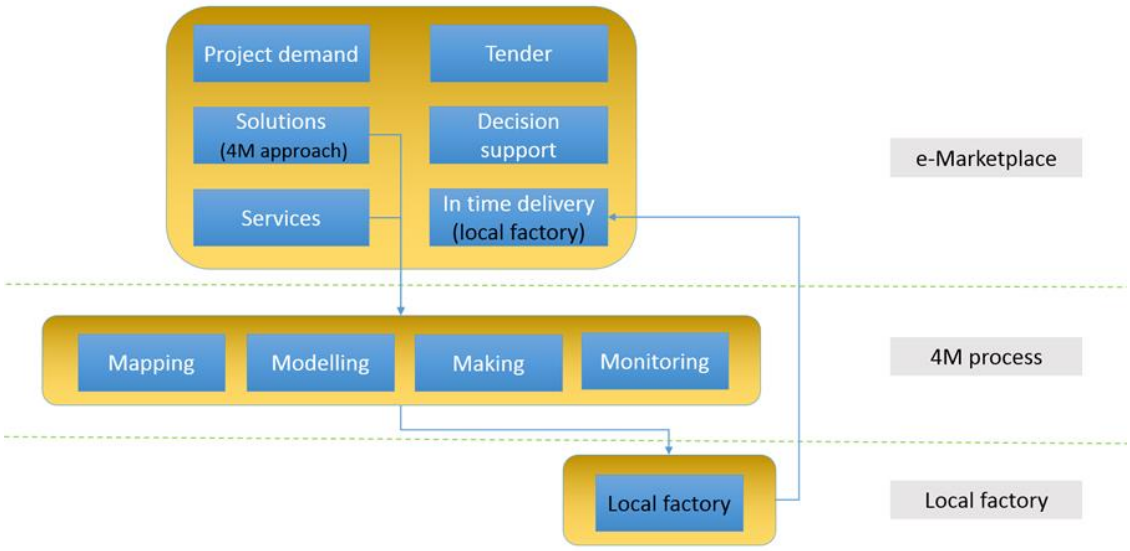

Figure 13: P2Endure local factory concept as part of the e-Marketplace integrating the 4M approach.

P2Endure introduces the Local Renovation Factory concept in order to bring the demand side and supply side in the retrofitting market together. P2Endure will stimulate a demand driven renovation market instead of a traditional supply driven market by offering consumers the possibility to make their own highly industrialized renovation configurations, enabled by the production of series-of-one in mass production prefabrication processes in local factory nearby. Furthermore, with the set-up of the local factory nearby most efficient logistics are achieved and low embodied energy as transport movements are reduced to the minimum.

5.1 Local factory establishment

The Local Renovation Factory in P2Endure gives a potential for quick and flexible set up of the facilities used for production of the designed PnP solutions installed in the retrofitting projects. It is both a physical production site and a logistic distribution centre for prefabricated building and MEP components. The local factory is a temporarily set-up in or close to the district to be renovated.

After the renovation the factory is closed and moved to the next district ('pop-up' factory). The goal is to maximize the benefit of a digital industrialisation and lean production process approach at a local level. At the same time the advantage compared to the conventional retrofitting approach is shown in the following graph (Reference: Othman et al, ManuBuild, 2009). The local factory produces an impact on the investment costs of about the 20% of reduction with respect to the traditional construction process.

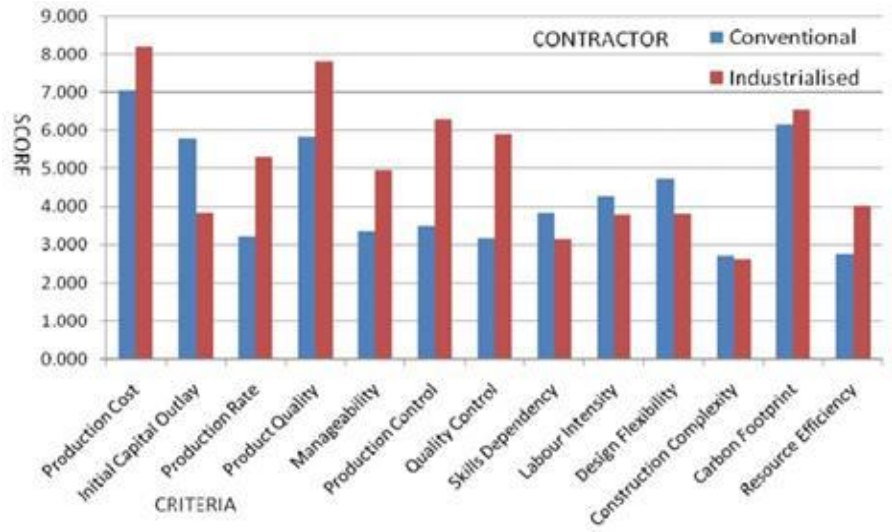

Figure 23: Scoring difference between conventional and industrialised housing for the contractor sector (ref.: Othman et al, ManuBuild, 2009

The local factory is more than just a production facility. It brings together the capacity of local SME's, addresses unemployment of local construction workers, forms the visual image of the joint community effort and is the heart of the local retrofitting implementation alliance. In context with the developed e-Marketplace, the local factories help realizing a streamlined supply chain that connects initial design to the material, order and (pre)fabrication process to the planning and final logistics on the site. The developed 4M approach is directly integrated in the activities and work process of local factories (Figure 13). Services supporting implementation of local factory concept within P2Endure business model include investment appraisal, performance-based maintenance contracts and performance guarantees. Furthermore, the products can also be sold to individual house owners at local retrofitting retailers. An important added value can be the collaboration with regional knowledge and research institutes in so called Real Life Learning Lab (RLLL) settings.

5.2 Local factory as part of the e-Marketplace integrating the 4M approach

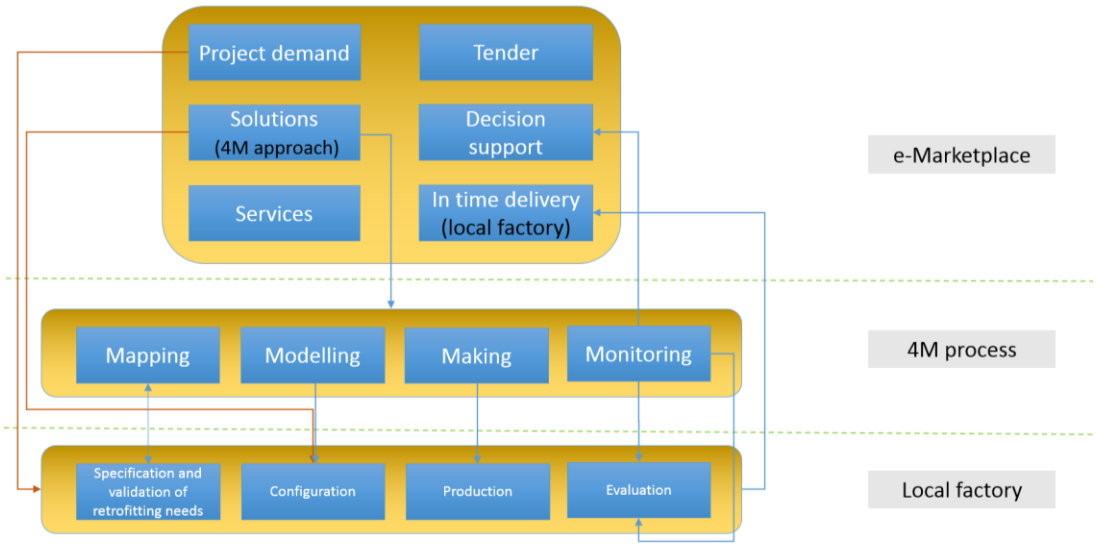

Figure 14: Local factory establishment introducing 4 step implementation integrated with the 4M approach and e-

As presented in Figure 16, a 4 step implementation plan is established as a generic implementation plan adaptable depending on the district characteristics, most suitable and available technical solutions for retrofitting:

1. Specification and validation of retrofitting needs (4M approach – Mapping)

Affordable retrofitting requires combining the energy performance improvement with other activities (maintenance, functional updating and increased comfort) so that different financial resources can be grouped to create the required budget. Building diagnosis serves as a first step in order to map the current building state (4M approach step: Mapping) leading to a certain technical and functional requirements of the PnP solutions in order to be tailored for the specific case. According to the D2.1 the mapping should not exceed one to two weeks for a typical residential building (e.g. single family house or low-rise apartment) or typical public building (e.g. small scale/low-rise office). Where the local factory is the core of the P2Endure approach, the district retrofitting model is the driving force in the background. The local building stock composition (quantity variables), technical, energetic and functional condition (quality variables) and predicted development over time (quantity and quality changes by new building, demolition, maintenance and retrofitting interventions) need to be developed.

2. Configuration (4M approach – Modelling)

One important part of the P2Endure demonstration strategy will rely on the representation of the generated solutions for deep retrofitting of buildings within the parametric modeller (see chapter 4). The parametric modeller will allow for making full avail of the evolved solutions within the specific context of a district (4M approach step: Modelling). The modeller will allow for the modular combination of the different systems that P2Endure solutions will integrate: HVAC, lighting, appliance within units that can be pre-fabricated within a local factory. The P2Endure parametric modeller will act as a configurator allowing to select the best options from a range of relevant retrofitting for specific local conditions, accompanied with descriptions of the most suitable solutions (based on energy, LCA analysis etc., see figure 13).

3. Production (4M approach – Making)

Local factory production allows mass production prefabrication process where all the PnP solutions are produced in the factory (optimizing production process via BIM based 4M approach step: Making) which also leads to shorter construction process on site. Within local factory the production time for deep energy renovation modules can be reduced to one week per dwelling where occupants can stay most of the time in their buildings since assembly on the site can be realized in one day per façade module (based on ThinkBuilding concept, http://thinkwonen.nl/). P2Endure will build further on the state-of-the-art of the "THINK Building concept" as proven successful in a number of retrofitting cases by producing building components in a local factory.

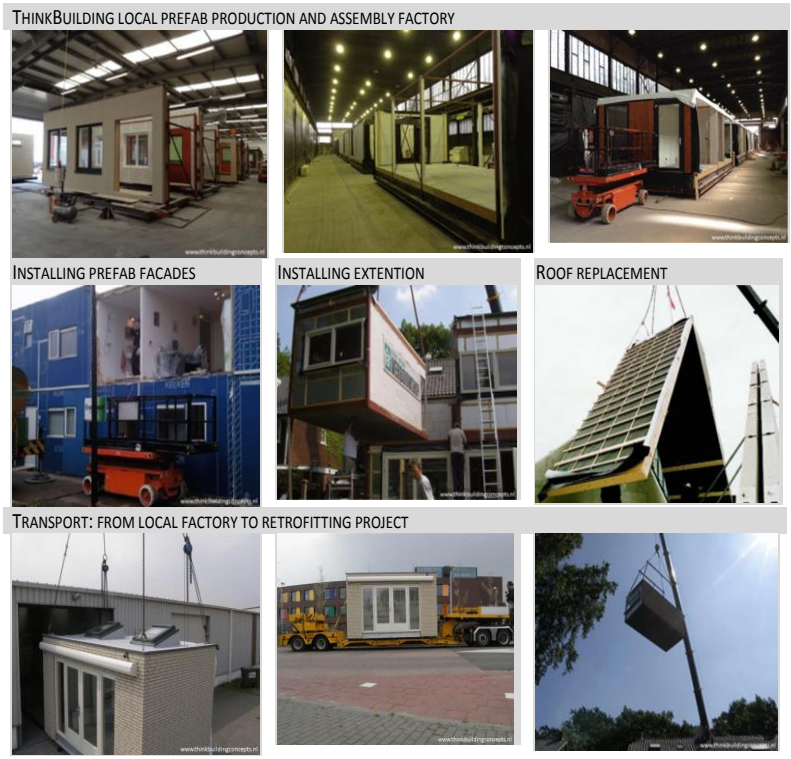

Figure 15: ThinkBuilding local factory concept: production, transport and installation (Adopted from: http://thinkwonen.nl/).

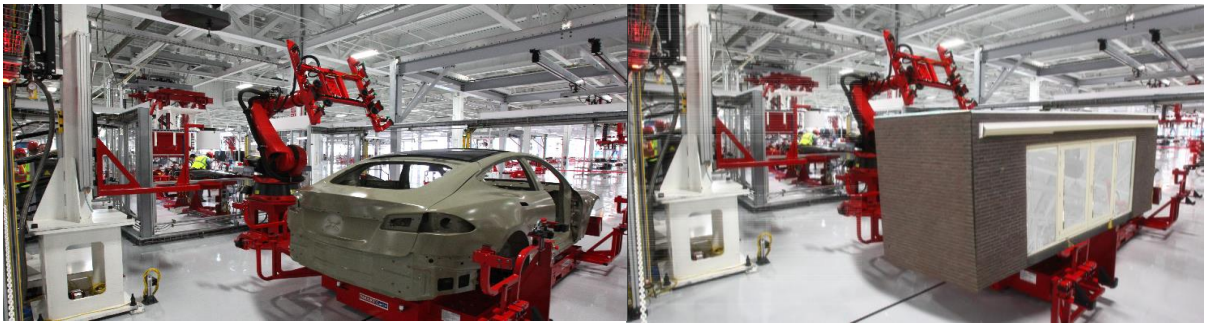

Figure 16: Local factory concept for building sector compared to automobile industry (Adopted from: http://www.24-home.nl/).

The production is based on a platform technique, known from the automobile industry that provides the flexibility to attach construction elements on a number of predefined positions.

- The components are manufactured with durable and traditional materials. The flexible placement of the building elements allows for a multitude of design options. Appliances and systems with the required hardware for the ICT platform (to allow monitoring and control) can be integrated already in the factory.
- Site preparation and foundation are the only on-site activities. All other production takes place in the local factory P2Endure envisions to complete the production time in the factory within in one week for a typical residential/public building (e.g. small office/low-rise building or small office/low-rise building), transport and assembly on site taking one day and finishing takes at a maximum another week.
- Cost optimisation will be achieved by:
    - Integration of several technical components, at all systems levels ranging from placeholders to ventilation system or wall or roof, corresponding with multifunctional elements;
    - Integration of systems leads to integration of components;
    - Re-design of components and renovation concepts for industrial assembling the component for reducing the amount of materials, time and costs;
    - Re-design to an integrated product, industrial, cost efficient and demand driven produced;
    - Scale advantages due to mass production in an extremely automated line production process;
    - Minimizing interior works in apartment (ventilation ductwork for example).

4. Evaluation (4M approach – Monitoring)

The main advantage in terms of quality assurance at the local factory and on site at the same time is created with the combination of an enhanced BIM model integrating 4M approach and by the application of low and low intrusive techniques. Different types of data measured allow for advanced monitoring and commissioning of the components as well as monitoring of the building actual performance (4M approach step: Monitoring).

The sensors integrated in the PnP building components reduce facility management costs. As these components are produced and assembled in a stable local factory temporarily built up at the near surrounding of the retrofitting area the quality of retrofitting will be reached at an affordable price at high quality level compared especially with regular retrofitting at building level. This simplifies the replication of the construction phase and reduces time losses and costs due to the required case-by-case configuration.

Furthermore, the district focus enables the application of effective and efficient energy concepts covering the demand economically especially compared with stand-alone solutions for single buildings provided by competitors. Scale effects meaning volume oriented bargain prices for products and services will be appreciated by the owners as they are not able to realize these effects themselves especially not at the quality level produced by the systemic approach and the district and neighbourhood level energy concept. The following table shows further actions steps of the 4 local factory step implementation integrating 4M approach.

Table 5: Actions steps for the elaboration of the local factory approach integrating 4M approach

Local factory	**Specification and validation**		**Configuration**	**Production**	**Evaluation**
4M approach	Mapping		Modelling	Making	Monitoring
Action steps	- Operation analysis (as built information) - Data gathering - Site visit (inspection)	- Define scope (deep renovation plan) - Define resources (market analysis) - IDENTIFY	- Information form supplier, local contractor - Model different solutions (design configurator, D2.2) - VALIDATE different	- Customized production of PnP modular solutions according to the specific district and building - INDUSTRIALIZE	- MONITORING and CONTROL - Verify the objectives - On-site documentation - Adjust

	BUILDING DIAGNOSIS (WP2 – self assessment tool)	REQUIREMENTS and OBJECTIVES	scenarios (parametric modeller) – BIM - Evaluate and find most optimal solution - Detailed design	D PREFAB PROCESS of PnP solutions	

5.3 Potential value of the local factory concept integrated as part of the e-Marketplace

P2Endure concept integrating local factory as part of the e-Marketplace aims to allow for a large-scale systemic approach based on the local factory which will enable the introduction of existing technological solutions for the energy efficient retrofitting with the economics of scale. The PnP solutions with an advanced BIM approach provide possibility of customization of the retrofitting solutions that are cost-efficiently mass-produced in the local factory. Though, the solutions are also context specific i.e. they respond to local climate, building type and tradition, social and economic contexts, etc. The advanced ICT/BIM platform and smart grid technology can help integrating P2Endure PnP solutions at the district scale.

For actual implementation of the developed concept for a specific district, a detailed action list should be provided to implement the district renovation P2Endure local factory concept (based on generic action list presented in Table 1). This concept takes into account the local needs according to different stages of development of the energy-efficient retrofit market in the EU countries.

It is believed that the spreading of Local Factory concept, accompanying the availability of e-Marketplace and associated tools, will induce a growing number of energy stakeholders (especially SMEs) to consider adopting and applying the local factory concept integrating 4M approach. In most cases, it is expected that as soon as they will have performed the district model economic and technical assessment, they will be strongly stimulated to consider integrating new knowledge to improve their construction retrofitting process performances.

5.4 Further sustainability aspects achieved by local factory integration

In general flexible local retrofitting factory concept leads to minimization of the embodied energy, transport and disturbance during the retrofitting process, and resolve fragmentation of the supply-chain. Within P2Endure the goal is to choose retrofitting concepts that work now and in the future as environmental, social and economic sustainable solutions. While offering as much as possible prefabricated solutions the production waste of such components is minimized since all elements are industrially optimized. By establishing a local factory nearby the site also the needed transport from factory to the building site is kept to minimum. Local factories bring the most added values in terms of efficiency for renovation projects at district scale. Global sustainability is met by using carefully selected (locally produced) materials and using local labour (community) and technology. With implementation of carefully selected building systems with high efficiency, these choices present cost-effective solutions in the long term run. The main environmental challenges that encourage integration of a local factory concept are:

- Material production: To choose materials with low embodied energy, based on local production, renewable, bio-based or recycled material.
- Transport: To reduce the transport of materials and components form factory to construction site by using local supply of material and local factory for the production of building concepts.
- Renovation: Through a development of PnP solutions in a factory where whole 4M process allows optimization of the renovation process pollution and waste management are addressed properly and minimized. Furthermore, with a maximal prefabrication of elements local disturbance of building occupants is reduced.
- Ensured quality: A better quality control of the process is ensured by adopting BIM and integrating 4M approach in the production line in local factory. Chances for errors are reduced by having a controlled industrialized factory process. Materials are chosen that do not emit harmful substances in the surrounding environment (VOC etc.).
- Employment: With the establishment of local factories new employment opportunities for the local people are elaborated where residents in a district do not need to go far to work (with bike etc.).
- Demographic change and lack of qualified personnel: The demographic change is causing in general a reduced availability of experts in the building market. Especially high end demands created by deep renovation projects cannot be covered easily in a growing market with reduced personnel. The local factory assures the quality by applying a new prefabrication process and enabling more efficient production not consuming the effort of human resources as the regular building process.

6. Development of a business model concept

6.1 Basics

The business model concept for the P2Endure platform presents answers on how to run the e-Marketplace and to present options how to implement the development and running of the e-Marketplace in principal efficiently and effective at an economical level and based on a unique selling proposition (USP) created by the collection of added values.

Following the principles of individual business model generation as described by Osterwalder and Pigeur under the headline of Canvas the start from scratch while creating a business model concept is foreseen. Canvas is an appropriate tool if the product to sell is not complex (e.g. a book, a single product or service) and the targeted customer group is homogeneous and easy to identify. The Canvas approach was often used in EU funded R&D projects as it is easy to apply by non-experts. In case of the core business offer of the P2Endure platform the product is extremely complex and demanding and the targeted customer group is heterogeneous. Therefore an innovative process or a better fitting new methodology is needed in order to fulfil these characteristic and complex demands of the e-Marketplace platform that is being used and applied by different user groups.

In order to create a fitting offer the change of customer behaviour in the construction sector has to be analysed precisely. OC&C, a strategy consulting company based in Düsseldorf, Germany, specialised on the construction market and its distribution channels, is doing exhaustive surveys about most important strategic adjustments of building supply companies –see figures below. One field of action identified by OC&C is the introduction and implementation of a multichannel distribution system providing information to all partners of the value chain. This plays an important role as a part of a changed demand definition caused by digitalisation of the process. The P2Endure e-Marketplace targets to close the digitalisation gap of many building supply companies at is offering a risk reducing share of costs for development and running, realised by a partner model funded platform. Furthermore, the knowledge for creating such a service is not available in companies that do not apply this multiple type of distribution channels. This represents one of the barriers of the conservative building supply industry that hinders them from investing in such innovative developments.

6.2 Existing distribution channels

Nevertheless the change in the market is moving at higher speed nowadays. The driver is a new generation of younger clients that are more self-organised and well introduced to analyse and handle digital offers in their daily business. For the building supply industry OC&C scanned five different and important distribution channels that deliver products to the client. The categories

are online, specialised trade, craftsmen and regional hardware store. In general the difference between the use of digital channels for gathering of information or buying of building products is closely related to demographic groups. The younger client (defined by the age range from 18 to 40 years) informs himself at a higher extent online. They inform themselves much less through craftsmen or builders as traditional referral marketing consultants and rather use personal investigation than to interact personally.

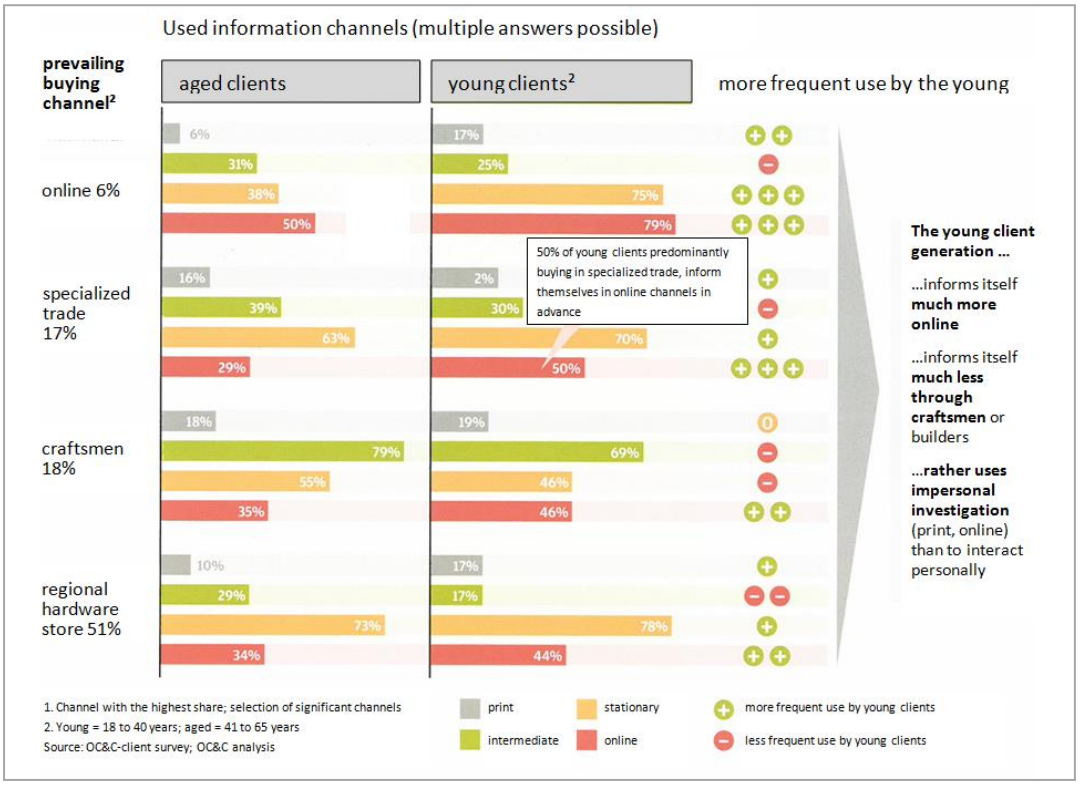

Figure 17: channel use by aged and young clients in %

If the distribution channel 'specialised trade' is analysed 50 % of the young clients predominantly buying in specialized trade inform themselves in online channels in advance. If information is not available the acceptance of the offer is low by the young client group. The acceptance is quite high if the information level is qualified at a high state. The business model concept for a digitalised multichannel distribution system has to cover this demand and the P2Edure platform development is in line with current market developments created for the near future of building product supply. In order to create a relevant and different offer in relation to competitors and at the same time realised and appreciated by our target group the functionalities of the platform developed and described in Chapter 3 are important. Nevertheless today's innovative business modelling is extremely important causing the relevance and difference in order to raise the success factor of new businesses like the P2Endure e-Marketplace.

6.3 The business model navigator approach

Referring to Prof. Oliver Gassmann, University of St. Gallen, head of the business model innovation lab and creator of the business model navigator approach, 90 % of today´s successful operating business models are built just out of 55 existing patterns of business models and the innovation creating successful breakthrough business models is just to combine 2 or 3 of these patterns to build up a new business model instead of developing self-standing ones in a smart way. Furthermore, Gassmann states in his breakthrough publication 'The Business Model Navigator' that a typical product innovation business modelling is replaced by business model innovation. For example, the success of innovative single products developed to be applied in the building market is more driven by distribution strength and diffusion capabilities than by real technical innovation height. This is extremely important for systemic offers as digital distribution platforms covering a holistic solution for deep renovation developed by P2Endure. Innovation height in the extremely conservative building market is defined as a real market advantage -e.g. costs, practical application issues, technical features as KPIs or lifetime performance etc. - in relation to relevant competitors and appreciated by the target group at the same time. The e-Marketplace created by P2Endure is focusing on a large collection of added values created by advanced product features and performance improvements. Furthermore the platform provides a sort of logistic solution closing the crucial coordination gaps from product choice to tendering to local pre-fabrication. This advanced support enables the target group of SMEs to act as high qualified total solution providers. The key factor to realise this offer and implement it in the market is the involvement of the building supply industry by opening another distribution channel for their products providing extra turn-over and profit. The expectation is that the building supply industry will sponsor the involved stakeholders offering free-of charge technical support and advanced logistics to answer the requests of just-in-time delivery and individualised production at local factory level.

The BIM based organisation of data exchange and communication builds the backbone of this approach. In WP5 the detailed business modelling and business plans providing important impact for exploitation activities for P2Endure will be elaborated. The perspective of business modelling based on the e-Marketplace and its features presented in D2.5 play an important role as they are representing the scheme how the e-Marketplace will generate an distribute profit in order to bound the stakeholders sustainably.

The main business plan of the platform, describing the business modelling idea and the combination of the applied patterns and the parts to be further built up, elaborated, revised and delivered in WP5, will indicatively include the following main contents:

1. Executive summary
2. Business venture description
3. Products and services
4. Business objectives and S.W.O.T. analysis
5. Market analysis and target markets
6. Competition analysis
7. Marketing/sales and promotion strategy
8. Further product/service research & development (incl. TRLs)
9. IPR management
10. Staffing and operations
11. Financial projections, (key assumptions, P/L, balance sheet, cashflow, RoI, IRR, NPV)
12. Sales pipeline
13. Funding and investment requirements.

The figure 18 below developed by the BMI –business model innovation lab run by Prof. Oliver Gassmann- shows different patterns and parallel lines that are analysed as parallel actions focusing on a time related basis. The junctions show the fusion and combination of patterns that strengthen the original business model and add up innovation and create success.

E.g. the 'Freemium' line representing providers like Skype is a well introduced business model that is upgraded with additional business models for innovation. The 'Freemium' model is building up a convincing tension with a targeted customer group if providing a certain value and has to find an innovative way to create revenues anyway. Often the combination is the 'Add-on' business model: the basic offer is for free, advanced offers providing extra value are charged often at a use frequency basis representing the 'Pay Per Use' model. P2Endure looks for a fusion of 'Digitisation', 'Freemium', 'Pay Per Use' and 'Revenue Sharing'. This combination is quite promising as the single business models are successfully applied as stand-alone solutions and they represent well introduced patterns in the market. The rules of buying are known by the stakeholders.

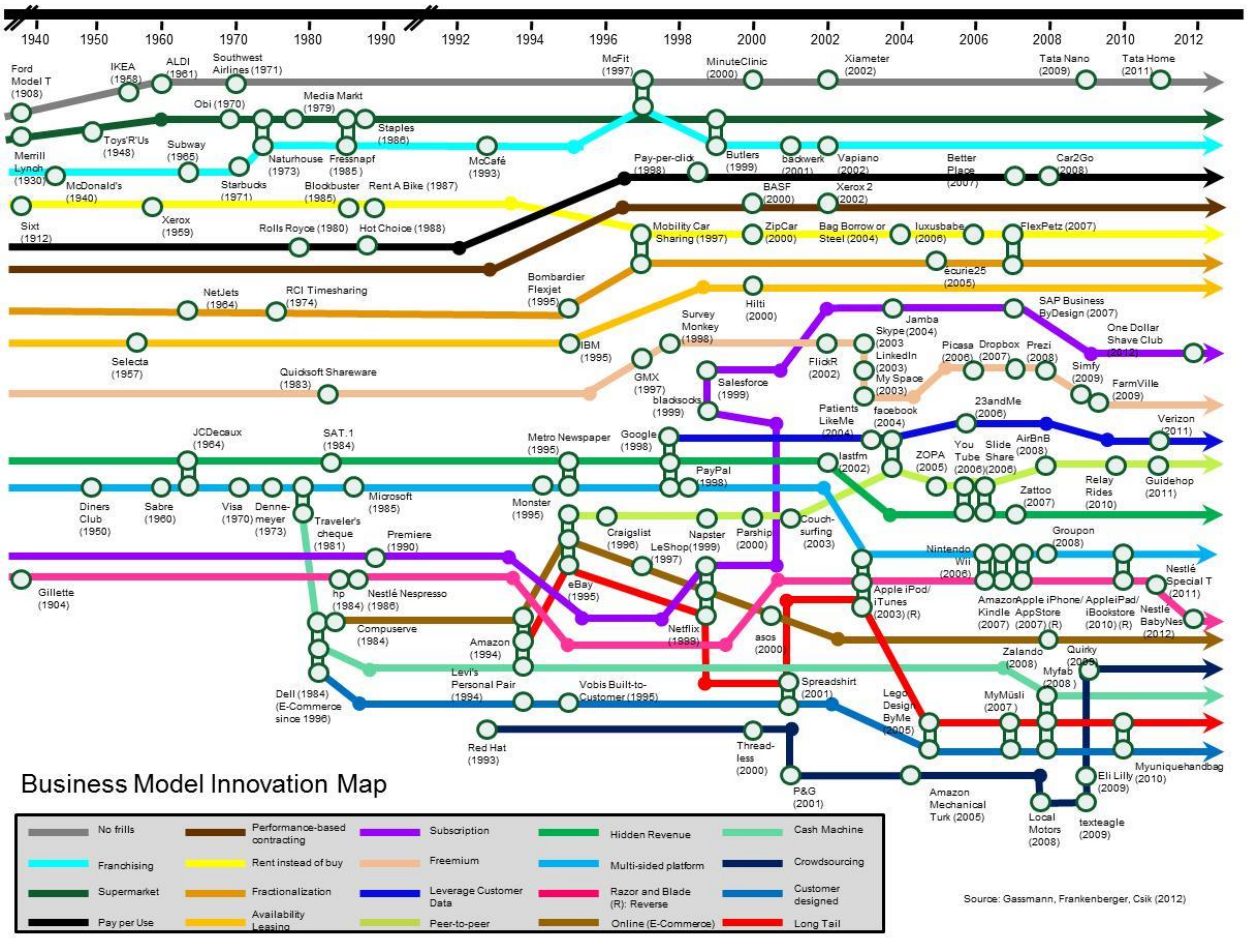

Figure 18: Business model innovation app

In case of P2Endure the idea is to develop a free-of-charge 'Freemium' concept following Gassmanns patterns- digitised e-Marketplace. The basic offer is the analysis of the IFC file showing possible results at a rough estimation level enabling the client to understand the added value. The profit will be generated by fees based on turn-over –Revenue Sharing- that are realised just by real projects and paid related to turn-over and profit. This approach gives extra faith in the concept at stakeholder level and creates a quick diffusion speed creating a win-win situation for the participating partners. The pre-investment for the running e-Marketplace is planned to be realised by involving the financing potential of the building supply industry as they are profiting the most. The industry is used today to pay opportunity costs for their regular 3 steps selling process from producer to wholesale to client.

The P2Endure e-Marketplace will focus on making this selling process extremely lean, profitable and quality assuring at the same time. Therefore, the pre-financing of the e-Marketplace by the building supply industry is quite realistic taking into account the expected advantages. P2Endure partner 3L is experienced in creating such business models and has realised

successfully a comparable solution for a network of building supply and construction companies in Germany. Alternative and even comparably promising solutions for funding the implementation and running of platform are 'Crowdfunding' and 'Franchising'. The implementation of franchise systems is ambitious as the development costs have to be covered and pre-financed by the funding company. As there is a risk of fail financing by a regular bank is ambitious, not easy to realise, needs a lot of own capital and is extremely expensive.

The financing costs are a huge burden for the start-up and as P2Endure is providing a social impact - sustainable improvement of the building stock is not just driven by economy but by ecology- a share model of these costs at an early stage is highly appreciated. One solution is an open crowdfunding approach looking for shareholders of any kind, even more promising is the closed crowdfunding approach. In this case the involvement of the building supply industry in the pre-financing stage is foreseen. In fact the support of the building supply industry is available in regular just analogue driven distribution and pre-selling activities but from the perspective of the offering company it is inefficient. The stronger relationship with a smaller group of fixed partners that share the platform is more focused on the direct turn-over volume created by consulting and service. In literature the service and consultancy part of the building supply industry is described as a part of marketing or pre-selling and the costs are assigned to the product sale. P2Endure raises the efficiency of these investments in marketing and distribution activities.

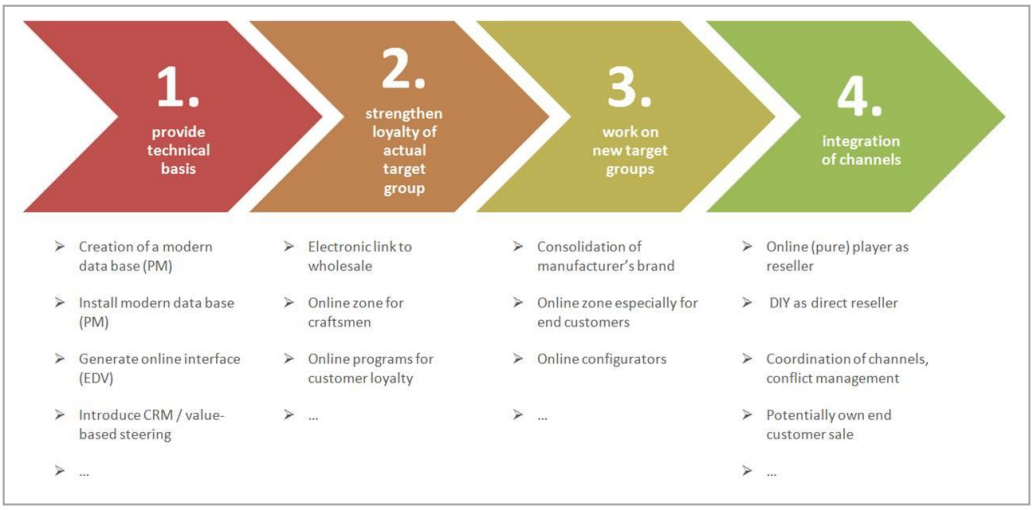

Figure 19: producers' multi-channel fields of action

Nevertheless, it is very important that P2Endure will demonstrate all advantages compared with competitors but as a focused offer for the needs of the building supply industry at the highest level. This is unconditional necessary in order to motivate the partners to pay for the development and running of the platform. The four step approach above identifies the important fields of action for implementing a valuable multi-channel distribution system for building products. The stepwise built up scheme shows the complexity of the action. The heterogeneous structure of data has to be professionalised in a central steering system. On behalf of P2Endure we are offering a professional data handling via the parametric modeller. The relationship to all target groups at a comparable level contains additional communication work that can just be handled at a digital level, too. Again the P2Endure e-Marketplace offers functionalities to create a stronger relationship focusing on business activities and revenue creating. The same holds true for step 3 work on new target groups and the need for creating online configurators –as our platform- and the integration of channels from delivery to pre-fab at local factory. This needs scheme for the building supply industry proofs the embedded extra value of the P2Endure e-Marketplace at different levels from customer relationship enhancement to a stronger bounding of product applicants of any kind and end clients.

7. Conclusions

The building supply industry was following a single three steps distribution channel for decades successfully. The basic idea was to deliver products via a wholesale and not directly to the client. The building supply industry profited from the wholesale and the craftsmen consulted the client in the product application and worked as a referral marketing agent. The industry was not concentrated that much on direct sale activities as focused communication is a minimum requirement looking for end customer. Nowadays, a good basis for communication is BIM application in order to steer and monitor project development processes and the objective of the parametric modeller is to ease the use of data for P2Endure.

Today, the 'younger' client (18-40 years) is more interested in product features and qualities that enable him to make decisions and this creates an adjustment of diffusion strategies in the building supply industry:

- Other partners as wholesale and craftsmen are continuously losing their decision making competence and influence.
- The building supply industry has to develop more client oriented advertisement and sales support which is realized by intensive use and development of online services.
- Focusing on the P2Endure targeted deep renovation market the complexity of the offer in terms of the technical demand, the composition of the holistic offer expected by the client and total warranties obligations is quite big and there is a need for creating a fixed network of partners involved. They have to be organized and supported at the highest level of efficiency and effectiveness.

Features that add quantifiable value compared with existing e-Marketplaces are most important to raise the acceptance and to collect a critical mass of users in order to run the platform economically. Expected functionalities of the e-Marketplace are focusing on the impact and interaction of the P2Endure platform created by stakeholder needs. The interaction of services is organised from two different sides following the client and the SME driven demands. The partners from the building supply industry are involved in service and logistics. The current demand of the single project is identified by the precise project data and the qualified identification of needed components by filtering of BIM data. The platform allows at least tendering, buying and contracting on basis of the available information. It gives a decision support for the client based on time, costs and facility management aspects and helps to organise the site logistics including pre-fabrication at the local factory. Furthermore, energy efficiency and performance issues and sustainable criteria are covered exhaustively.

It is quite ambitious to develop a new market place with embedded functionalities as described above. Therefore the objective was to identify existing offers that are providing synergies in order to upgrade or implement P2Endure features.
The analysis of the existing platforms summarises the generic scope of the deliverable and is giving an insight in current developments in market diffusion strategies of the construction market developed or demanded by the building supply industry.
It contains the idealistic benefits survey of a BIM based platform for all stakeholders. The vision for the P2Endure platform is the 'Building Amazon' a holistic platform operating in the field of building supply and retrofitting.
The demonstrators' values and its benefits for all market partners are crucial. The introduction of an e-Marketplace and its functionalities in general helps to define the difference between e-Marketplace and e-Commerce. The reasons for the late adoption of a digitalised selling process in the construction industry are manifold. Nevertheless the changed buying approach of target groups forces the building supply industry to react.
Additionally, the overview of the initiatives undertaken in EU projects aiming at fostering the transition to e-Marketplaces at many levels and in several industries shows cooperation and improvement potential at the same time. Such initiatives include PaaSport, MOBiNET, WaterInnEU, AppHub, AutoMat, and Proficient.
Lastly, section 2 identifies possible e-Marketplace models that could be suitable to the needs of P2Endure.
The P2Endure e-Marketplace provides the user a ready-to-implement prefabricated Plug-and-Play (PnP) system for deep renovation of building envelopes. These innovative solutions can be used to transform non-functional or sub-functional buildings into thermally and energetically improved houses.
The front-end display provides the user with the possibility to use his 'as is BIM' model to carry out energetic and thermal calculations. For this purpose, the parameters of the products the user can select on the P2Endure e-Marketplace are added to the *as is BIM* model. Based on the comparison between the old and the new values, the user can see the thermal and energy saving potentials of his future renovation process. For the calculation of the data, the products must be described as precisely as possible by the providers. The TU Berlin has developed guidelines for the necessary parameters for the individual product groups. The described products will be stored in a product catalogue and are available for application at modelling stage and for calculation needs at any time.

P2Endure will stimulate a demand driven renovation market instead of a traditionally supply driven market by offering consumers the possibility to make their own highly industrialized renovation configurations, enabled by the production of series-of-one in mass production prefabrication processes in local factory nearby. This development is in line with the current forecasted

market adjustments leading to pull and push activities that are more driven by a demanding young client - see Chapter 1.

Furthermore, with the set-up of the local factory -enabled by a digitalised lean management process realised by the P2Endure platform- nearby the construction site most efficient logistics are achieved and low embodied energy as transport movements are reduced to the minimum. In general a flexible local retrofitting factory concept leads to minimization of the embodied energy,
Transport and disturbance during the retrofitting process, and resolve fragmentation of supply-chain. Within P2Endure the goal is to choose retrofitting concepts that work now and in the future as environmental, social and economic sustainable solutions. While offering as much as possible prefabricated solutions the production waste of such components is minimized since all elements are industrially optimized. By establishing a local factory nearby the site also the needed transport from factory to the building site is kept to a minimum. Local factories bring the most added values in terms of efficiency for renovation projects at district scale. Global sustainability is met by using carefully selected (locally produced) materials and using local labour (community) and technology. With implementation of carefully selected building systems with high efficiency, these choices present cost-effective solutions in long term. The existing coordination gap on deep renovation sites can be closed.
With respect to other industries, the construction industry has definitely been a late adopter of e-Marketplace and e-commerce because of its fragmentation, relative low standardization, and inadequate preparedness to new technologies. Nevertheless, the construction industry's attitude towards e-commerce is positive and there is a number of ongoing initiatives to bring the construction processes on-line, including EU projects (e.g. Proficient).

Under the awareness that the P2Endure e-Marketplace is not the only one of its kind on the market, it is particularly important to focus and work out the unique features. The essential characteristics of the e-Marketplace are the conception as a software instrument that will support decision-making based on a life-cycle assessment and life-cycle information. The e-Marketplace will be interfaced with a BIM-oriented procurement/tendering platform that facilitates multi-criteria decision making for optimizing the different offers to clients share and store all relevant material on deep renovation packages, their performances and understanding real energy use and energy costs for consumers after renovation. To realize this, a parametric BIM modeller implemented. With the aid of this modeller the thermal and energetic calculations can be generated. In order for the e-Marketplace to meet its characteristics, more and more products will be added to the digital product library over time. This allows the user to access a wide range of products that he can include in his costing.

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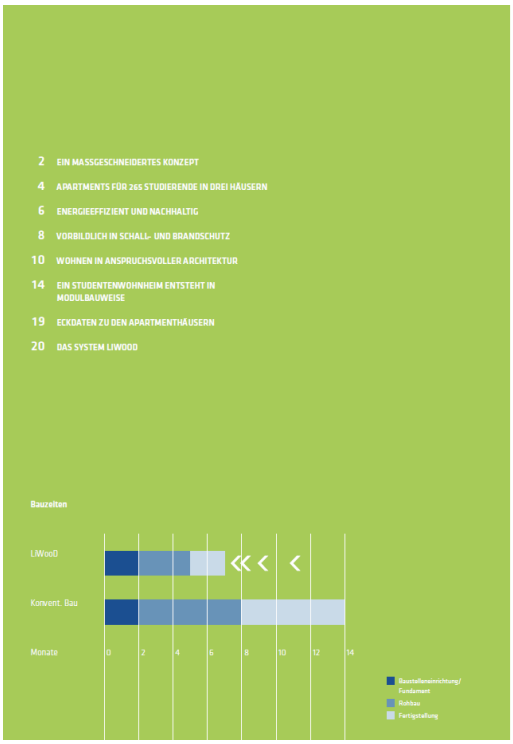
Annex 1 - example field factory Heidelberg, Germany


2 EIN MASSGESCHNEIDERTES KONZEPT
4 APARTMENTS FÜR 265 STUDIERENDE IN DREI HÄUSERN
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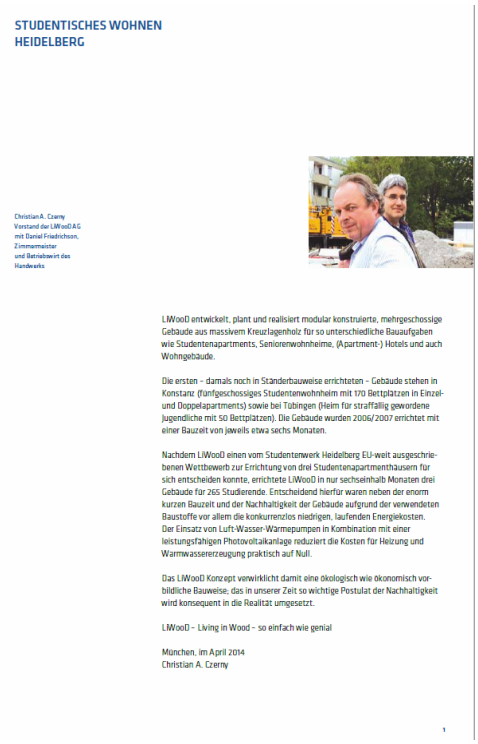

STUDENTISCHES WOHNEN HEIDELBERG

Christian A. Czerny
Vorstand der LiWooD AG
mit Daniel Friedrichson,
Zimmermeister
und Betriebswirt des
Handwerks

LiWooD entwickelt, plant und realisiert modular konstruierte, mehrgeschossige Gebäude aus massivem Kreuzlagenholz für so unterschiedliche Bauaufgaben wie Studentenapartments, Seniorenwohnheime, (Apartment-) Hotels und auch Wohngebäude.

Die ersten - damals noch in Ständerbauweise errichteten - Gebäude stehen in Konstanz (fünfgeschossiges Studentenwohnheim mit 170 Bettplätzen in Einzel- und Doppelapartments) sowie bei Tübingen (Heim für straffällig gewordene Jugendliche mit 50 Bettplätzen). Die Gebäude wurden 2006/2007 errichtet mit einer Bauzeit von jeweils etwa sechs Monaten.

Nachdem LiWooD einen vom Studentenwerk Heidelberg EU-weit ausgeschriebenen Wettbewerb zur Errichtung von drei Studentenapartmenthäusern für sich entscheiden konnte, errichtete LiWooD in nur sechseinhalb Monaten drei Gebäude für 265 Studierende. Entscheidend hierfür waren neben der enorm kurzen Bauzeit und der Nachhaltigkeit der Gebäude aufgrund der verwendeten Baustoffe vor allem die konkurrenzlos niedrigen, laufenden Energiekosten. Der Einsatz von Luft-Wasser-Wärmepumpen in Kombination mit einer leistungsfähigen Photovoltaikanlage reduziert die Kosten für Heizung und Warmwassererzeugung praktisch auf Null.

Das LiWooD Konzept verwirklicht damit eine ökologisch wie ökonomisch vorbildliche Bauweise, das in unserer Zeit so wichtige Postulat der Nachhaltigkeit wird konsequent in die Realität umgesetzt.

LiWooD - Living in Wood - so einfach wie genial

München, im April 2014
Christian A. Czerny


EIN MASSGESCHNEIDERTES KONZEPT

Die Gebäude sind energetisch effizient sowie ressourcenschonend konzipiert. Sie werden unter Berücksichtigung der Anforderungen des Bauherren, des Standorts und der individuellen Nutzungsbedürfnisse der Bewohner industriell vorgefertigt und anschließend vor Ort endmontiert.

Aufgrund ihrer Modularität und Flexibilität - jedes Haus kann unabhängig von Standardmaßen individuell gefertigt, ausgestattet und möbliert werden - sind die Gebäude in der Lage, fundierte Antworten auf die spezifischen Anforderungen unserer Bauherren und Auftraggeber zu geben.

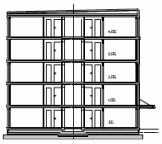
Das Einzelapartment (Grundmodul) funktioniert als autonome Wohneinheit mit einer Wohnfläche von 20 Quadratmetern. Es besteht aus einem Wohnraum, ausgestattet mit einem Vollholzbett (100 x 200 cm) mit Nachttisch, einer Schrank-/Regalwandkombination, einem Arbeitsplatz mit Schreibtisch und Bürostuhl. Bad mit ebenerdiger Dusche, Toilette, Waschtisch mit Ablagen und beleuchtetem Spiegel und einer Pantrykücke mit Ceran-Kochfeld, Spüle sowie Kühlschrank mit Gefrierfach.

Das Doppelapartment verfügt über die doppelte Grundfläche des Einzelapartments und besteht aus zwei identischen, abschließbaren Wohnräumen sowie einem dritten, gemeinsam nutzbaren Raum. Dort befinden sich die großzügige Wohnküche und das gemeinsame, gegenüber dem Einzelapartment größere Bad. Zusätzlich zur Grundausstattung ist die Küche mit einer größeren Arbeitsfläche mit Herd und erweiterten Schränken ausgestattet.

Die Struktur des Dreier-Apartments orientiert sich an der des Doppelapartments, bietet darüber hinaus jedoch eine erheblich größere Gemeinschaftsfläche. Das Apartment umfasst drei gleich große Wohnräume und eine geräumige Wohnküche mit kompletter Küchenzeile, Tisch und Stühlen, die optional mit einer Regalwand und einer Sitzgarnitur ausgestattet ist. Das Bad entspricht dem des 2er-Moduls.

APARTMENTS FÜR 265 STUDIERENDE IN DREI HÄUSERN

Der Lageplan illustriert die Flexibilität der Grundrissgestaltung und die Bandbreite an Variationsmöglichkeiten je nach den individuellen Gegebenheiten des Grundstücks: Einzelapartments lassen sich mühelos mit Gemeinschaftsräumen und 2- bis 4-Zimmer-Modulen für Familien oder Wohngemeinschaften kombinieren, die I-Form des westlichen Baukörpers wurde bei den beiden anderen Gebäuden zu einem L erweitert (das sich prinzipiell zu einem U ausbauen lässt). Das von LiWooD entwickelte ILU-Prinzip ermöglicht somit eine optimale Ausnutzung des Baugrunds auch bei nachträglicher Weiterentwicklung der Fläche.



Die drei neuen fünfgeschossigen Apartmentgebäude des Studentenwerks am Klausenpfad auf dem Campus „Im Neuenheimer Feld" bieten Platz für 265 Studierende in einer durchgrünten Wohnsiedlung für rund 1.600 Mieter. Das Serviceangebot des Studentenwerks umfasst PKW-Stellplätze und überdachte Fahrradabstellplätze ebenso wie einen zentralen Waschsalon und einen Grillplatz.

ENERGIEEFFIZIENT UND NACHHALTIG

Innovativer Holzbau ermöglicht eine energieeffiziente Konstruktion. Dank der relativ geringen Wärmeleitfähigkeit von Holz lassen sich zusammen mit Dämmmaterialien aus nachwachsenden Rohstoffen Niedrigenergie-Standards bis hin zum Passiv- oder Null-Energie-Haus realisieren. Dabei ermöglicht es der Holzbau, gegenüber Baumaterialien wie Beton, Stahl oder Ziegel bereits bei der Herstellung und Verarbeitung in erheblichem Maß Energie einzusparen. Zudem sind Nadelhölzer (vor allem Fichte) ein regional vorhandener, nachwachsender Baustoff und binden CO_2.

Im Gegensatz zu herkömmlichen Heizsystemen mit Vorlauftemperaturen von 70 bis 90 °C benötigen effiziente Lösungen deutlich niedrigere Temperaturen (etwa 35 °C Vorlauftemperatur). Insbesondere ermöglicht es die – dank hervorragender Dämmeigenschaften der äußeren Hülle – höhere Oberflächentemperatur der Wandinnenflächen, Niedertemperaturheizsysteme ohne Behaglichkeitseinbußen flächendeckend einzusetzen. Diese Wärmeübergabesysteme lassen in Verbindung mit Wärmepumpen die Nutzung von Umweltwärme zu.

Die auf dem Flachdach installierten Photovoltaik-Elemente erzeugen den für den Betrieb der Luft-Wasser-Wärmepumpen – sie liefern ihrerseits die Energie für Heizung und Warmwasserbereitung – benötigten Strom.

Wärmedämmung

Außenwand
1 Gipsfaserplatte
2 Massivholzelement
3 Gipsfaserplatte
4 Dämmebene 1 / KVH
5 Dämmebene 2 / KVH
6 Hinterlüftung
7 Fassadenbekleidung

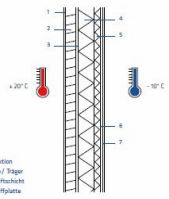
U-Wert
0,148 W/(m²K)

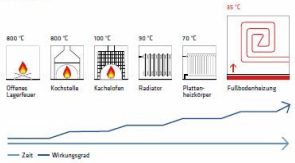
Bodenplatte
Estrich mit Bodenbelag
Trittschalldämmung
Trägerplatte
Bodenplatte
Perimeterdämmung

U-Wert
0,160 W/(m²K)

Flachdach
Tragkonstruktion
Dämmebene / Träger
Stehende Luftschicht
Holzwerkstoffplatte
Abdichtung
Substrat

U-Wert
0,127 W/(m²K)

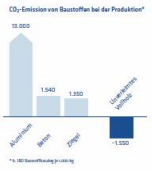


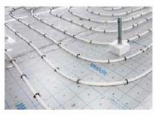


LiWooD ist in der Lage, Hausenergie weitgehend kosten- und klimaneutral herzustellen: so lassen sich ohne Eingriff in das Erdreich durch das Aufstellen von Luft-Wasser-Wärmepumpen umweltfreundlich und kostensparend Wärme oder Kälte gewinnen, welche über das hauseigene Energiezentrum in das Heiz- oder Kühlsystem eingespeist werden. Zudem erzeugt eine ausreichend dimensionierte Photovoltaik-Anlage einen Großteil des eigenen Strombedarfs bei minimalem Wartungsaufwand und langer Lebensdauer.

Holz war über Jahrhunderte das am weitesten verbreitete Baumaterial im Alpenraum – insbesondere in Bayern, Österreich und der Schweiz. Dabei kann der Baustoff dank moderner Verarbeitungstechniken problemlos mit der großen Palette heute verfügbarer Materialien konkurrieren.

Als nachwachsender Baustoff weist Holz eine überaus günstige Ökobilanz auf: In einem Kubikmeter Holz sind 0,9 to CO_2 gebunden. Dazu reduziert Holz als Ersatz für andere Baustoffe die CO_2-Emissionen um durchschnittlich 1,1 to. In den neuen Studentenapartments sind damit rund 3.000 to CO_2 gespeichert.



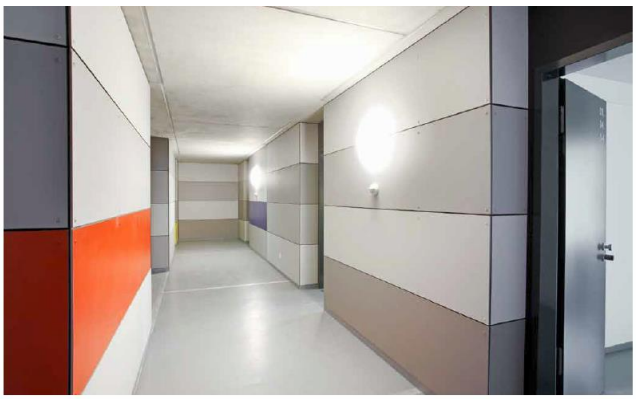


WOHNEN IN ANSPRUCHSVOLLER ARCHITEKTUR

Die Materialisierung des Wohnheims genügt hohen gestalterischen Ansprüchen: Oberflächenbehandelte Sichtbetonflächen sorgen für eine hochwertige Optik im Foyer, filigrane Treppengeländer setzen Akzente.

Zugleich sind die verwendeten Materialien langlebig und damit wartungsarm und nachhaltig: So sind die Faserzementplatten im Eingangsbereich, auf den Erschließungsfluren und an der Außenfassade nicht nur leicht abwaschbar, sondern auch mit einem Graffitischutz versehen; die Treppenläufe aus Stahlbeton sind ebenso robust wie der verlegte Linoleumboden. Damit entfallen weitere Nachbehandlungs- und/oder Instandsetzungsarbeiten wie Schleifen, Streichen und ähnliches weitestgehend.

Die gestalterischen Freiräume reichen dabei von unterschiedlichen Farbkombinationen und -konzepten bis hin zu Variationen des Fassadenrasters durch wechselweises Versetzen der Fensterachse der einzelnen Module.



10

11

Die Ausstattung der Küchen und Bäder richten sich ebenso wie das Mobiliar der Apartments stets nach den individuellen Wünschen des Bauherrn.

In Heidelberg sind die Wohneinheiten speziell auf die Anforderungen junger Menschen abgestimmt und bieten ausreichend Platz für Individualität im studentischen Leben. Der Arbeitsplatz erfüllt sämtliche Kriterien von Ordnung und Zweckmäßigkeit, eine durchdachte Möblierung und flexible Gestaltungsmöglichkeiten schaffen zugleich Freiräume für persönliche Entfaltung. Damit sind die wesentlichen Bedürfnisse studentischen Wohnens in hoher Qualität abgedeckt.

Die Zwei- und Drei-Zimmer-Varianten ermöglichen Wohngemeinschaften, die jedem Bewohner den gleichen Wohn- und Arbeitsbereich des Einzelmoduls zur Verfügung stellen und darüber hinaus einen zusätzlichen Gemeinschaftsraum mit großem Bad, Wohnküche und Aufenthaltsbereich bieten.

13

EIN STUDENTENWOHNHEIM ENTSTEHT IN MODULBAUWEISE

1

VORFERTIGUNG BAUTEILE

LiWooD errichtet Wohngebäude aus einzelnen Modulen in äußerst variabler Planungsvielfalt und mit hohem Vorfertigungsgrad. Die Gebäude werden energetisch effizient und rohstoffschonend konzipiert und industriell vorgefertigt. Sie werden direkt am Standort des Gebäudes in einer Fertigungsstraße montiert, als fast fertige Module aneinander gereiht und geschossweise gebunden. Die in hohem Maß ökologische und ökonomische Bauweise erfüllt die Wohnbedürfnisse und Umweltanforderungen der heutigen Zeit vorbildlich.

Die rationelle Ausführung ermöglicht ausgesprochen kurze Erstellungszeiten. Die von LiWooD verwendeten Materialien werden nach Kriterien der Nachhaltigkeit sorgfältig ausgewählt und bestehen aus hochwertigen Rohstoffen: primär Holz, kombiniert mit Gipsfaser, Glas und Stahlbeton. Dadurch entsteht ein ausgeglichenes und gesundes Wohnklima.

Die Bäder werden analog des Prinzips vorgefertigter Bauteile komplett ausgestattet und vollkommen funktionsfähig als ein Bauteil angeliefert und eingebaut. Der Wegfall von über einem halben Dutzend Gewerken in diesem sensiblen Segment trägt erheblich zur Beschleunigung des Baufortschrittes bei und reduziert potentielle Bauschäden auf ein Minimum.

2

LOGISTIK

Aus den genehmigten Baugesuchsplänen erstellt LiWooD für jedes Objekt die Konstruktions- und Werkplanung sowie die Werkstattpläne/Arbeitsvorbereitung für die produzierenden Firmen. Anschließend werden die einzelnen Bauteile – von den bauteilaktivierten Stahlbeton-Geschossdecken über die Brettsperrholzwände bis zu den Bädern – von umliegenden Fertigungsbetrieben und Zulieferern hergestellt und nach komplexen logistischen Vorgaben zeitgesteuert auf der Baustelle angeliefert, wo die einzelnen Komponenten in der Feldfabrik zu Wohnmodulen montiert werden.

Dabei sichert die Standardisierung und Industrialisierung des seriellen Herstellungsprozesses nicht nur eine hohe Präzision der Bauteile und gleichbleibende Qualität, durch die Vergabe der Fertigungsaufträge an Drittfirmen ist die Produktion auch stufenlos skalierbar.

3

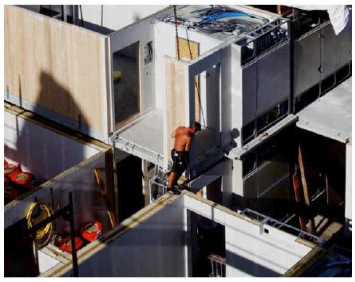
MODULMONTAGE FELDFABRIK

Auf der Baustelle werden die noch im Abbundwerk komplett fertig gestellten, mit Gipsfaserplatten beplankten und gespachtelten Wandscheiben in der von LiWooD festgelegten Reihenfolge zu Wohnmodulen zusammengebaut und komplettiert. Die witterungsunabhängige Montage in der Feldfabrik reduziert die Erstellungs- und Logistikkosten erheblich: Bei 70 –90 Minuten pro Modul beträgt die Kapazität der Feldfabrik bis zu 10 Module pro Tag.

4

VERSETZEN

Mit Hilfe eines Autokrans werden die Module gereiht, gestapelt und anschließend durch industriell vorgefertigte Erschließungseinheiten geschossweise gebunden: so entstehen holztragende Gebäude mit bis zu acht Geschossen. Neueste technische Ausstattungen wie schlüssellose Zugangs- und Abrechnungssysteme als auch moderne Medieneinrichtungen sind bereits integriert.



Fertigung und Montage

Sechs Module pro Tag

Die Raummodul-Fertigung erfolgte in einer Feldfabrik direkt vor Ort. Dafür fertigen nahe gelegene Holzbauunternehmen einen Großteil der Modulbauteile und -komponenten vor und bringen sie nach Zeitplan auf die Baustelle.

Die Raummodule wurden in einer Feldfabrik auf dem Baustellengrundstück zusammengebaut

Alles, was auf öffentlichen Straßen transportiert werden soll und zwischen 2,50 m und 3,40 m breit ist, darf trotz „Überbreite" noch in Begleitung privater Fahrzeuge zum Zielort gebracht werden. Was über 3,40 m hinausgeht, macht beim Transport eine Polizeieskorte erforderlich und kommt teuer. Daher begrenzt LiWooD seine Kuben in der Regel auf eine Breite von 3,40m.

Fertigung in der Feldfabrik

Dass die Raummodule in Linienfertigung in einer Feldfabrik auf einem ungenutzten Teil des Baugrundstücks vor Ort montiert wurden, hat vor allem Umweltschutzgründe: Nahe gelegene Unternehmen fertigen einen Großteil der Modulbauteile und -komponenten und bringen sie nach Zeitplan direkt auf die Baustelle. So auch die BSP-Wände. Sie kamen vom Abbundwerk mit Gipsfaserplatten beplankt und gespachtelt. Das spart Transportwege und reduziert den CO_2-Ausstoß. Das Vorgehen ermöglicht einen systematischen Zusammenbau der Module bei minimaler Bereitstellung von Lagerfläche in der Feldfabrik für die jeweils zu verbauenden Elemente.

Bei 70 bis 90 Minuten Montagezeit können bis zu zehn Module am Tag gefertigt werden. Die Anzahl variiert je nach Gegebenheiten auf der Baustelle bzw. den logistischen Rahmenbedingungen wie etwa der in der Planungsphase festgelegten Menge der zu liefernden Bauteile oder der Taktzahl der Lkw-Anlieferungen. In Heidelberg waren es sechs.

Nach Abbau der Feldfabrik erfolgte die Montage der Fassadenbekleidung, innen wurden parallel dazu sämtliche Installationen fertiggestellt und alle Möbel eingebaut.

Jahreszeitlicher Stromausgleich

Photovoltaik-Elemente auf den Dächern erzeugen den für den Betrieb der Luft-Wasser-Wärmepumpen benötigten Strom hauptsächlich zu den Zeiten, zu denen am meisten Energie benötigt wird (morgens und am späten Nachmittag).

Im Sommer, wenn die Elemente viel Energie erzeugen, aber die Wärmepumpen nur wenig für die Warmwasserbereitung benötigen – Heizen entfällt ja –, wird der Überschuss-Strom nicht ins Netz gespeist, sondern für andere Bedarfe wie Kühlschränke oder PCs im Gebäude genutzt.

Im Winter kehrt sich die Situation um: Die Wärmepumpen fürs Heizen und Warmwasser benötigen viel Energie, aber die Sonne scheint zu wenig. Für diesen Fall kauft das Studentenwerk Strom zu. In der Jahresbilanz gleichen sich die gesparten Kosten für den Strombedarf der erwähnten Geräte im Sommer mit denen des im Winter zugekauften Stroms aus.

Leitungen sind verschraubt statt verpresst

In der jeweiligen Fundamentplatte, auf der die Raummodule gegründet sind, wurde ein horizontaler Kanal mit einer Art Kabelbaum geführt, der zu den einzelnen Modulen abzweigt. Dieser fährt in die untersten Installationsschächte hinein und von dort in jedes darüber liegende Raummodul.

Alle wasserführenden Leitungen sind von Hand verschraubt statt verpresst, sodass Reparaturen jederzeit mit einfachem Werkzeug und damit

▲ Die gelieferten Elemente werden systematisch in Linienfertigung montiert

▶ Fertige Module werden direkt auf die Baustelle gefahren und an ihren Platz gehoben

ebenso vom Hausmeister wie von handwerklich begabten Menschen ausgeführt werden können. Das ist zum einen nutzerfreundlich, zum anderen ermöglicht es eine einfache Überprüfung (Revisionierbarkeit) der Leitungen bei der Wartung.

Das Energiekonzept für die Apartmenthäuser kann die benötigte Energie für Wasser und Strom weitgehend klimaneutral herstellen: Mit den Luft-Wasser-Wärmepumpen lassen sich ohne Eingriff ins Erdreich umweltfreundlich und kostensparend Wärme oder Kälte gewinnen, die über das hauseigene Energiezentrum in das Heiz- oder Kühlsystem eingespeist werden.

Die drei Apartmenthäuser sollen vor allem drei Gruppen nutzen: Ein Haus ist reserviert für Kurzzeitmieter, eines für Doktoranden und Masterstudierende und das dritte für Alleinerziehende.

Flexibel mit vielen Optionen

Sollten die Studentenzahlen in einigen Jahren rückläufig sein, könnten die „Studierstuben" wieder Geld in die Kassen spülen. Die Einheiten sind so konzipiert, dass sie sich mit geringem Aufwand umbauen lassen. Vom Einzimmerapartment bis hin zu offenen Raumstrukturen über mehrere Module hinweg lassen sie sich als Hotel, Seniorenwohnheim oder Büro nutzen. Sie sind auch demontierbar und können an anderer Stelle wieder neu zusammengesetzt werden. Andererseits lassen sich die Gebäude bei Bedarf erweitern: Die I-Form des westlichen Baukörpers könnte man wie die beiden anderen Gebäude zu einem L erweitern oder die L-Form zu einem U ausbauen. Das von LiWooD entwickelte ILU-Prinzip ermöglicht eine optimale Ausnutzung des Baugrunds auch bei nachträglicher Weiterentwicklung der Fläche. Angst vor Fehlinvestitionen muss man bei diesem Konzept also nicht haben.

Dipl.-Ing. (FH) Susanne Jacob-Freitag, Karlsruhe ■

PROJEKT 3

Fazit

Mit Holzbau fast CO_2-neutral

Nachhaltigkeit und Umweltschutz spielen bei den Neubauten des Studentenwerks Heidelberg eine große Rolle. Es kamen Baumaterialien aus der Region zum Einsatz, was die Umweltbelastung dank kurzer Transportwege gering hielt und für die Zimmereibetriebe aus der Region ein lukratives und gut kalkulierbares Geschäftsmodell sein kann. Im Endeffekt ist die Lebenszyklusbilanz der Häuser bezogen auf die Nutzungsdauer fast CO_2-neutral. Durch den Einsatz von Holz sind in den Studentenapartments auf dem Campus „Im Neuenheimer Feld" insgesamt 3000 Tonnen CO_2 gespeichert.

Annex 2 - Article O. Gassmann, BMI, University of St. Gallen

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The Business Model Navigator

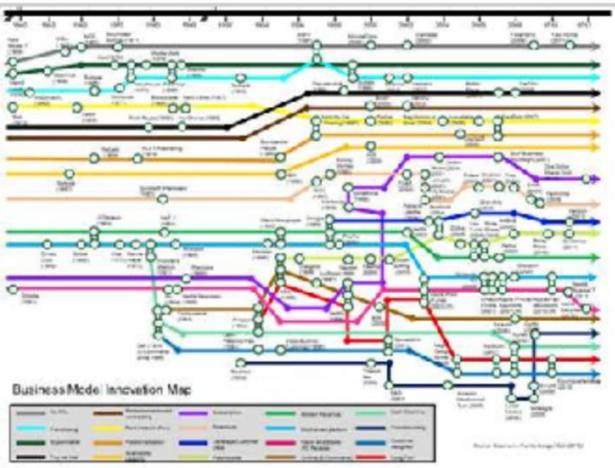
The Business Model Navigator

Author: Oliver Gassmann Co-authors & Organisations: Karolin Frankenberger Source: ISPIM

Products, products, products?

There are many companies with excellent technological products. Especially in Europe, many firms continuously introduce innovations to their products and processes. Yet, many prominent companies do not survive in the long term despite their product innovation capabilities and suddenly lose their competitive advantage. Strong players such as AEG, Grundig, Nixdorf Computers, Triumph, Brockhaus, Agfa, Kodak, Quelle, Otto, or Schlecker are vanishing from the business landscape. To put it in a nutshell: We have arrived in the age of business model innovation (BMI), where a company's fate increasingly depends on its ability to differentiate itself with an innovative business model.

Since there do not exist structured processes such as the case for product innovations, the goal of our research was to develop a methodology that helps firms navigate the process of BMI. In order to do so, we started our studies over 5 years ago by analyzing 250 successful business models that had been applied in different industries within the last 25 years. The phrase 'There's no need to reinvent the wheel' describes our findings very well. At a closer look, only few phenomena turned out to be entirely new. Often, innovations are slight varia-tions of something that has existed elsewhere, in other industries, or in other geographical areas. We identified an entirety of 55 repetitive business mod-el patterns that form the core of many new business models (click here to see figure and for further information: Gassmann et al. 2012; Gassmann et al. 2013). About 90 % of the analyzed innovations turned out to be re-combinations or adaptations of these previously existing concepts. To demonstrate this mechanism, a BMI map (see figure below - click to enlarge) depicts the 20 most popular of all 55 patterns as time-lines. Along those lines it is shown how companies applied and combined the correspondent patterns for their business model.



The BMI map: Every node represents a revolution of an industry (click to enlarge)

Let's have a closer look at the "Razor and Blade" pattern (pink line, pattern no.39): The main idea behind the pattern is to provide a base product to customers cheaply or even for free and to sell disposables that are required to use the base product at very high margins. Gillette innovated its industry by giving razor holders to customers and selling matching blades at high prices. Hewlett-Packard discovered the potential of this pattern for the printing industry shortly after; it offers cheap printers and expensive cartridges. Nestlé finally applied the pattern onto the food business through Nespresso. As the concept was extremely successful, very soon Nestlé Special.T and BabyNes followed.

The methodology: Creative Imitation and the Power of Recombination

It is evident, that our findings may well be used in a similar way to the widely-adopted theory of inventive problem solving (TRIZ) from engineering design. TRIZ is a methodology that supports the systematic generation of ideas within technical invention processes. In a like manner, the basis is 40 generic principles and rules of invention that help in solving technical contradictions and finding technical solutions. On the basis of 55 business model patterns, St. Gallen Business Model Naviga-torTM paves the road to a new business model fol-lowing three steps:

Step 1: Initiation – preparing the journey

Before embarking on the journey towards new business models, it is important to define a starting point and a rough direction. Describing the current business model, its value logic, and its interactions with the outside world is a good exercise to get into the logic of business model thinking. It also builds a common understanding of why the current business model will need an overhaul, which factors endan-ger its future,

or which opportunities cannot be exploited due to the current way of doing business.

To describe a business model throughout the methodology, we employ a conceptualization that consists of four central dimensions: the Who, the What, the How, and the Value (see fig. 3). Due to the reduction to four dimensions, the concept is easy to use, but at the same time, exhaustive enough to provide a clear picture of the business model architecture:

Who: Every business model serves a certain customer group. Thus, it should answer the question: "Who is the customer?"

What: The second dimension describes what is offered to the target customer, or, put differently, what the customer values. This notion is commonly referred to as the value proposition. It can be defined as a holistic view of a company's bundle of products and services that are of value to the customer.

How: To build and distribute the value proposition, a firm has to master several processes and activities. These processes and activities, along with the involved resources and capabilities, plus their orchestration in the focal firm's internal value chain, form the third dimension.

Value: The fourth dimension explains why the business model is financially viable. In essence, it unifies aspects such as the cost structure or applied revenue mechanisms. It points to the elementary question of how to make money and capture value.

Business model definition - the magic triangle

By answering the four associated questions and thus explicating the four dimensions, the business model of a company becomes tangible and a common ground for its re-thinking is achieved. As a rule of thumb, we consider the alteration of at least two dimensions a BMI.

Step 2: Ideation – moving into new directions

Re-combining existing concepts is a powerful tool to break out of the box

and generate ideas for new business models. To ease this process, we have condensed the 55 patterns of successful business models into a handy set of pattern cards. Each pattern card contains the essential information that is needed to understand the concept behind the pattern: a title, a description of the general logic, and concrete examples of companies implementing the pattern in their business model.

The way in which we apply the cards is termed pattern confrontation to describe the process of adapting the pattern to one's own initial situation. Participants, typically divided into groups of three to five people, ask themselves how the pattern would change their business model if applied to their particular situation.

Step 3: Integration – completing the picture

There is no idea that is clear enough to be immediately implemented in a company. On the contrary, promising ideas need to be gradually elaborated into full-blown business models that describe all four dimensions - Who-What-How-Value? - and also consider stakeholders, new partners, and consequences for the market. A set of checklists and tools, such as the value network methodology, are available in the St. Gallen Business Model Naviga-torTM to ease the process of quickly elaborating and explicating the business model around a promising idea.

Conclusions

The St. Gallen Business Model NavigatorTM builds on the central idea that successful business models can be built by creative imitation and re-combination. The 55 business model patterns are the basis of our action-oriented methodology. In order to validate and evaluate our approach thoroughly, we selected a wide base of companies and teams from different industries: BASF (chemicals), Bühler (machinery), Hilti (construction tools), Holcim (cement), Landis&Gyr (electricity metering), MTU (turbines), SAP (software), Sennheiser (audio technology), Siemens (healthcare), Swisscom (telecom). The application of the St. Gallen Business Model NavigatorTM showed a high success rate in creating new ideas. The methodology eases the innovation process as it structures it, and at the same time forms a framework for BMI. Following this systematic process, BMIs are developed with-out having to possess the gift of prophecy.

Annex 3 - UML diagram