Refurbishment comparison of Austria vs. Finland

CalCon provides its experience of rating buildings with the epiqr® method which is a fast tool to predict refurbishment costs. The following comparison of refurbishment procedures and related cost is structured as follows:

1. Explanation of the epiqr® methodology
2. Examination of the geometrical relations between Finnish (short Fi) and Austrian (short At) buildings
3. Comparison of different measures due to different boundary conditions
4. Comparison of used material and degradation state and related cost
5. Conclusion

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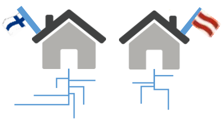
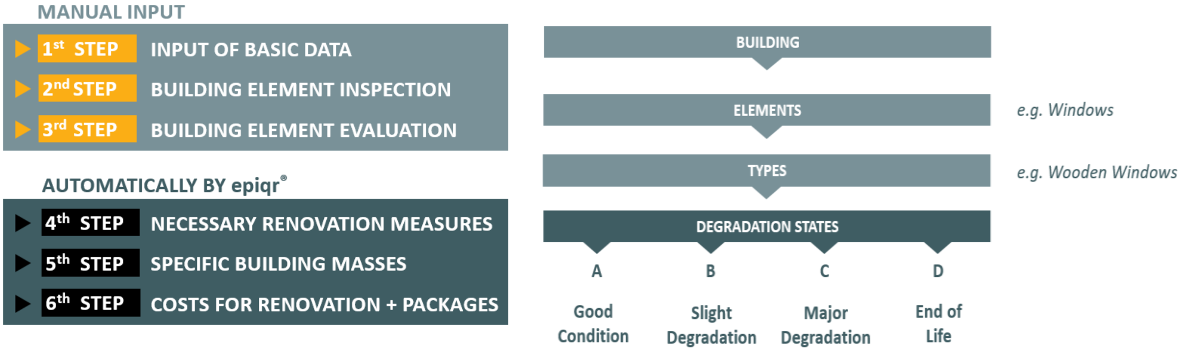
epiqr® erlebe einfach				

Picture 1: Chapter overview of the report.

1. EPIQR®-method

1.1. The epiqr® principle:

epiqr® offers standardized guidelines and procedures to evaluate the degradation state of the building within a few hours. It's working by using the "Pareto principle" i.e. to optimize the ratio of accuracy and time consumption. The approach of epiqr® therefore is unique: only a small number of geometrical factors is assessed systematically and only the degradation state of the most important building components is evaluated. To determine costs reliable an efficiently, the system then automatically calculates the necessary quantities using statistical extrapolation based on CalCon's huge database of already surveyed buildings. To facilitate the assessment of the degradation state of the building components four states are being defined.



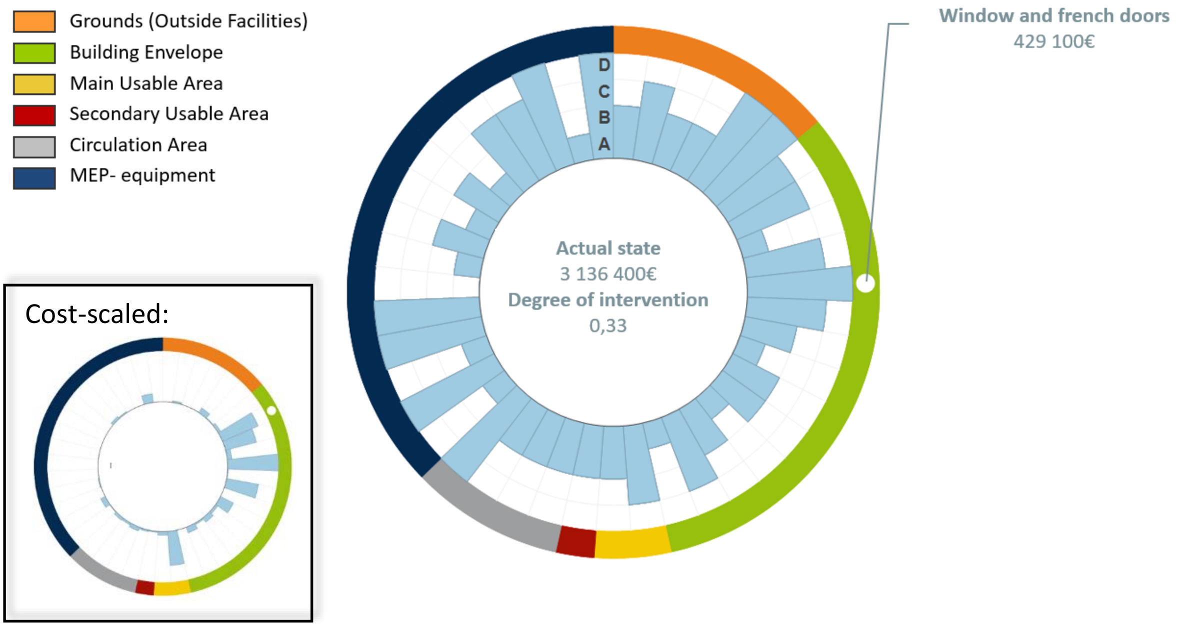
Picture 2: Left side: Manual and Automatic input that is necessary to calculate the refurbishment cost. Right side: Structure of the building assessment by defining the most expensive building elements, classifying these elements into types and then defining 4 degradation states for each building/element/type.

1.2. Step by step:

First basic data for each building is entered in the common building page. These include data on the precise location of a building and fundamental building values like the number of staircases and the gross floor area. In the second step, a trained surveyor inspects the building, checking a defined set of building elements per their type and degradation state. The epiqr® software then adds automatically necessary renovation measures and calculates specific building masses. Finally, the software calculates the refurbishment cost using a yearly updated cost database with average cost that are multiplied with adaptation factors to consider cost deviations caused by region, building size and building site situation. Depending on the customer's strategy the software calculates automatically different refurbishment strategies for the building (e.g. urgent measure, standard measure or modernization) and these could be adjusted by hand into detailed level of planning. In a further step the software epiqr® offers to bring all planned measures for all buildings together to plan the overall budget for the forthcoming years. So, in the end, epiqr® is providing a strategic maintenance management and helps to invest in the right buildings in the right way.

1.3. The epiqr® diagram:

To get an easy overview about the degradation state of the building or the extent of the renovation, CalCon organizes all the rated element types of one building in a circle-diagram. The length of the ray of each element type represent the degradation. If the element type is in a bad condition, the ray is long and thus all problems of the building are immediately visible. Besides the degradation state also the highest cost per element can be easily shown in the epiqr®-diagram (see small diagram in Picture 3). A colored ring around the circle groups the elements in building components (e.g. building envelope or main usable area).



Picture 3: The epiqr® diagram.

To have a dimensionless size of comparison, the degree of intervention is defined.

$$degree\ of\ intervention = \frac{\sum_{rated\ elements} cost\ of\ the\ actual\ state}{\sum_{rated\ elements} costs\ of\ the\ worst\ state}$$

It calculates the Quotient of the sum of costs of the rated degradation to the sum of the costs if all rated element types would be in worst state "d". With this a building with a Degree of intervention of 0, "0" needs no interaction and a building with the rating of "1,0" is worst. Regardless if it would cause 100 € or 1.000.000 €. In normal cases the Degree of intervention lies between "0,05" and "0,60".

If you want to see the impact of the different rays, you can change the scale of the length of the ray to costs and it will scale the length of the rays in comparison to the element type with the highest costs.

1.4. About CalCon:

CalCon was founded 2000 as the spin-off to further develop the products of the Fraunhofer Institute of Building Physics. The assessment of over 130 million m^2 gross building area, till now mainly in Germany and Austria, helps to validate and improve the system continuously. With this knowledge epiqr® is the excellent result of European research and a reliable tool in the real estate sector.

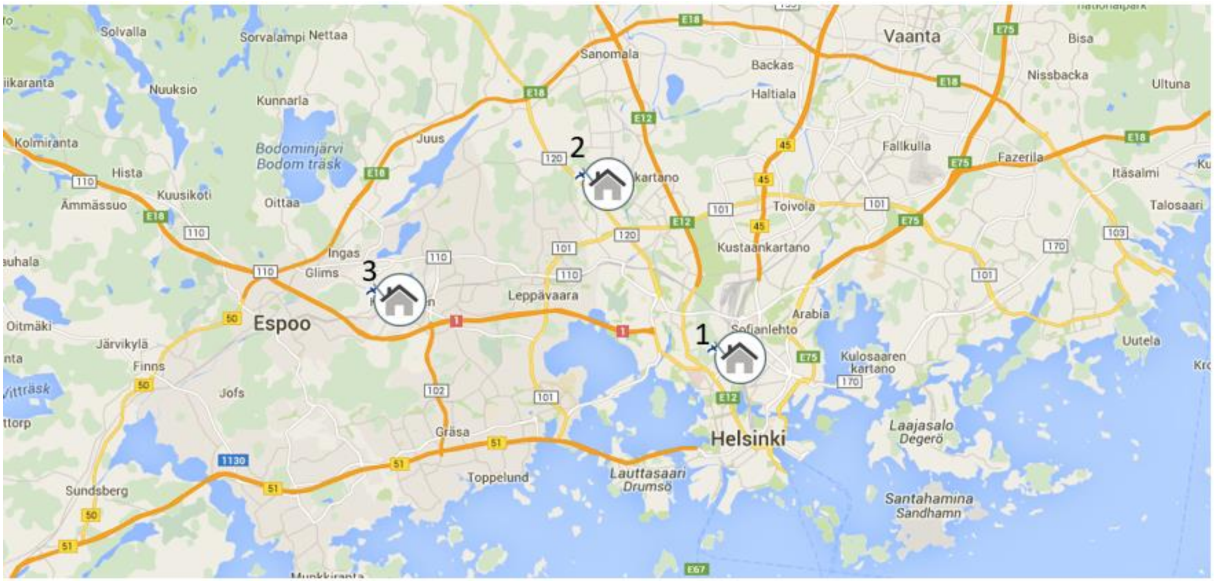
1.5. Statistical values:

An example for the statistical approach is the calculation of the glazed area of apartment buildings: In the conventional approach, if old reliable plans are available, the areas are calculated from plans or (in most cases as plans in reality are not available) the areas are measured with laser meters or other tools. In the epiqr® methodology a statistical survey gave the result, that in 95% of all surveyed residential buildings the maximum deviation was 3% to the given ration of 1/6 for the window area to the gross building area. Accepting this inaccuracy alone saves 30 to 90 minutes per building. For the research and the comparison of the Finnish and the Austrian building costs, CalCon could use these statistical approaches coupled with the current cost database set on Austrian (Styrian) price-level. For the research a surveyor of CalCon inspected three buildings in Finland and two buildings in Austria. The buildings in Finland where searched and selected by Rakli and a renovation of each of them were planned, so that that real Finnish costs might be available. The building sites in Finland where all located in the greater Helsinki area.

2. Buildings, used sources and reliability of data and results

2.1. Finnish buildings and provided information:

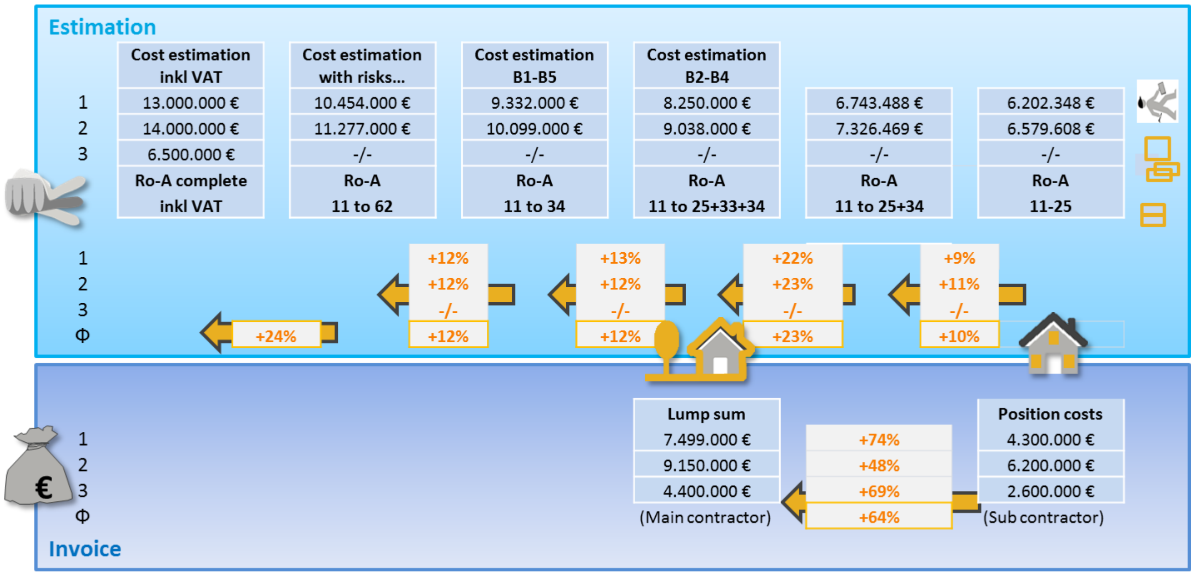
The Finnish buildings taken into account are all located in the greater Helsinki area. The rental area of the buildings varies between 3.600 and 10.500 m². They have all more than one staircase and the epiqr® site survey for Palkkatilankatu and Naapuripellontie examined just a part of the complex. The epiqr®-costs of these sites got extrapolated for the comparison with the real costs.



Finland	1 Palkkatilankatu	2 Naapuripellontie	3 Kavallintie
Height of building	Up to 9 floors (1,5 underground) Eaves height max. 22m	3 to 4 floors (no underground) Eaves height ~10,2m	4 floors (0,7 underground) Eaves height ~12,7m
Construction year	1983	1985	1972
Rentable Area (m²) Building footprint (m²) Lot –Area (m²)	10540 2650 7150	6480 2655 6230	3590 1300 3000
			

Picture 4: Overview of the Finnish buildings that were surveyed in the project.

During the research three different "Fi-" costs of the renovation of the Finnish objects where available for each Fi-building. The highest of all was the cost estimation, which includes also VAT, costs of risk, project developing costs and project management during renovation. Then the position costs were available, which got extracted from the (sub) contractor invoice and last the lump sum, which provide the real costs of the renovation incl. site and management tasks. Like the position costs before, these are real paid costs. In the diagram below we try to show this split of costs and estimations. Because the basis of cost estimation was in the end available for two of the buildings, it's possible to do a very detailed split up, which gives a good overview of the distribution of cost estimation, lump sum and position costs. For two of the buildings the detailed calculation of the cost estimation where available. In the further study these cost estimation with all its detailed split up are taken as reference. The real costs (shown in the invoice field below) are the really existing costs. But these are difficult to take into account, because the lump sum lies on average 64% above. Since this would mean the additional costs would be nearly double as high as calculated in the cost estimation. Because no further information of the position costs were available we could not detect the lack of costs there.



Picture 5: Different cost estimations and invoices found in the project. The different cost estimations are explained below.

The cost estimation comprises cost items in cost categories. In the "Ro-A 11-25" are summed up masses multiplied with unit prices for the different trades. With "Ro-A 34" the site equipment and site tasks are coming on top of it (on average 10% is coming on top). Together with the "Ro-A 33" it's congruent with the sum of "B2-B4" of "Perustamiskustannukset" (which divide the costs into trades as shown in the table below) and contains the same than the lump sum in real costs and comprise the complete project realization. By adding "B1" (respective Ro-A 31 and 32) with the project development costs (e.g. building design) again an average of 12% is coming on top of the calculation. For different upcoming risks, like if changes in the planning are later necessary typically you add on average another 12% of the Costs of "B1-B52. And in the end, the VAT had to be mentioned. So finally you end up in more than the doubled sum of position costs.

„Perustamiskustannukset“ –costs separated by trade		Naapuripellontie		Palkkatilankatu	
B1	developing costs	1061000	12%	1082000	13%
B2	civil enginiering (construction) works	6982000		7592000	
B3	heating and plumbing works	1436000		585000	
B4	electricity works	620000		73000	
B5	separate supply				
additional	(maintanance, risks, reserves …)	1178000	13%	1122000	14%
VAT		2706000		2509000	
TOTAL COSTS		**13983000**		**12963000**	
B2-B4	trade costs	9038000		8250000	

Table 1: Different additions used in the cost estimation.

2.2. Austrian buildings and provided information:

In Austria both buildings are located in the city Graz. For the Austrian buildings no renovation is planned in the moment. So no real costs are available for this study. But the survey was done by the same specialist which was very accurate comparing the countries. The locations and the basic data of the objects are shown below.

Graz	1 Billrothgasse	2 Vinzenzgasse
Height of building	7 floors (1 underground) Eaves height ~16,7 m	10 floors (1 underground) Eaves height ~24,3m
Construction year	1961	1970
Rentable Area (m²) Building footprint (m²) Lot –Area (m²)	845 225 778	1995 325 1300
		

Picture 6: Overview of the Austrian buildings used in the survey.

2.3. Differences caused by the location (external sources)

In in both countries, all the buildings are located in good rentable areas. In the national comparison, Greater Helsinki Area is the most expensive region in Finland to build and renovate houses. Graz take part in the upper middle of the Austrian building cost range.

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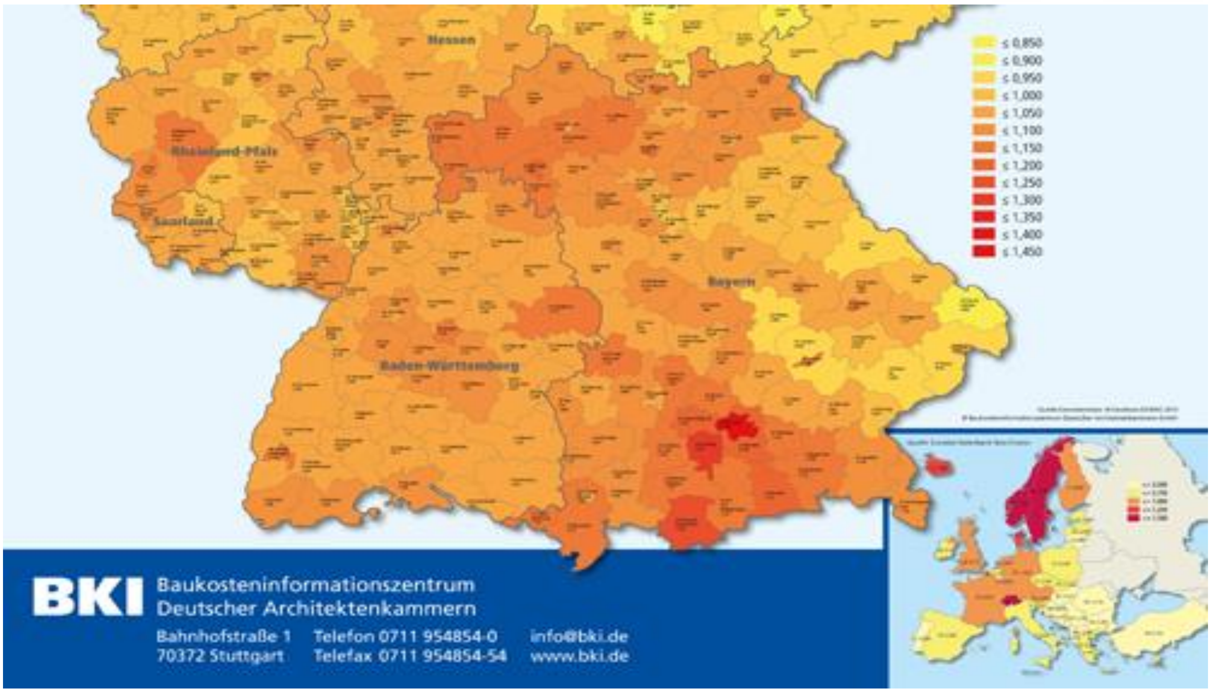


Picture 7: Comparison of the different European construction cost (source: BKI, chamber of German architects, www.bki.de)

One very cost intensive factor of a building is the building envelope. Due to the climatic boundary conditions the building envelope is constructed in different ways. So the climate and weather is a

very important factor, if you want to choose the best building envelope for your building. In our study it must been taken into account that during the winter month Finnish temperatures are lower than the ones in Austria. It is not only a question of energy saving but also of the comfort of the inhabitants to insulate the building envelope there.

In the further work three different construction differences could be mentioned directly with this higher impact of the cooler month. We will see it in the construction of the non-transparent parts of the building envelope, the windows and that typically a pilpit system is planned in the modernization, so that you can minimize transmission and convection caused heat dissipation.

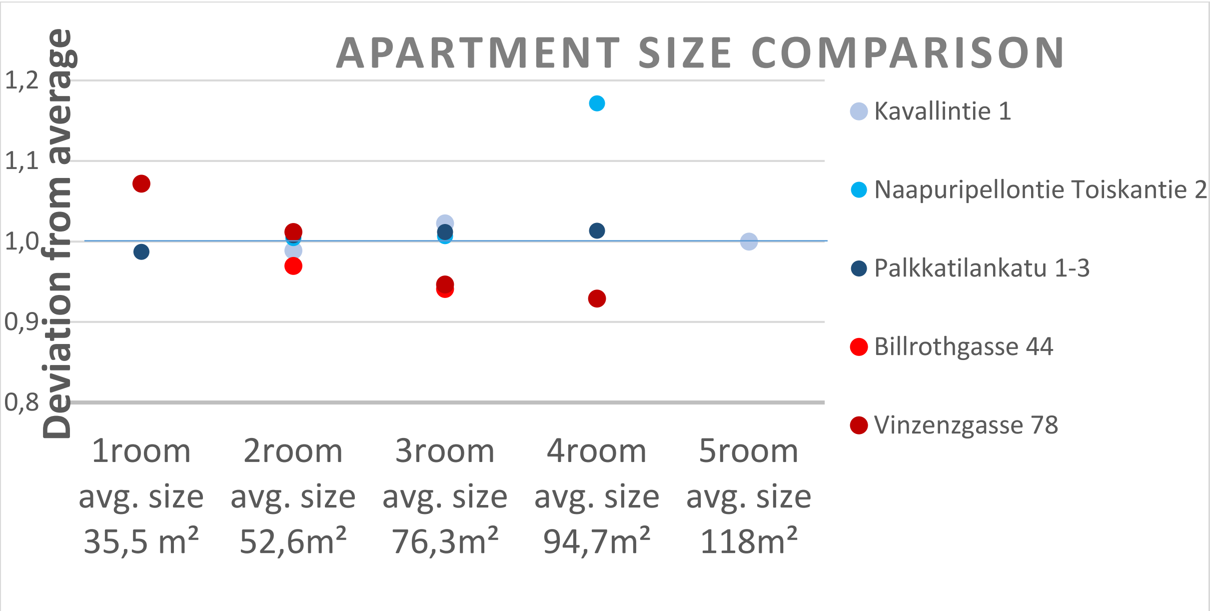
ELEMENT	Fi requirement		At requirement	Ger reference-building
	max. U-value	(W/(m²K))	(W/(m²K))	(W/(m²K))
windows		1,00	1,32	1,30
external walls	½ of current U-value	0,17	0,33	0,24
roof	½ of current U-value	0,09	0,19	0,20

Table 2: Different energy requirements in Finland, Austria and Germany

2.4. Is the epiqr®-estimation for geometries reliable for Fi-buildings?

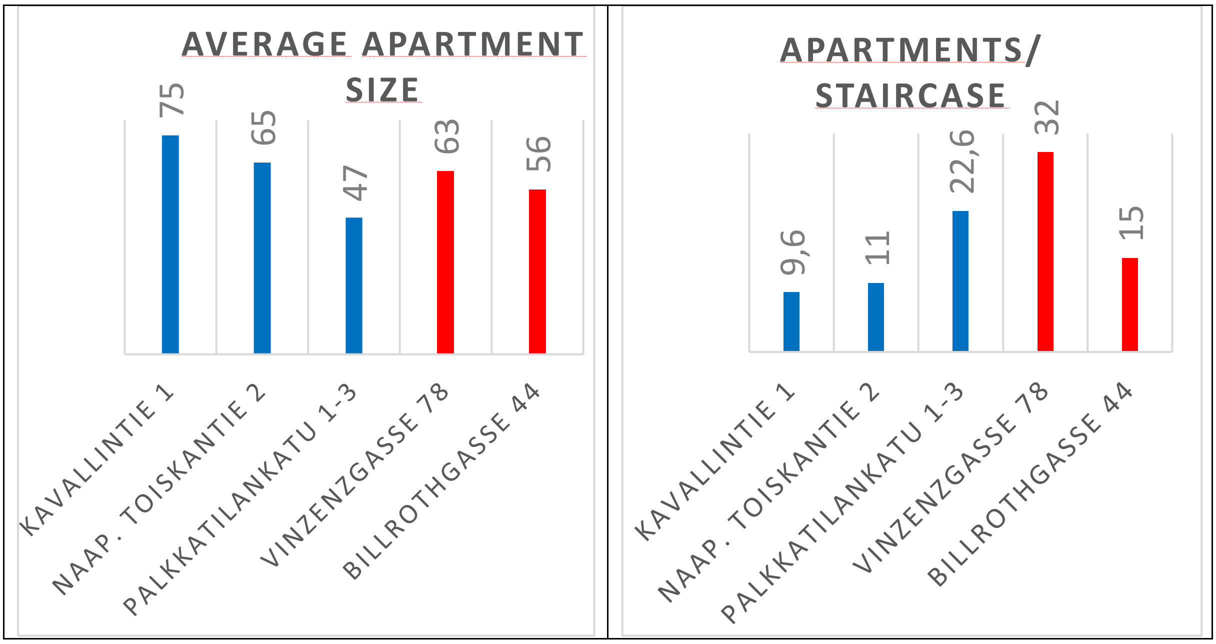
As shown before, epiqr® is using the Pareto principle and calculates a lot of geometries using statistical values. Therefore we have to prove, if we can work with our statistical values. The first step was the comparison of the buildings of Austria and Finland via their geometries (e.g. window area, gross area to apartment area, bathrooms per apartment and apartment size or number of floors).

First take a view at the common apartment sizes. The Finnish apartments tend to be bigger than Austrians, within more rooms. The Austrian apartments are inclined to be a bit bigger when it comes to one room apartments.



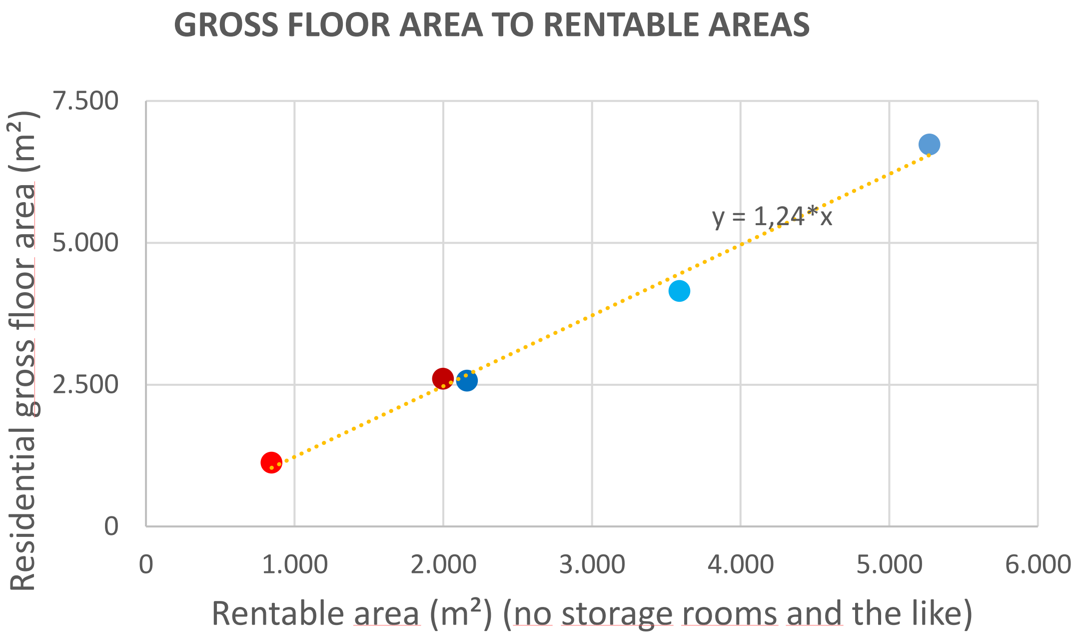
Picture 8: Comparison of Austrian and Finnish apartment sizes.

In average the medium apartment size lies around 65m² and is more dependent on the building itself then on the country. To compare the circuit area, we first take a look at how many apartments are located in one staircase. It is shown that it is in every building the same with 2-4 flats per floor.



Picture 9: Comparison of average apartment size and number of apartments per staircase.

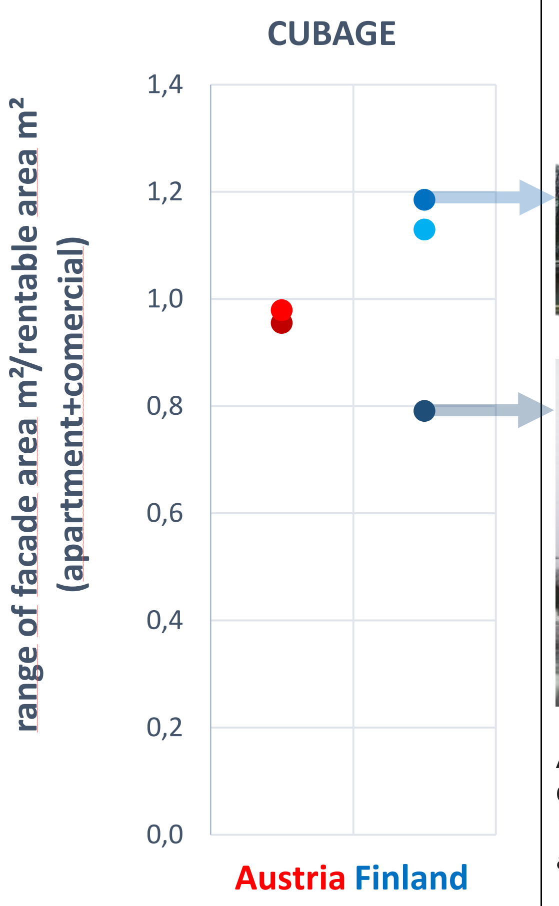
Also the relation of gross area to rentable areas (without storage rooms etc.) have the same relation and divagate more per building than per country (as shown in the diagram below).



Picture 10: Comparison of the relation of gross floor area to rental area.

In summary we don't see a huge difference between the Finnish and the Austrian buildings. The difference between the Finnish objects itself is in the same range than the Austrian buildings. But if we want to compare the costs of different buildings with each other we need next to the complete sum of costs some geometrical size, like the rentable floor area or the gross area to scale. If we do a comparison like that we have to mention that the geometrical structure of the building envelope has a high impact on this m²-cost too.

Therefore we just compare the Austrian costs for the Finnish building with geometric data from epiqr®. If we compare costs/rentable m² between different buildings, we have to take into account which cubage the building has. A much cost intensive point (as shown later) is the renovation of the thermal envelope of the building, it is very important how the relation between m² and façade-area is. If you look at a building like Palkkatilankatu, it has a lot of façade protrusions and recesses which causes more exterior surface than a compact architecture even if the building is a big complex like Palkkatilankatu. (Also to mention at this point is that it causes more edges and flaws then a compact cuboid. Those details need more material and more working effort.) Also in Naapuripellontie we have a high range of façade area to rentable floor area and would end up at nearly 20% more costs for the same action.



An important question for refurbishment costs/rentable m² is:
"How much façade area comes up to 1m² rentable area?"

Picture 11: Comparison of cubage.

Two out of three Finnish buildings has a high rate of façade area per m² rentable spaces. The Austrian buildings are on a similar level. Even if Billrothgasse is a part of a building row and Billrothgasse stands alone their rating is very similar.

3. Fi-buildings to At-buildings

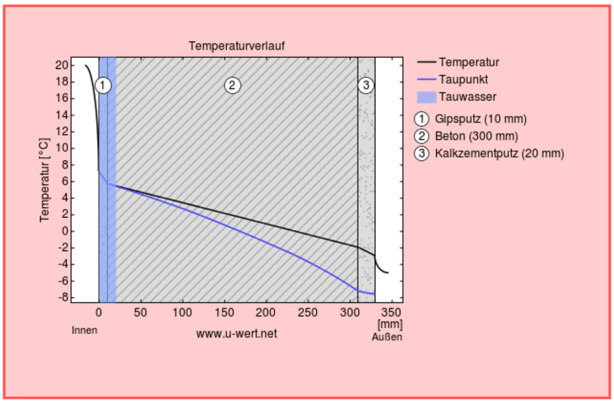
3.1. Fi-At differences in elements

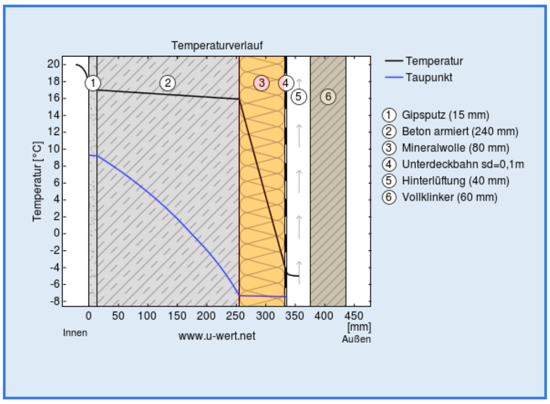
With the epiqr-system we are able to compare the buildings within dividing them into elements and element types. To analyze the difference between Fi and At the typical used elements in the buildings were compared. While the Austrian buildings had all a pitched roof, the Finnish buildings have flat roofs with all the typical differences coming up (roof termination (e.g. parapet), type of water handling, roofing material and the like).

The next big difference is the typical design of the façade. While the Austrian buildings have mainly plastered surfaces with a construction without ventilation, the Finnish construction has typically a ventilated façade with an exterior brick or tile surface. All the surveyed Finnish building had already an insulation in between the construction. So if you modernize one of Austrian building a thermal insulation composite system with a plastered surface is the typical way to improve the energetic quality. Because even before modernization there is no rear-ventilation the insulation is fixed with some glue and drilling anchors.

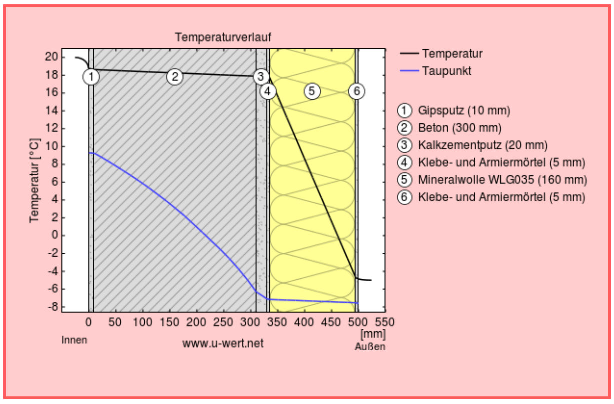
In Finland, if you want to improve the heat transmission resistance and therefore lower the thermal transmission coefficient of a new rear-ventilation façade surface, you can choose several ways. In this research the typical way is, to dismantling the facing layer and to double or exchange the existing insulation with new thicker insulation up to 16 cm and build up the facing layer new or partly plastering it. So at least you need more effort in Finland for the dismantling and in the case of a new rear-ventilated facade for the new building up.

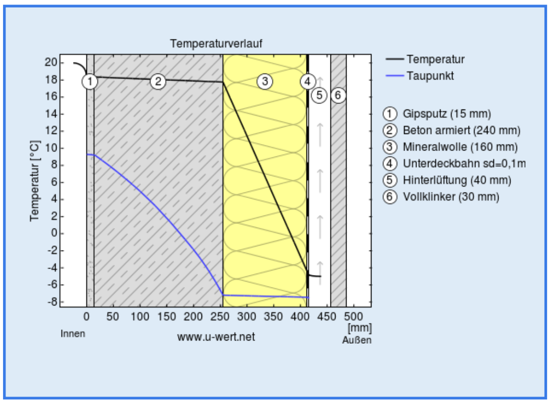
The different ways are shown in the simplified diagram below.





Typical (simplified) exterior wall construction in actual state





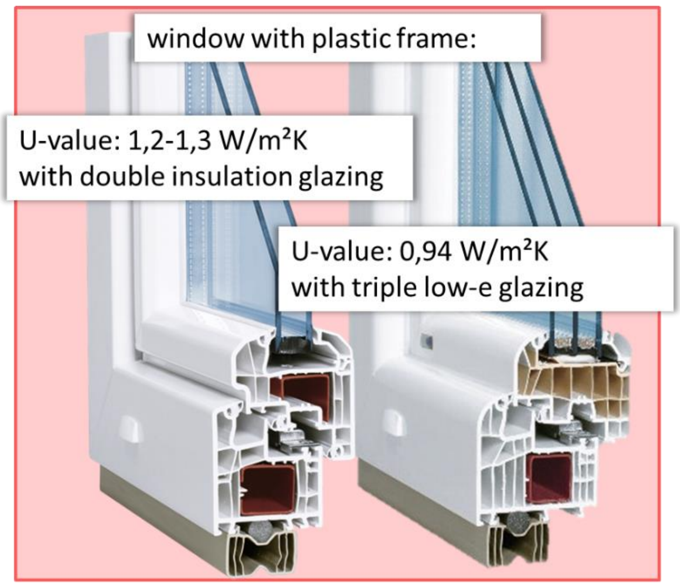
Typical (simplified) exterior wall construction after new insulation/refurbishment

Picture 12: Typical wall construction before and after modernization in Austria (left, RED) and Finland (right, BLUE)

If you plan both of the above shown renovations with epiqr®, the Finnish end up on average at 220 €/m²-façade (with dismantling, demolishing and rebuild of a thin new facing layer). If you compare it to the insulation composite system with plastered surface and same energetic standard, it costs on average just around 150€/m². In Finland this seems to be a bit cheaper to build this rear ventilated version. It is never the less more expensive than the Austrian composite version with around 195 €/m² without scaffolding (according to position costs of the cost estimation of Palkkatilankatu).

Another fact to take into account is the typical type of windows before renovation. While the Austrian buildings have mainly plastic windows (since they were already changed). The Finnish windows where mostly out of the building year and a wooden construction. If you would plan a new window in Austria the cheapest and therefore most common way would be a plastic window with a two layered low-e glazing, which would end up in an U-value of 1,3 W/(m²K). If you need a higher energetic quality you would plan with a special plastic frame and a three layered low-e glazing. To build box typed windows, like in Finland with two frames is just typical for some historic monuments.

The position costs from the cost estimation of windows (dismantling and new construction) between Naapuripellontie and Palkkatilankatu per m² is very big. It seems even if both are MSE windows with quite similar demands the costs have a range between 450 and 715€/m² window area. For the Austrian standard epiqr® provides around 440€/m² (in wood it would extend to 470€/m²). If you build in a high insulation window with three layered glazing you would end up at an additional 130€/m² window area.



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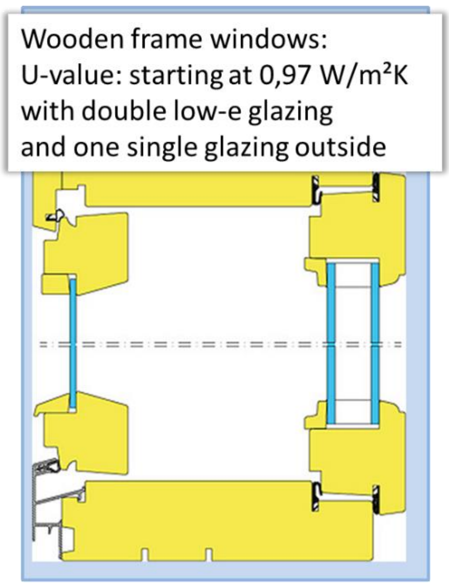


picture:
http://www.alavusikkunat.fi/en/windows/openable/wood-window/mse-2-1

Picture 13: Comparison of Austrian (RED) and Finnish (BLUE) window constructions.

The analysis of one representative apartment was quite similar for both countries. There were just a few differences in the typical design of the bathrooms visible which may end up to be more of effort in Finnish buildings.

Picture 14: Constructions in Finnish apartments that are usually not found in Austrian apartments.

More differences were found in the technical equipment of the building. Starting with a difference in the low voltage use. While the Austrian buildings has a central bell system, this is not usually in Finland. In the apartment door we found in both countries still some ones with postboxes. But in Austria you do not use these postboxes anymore, because there is a central postbox element next to the entrance door. In Finland they are - next to decentral apartment bell system - still in use and are planned in the same way for new buildings too. But to keep the construction soundproofing and a good fire protection the apartment door is out of two door leaves – one on each side of the frame. Due to the fact that the Fi- buildings have no central bell system and door open utility, the entrance door to the staircase is during daytime open or you can access with a code. Otherwise you need to have a key to open it.

The comparison of the different system showed that in the end the costs are quite equal in both countries.

Picture 15: Different typical constructions in Austria (RED) and Finland (BLUE).

Similar is, that all the buildings are connected to a district heating system, with the difference that the Finnish systems provides also hot water while the Austrian buildings have decentral electric heating supplies in the apartments.

Big differences were found in the building site equipment and scaffolding. Finnish site equipment together with the scaffolding seems to cost up to 8 times the costs of Austrians. The reason is, that in Austria, most time there is just a mobile electrified toilet and a quite simple scaffolding with a simple ladder. In Finland it’s more common to have real stairs and electrified containers with bathroom utilities and so on.

Picture 16: Differences in scaffolding and building site in Austria (RED) and Finland (BLUE)

It’s conceivable that this is even more important for new buildings, where the hold-off times are longer than in the refurbishment and you need further equipment.

And there are even a few facilities which are not common a residential buildings in Austria and therefore could not been taken into account with epiqr. The common spaces in Fi- buildings seem - according to the above shown relation between rentable floor space and gross area quiet similar-, but, the usage is very different. In Austria you have big storage areas and probably a drying room and in Finland this sizes are probably smaller but you have common Saunas and common living rooms or even a swimming pool.

Picture 17: Different use of the common areas in Austria (RED) and Finland (BLUE).

Because of the Fi-regulations residential buildings must have a bomb shelter. This installation is not (anymore) mandatory in Austria and therefore not common. Because you can use them as a storage room as long as there is no evacuation, it does not cost too much additional money in the maintenance but if you have to repair some special utility like the ventilation system we find costs, that don't occur for Austrian buildings.

In the overview you can mainly summarize following differences in the actual state

Finland	Austria
Mainly flat roofs	Pitched roofs
Rear-ventilated insulated façade	Façade without thermal insulation
Old wooden windows (but with three single layered glasses)	Windows mainly <15 year, plastic framed and with two layered isolation glass/low e-glass.
Central heat preparation	Decentral boilers in the apartments
Decentral bell and post box in apartment door	Central post box and bell system
Common Sauna and bomb shelter	Big storage/drying rooms.
High demand on site equipment and scaffolding	Simple site equipment and scaffolding

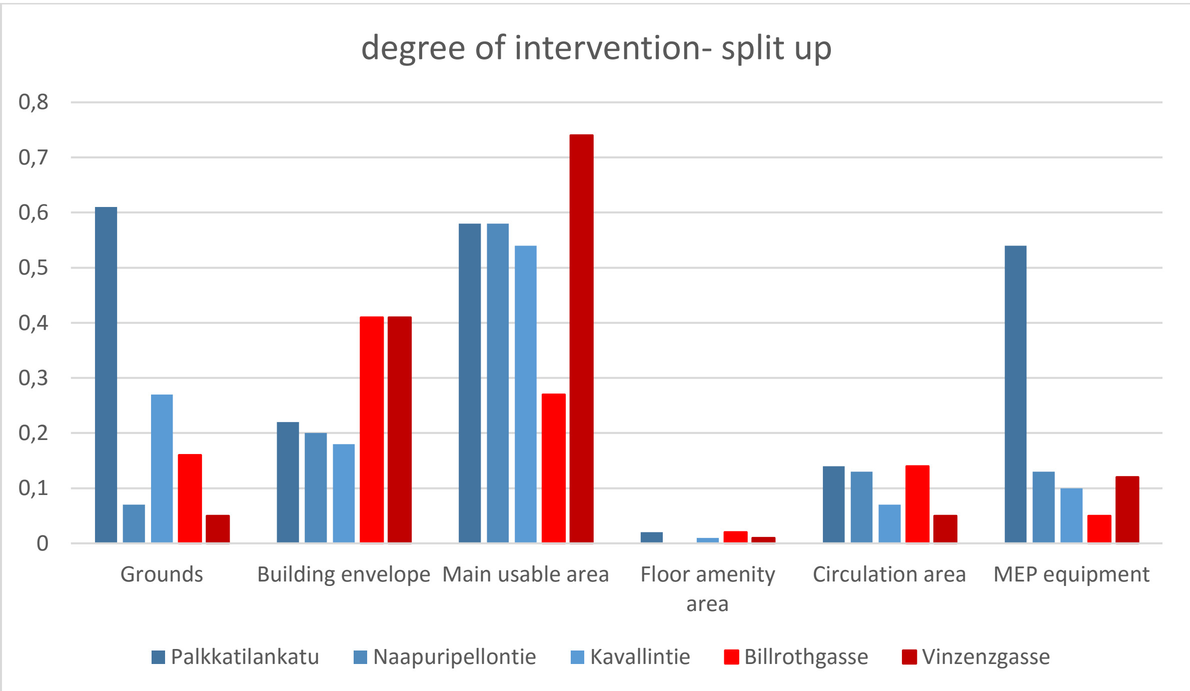
Table 3: Overview of differences found between Austrian and Finnish buildings.

3.2. Fi-At differences in the rating and state

If we look at the actual state of the buildings, we see no difference on the first view. All the buildings are in use and are maintained continually and between 0,20-0,33 in the range of intervention.

Picture 18: Comparison of the degradation state of Austrian buildings (RED) and Finnish buildings (BLUE).

If you look at it in the detail, and split up the degree of intervention to the building components you can identify, that there is a higher split between individual buildings in one country than between the two countries in general. Just the cost for the building envelope varies significantly between the counties. This is caused by the differences in insulation standard. While the Finnish buildings had already some insulation in the 80ties. In Austria it was not common to have up to 8cm insulation till the mid of the 90ies. Even that the windows are mostly changed in Austria cannot compensate this big difference in the degradation of the actual state (before renovation).



Picture 19: Comparison of degree of intervention grouped by building components.

If you compare the state of intervention with the costs per square meter you see, that even if the state of the very cost intensive part of the thermal envelope is in Austria in a worse state, the average costs per square meter rentable area in the actual state for the Finnish buildings with Austrian epiqr® costs would be 10% higher than the Austrian buildings. Reason for this differences may be, that in Finland the more cost intensive elements and element types (recording to Austrian price level) are chosen. As shown later on the example of the exterior wall and the windows.

But more important than the actual state is the planning for modernization. Therefore two different scenarios are planned for the Finnish buildings. One just like you would plan it probably in Austria (on basis of epiqr® data), if you have exactly this building. The second one with the Austrian costs and modelling as much as possible the Finnish planed refurbishment. Source for the Finnish planed actions where from the survey, the cost estimation of the Finnish objects (as far as it was possible because of the language barrier) and a request sheet for each building.

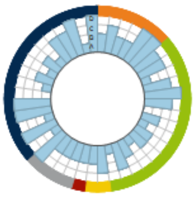
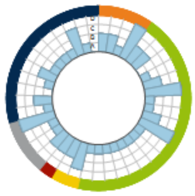
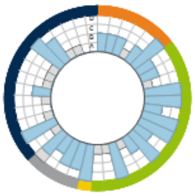
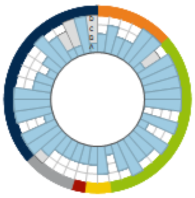
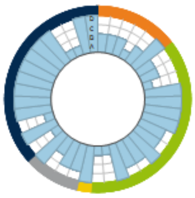
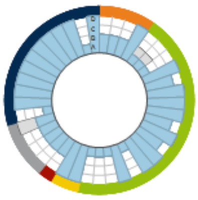
4. What would change if you place the Finnish buildings to Austria?

It should be investigated, if an identical building causes different cost in different countries. Therefore, we first compare the typical modernization measurements for the Finnish building according to the typical Austrian modernization and the typical Finnish modernization. In the next step the Finnish measurement page (of epiqr) will be compared with the real Fi-estimated costs. That will allow to identify differences in the Finnish and Austrian costs.

4.1. Fi-At differences in the predicted actions

The scenario for modernization is planned in the Finnish and the Austrian way, all with the epiqr® costs for Austria. In comparison to the actual state this increases the cost per m² for every variant, because more action need to be done in the real refurbishment. For example, if you need a new insulation on the exterior walls you may need also a new façade-covering, even if the actual state of the covering is good.

These changes in the overview are shown by the following graphic.

Palkkatilankatu	Naapuripellontie	Kavallentie	Billrothgasse	Vinzenzgasse
Actual state				
				
Degree of intervention				
0,33	0,23	0,20	0,26	0,33
Costs per m² rentable area [€/m²]				
522	374	278	426	477
Modernization scenario planed like in Austria (according to epiqr)				
				
Costs per m² rentable area [€/m²]				
767	594	358	525	477
Modernization scenario planed after Finnish intend (with epiqr elements)				
				
Costs per m² rentable area [€/m²]				
761	876	1048		

Picture 20: Cost comparison for different modernization scenarios.

The main difference between the planned scenarios in Austria and Finland is the fact, that in the scenario planed according to Austrian rules, the Finnish buildings would not get a new insulation, because the insulation in the actual state is sufficient for the Austrians point of view (for refurbishment – of course also for modernization additional insulations is used in Austria). But for Palkkatilankatu we assumed to plan the renewing of the elevators and renew the apartments completely. Thus the costs per m² are for both scenarios quite the same but include different actions. In the second building Naapuripelontonie the main differences between the costs are from the technical installations (inter alia the new ventilation system). Here no renewing of the insulation is planned and so the difference between the scenarios planned in Austria and the scenario planed in Finland is not as far away, as in the third case, where the complete façade gets a new insulation in the Finnish way. So, in average the planned (real) refurbishment in Finland in comparison to the suggestion by epiqr® for Austria causes 80% more funding costs.

4.2. Cost comparison for the Fi-way of modernization

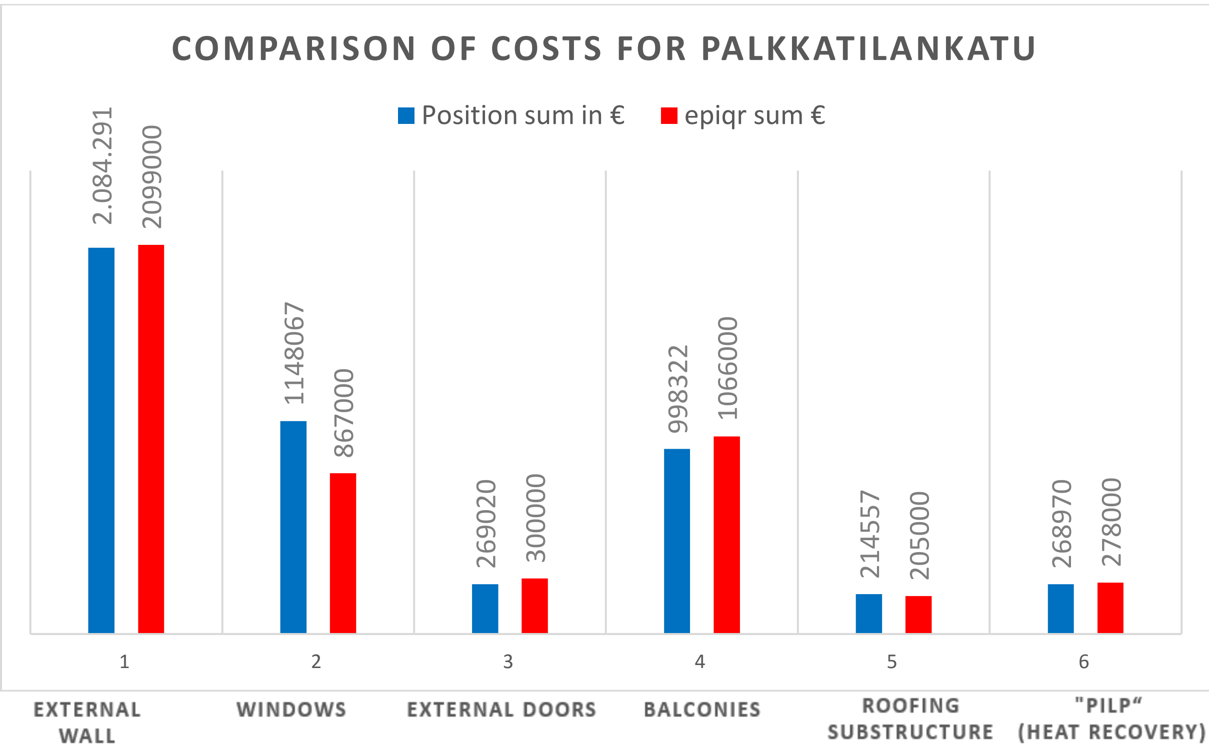
In the first view the sum of position costs are compared with the epiqr® costs for the same positions calculated in elements.

Building	Invoice: Position sum	Estimation: Position sum	epiqr for At (just 11 to 25)
Palkkatillankatu	4.300.000	6.202.348	6.000.000
Naapuripellontie	6.200.000	6.579.608	6.800.000
Kavallintie	2.600.000	(not available)	3.780.000

Table 4: Comparison of cost.

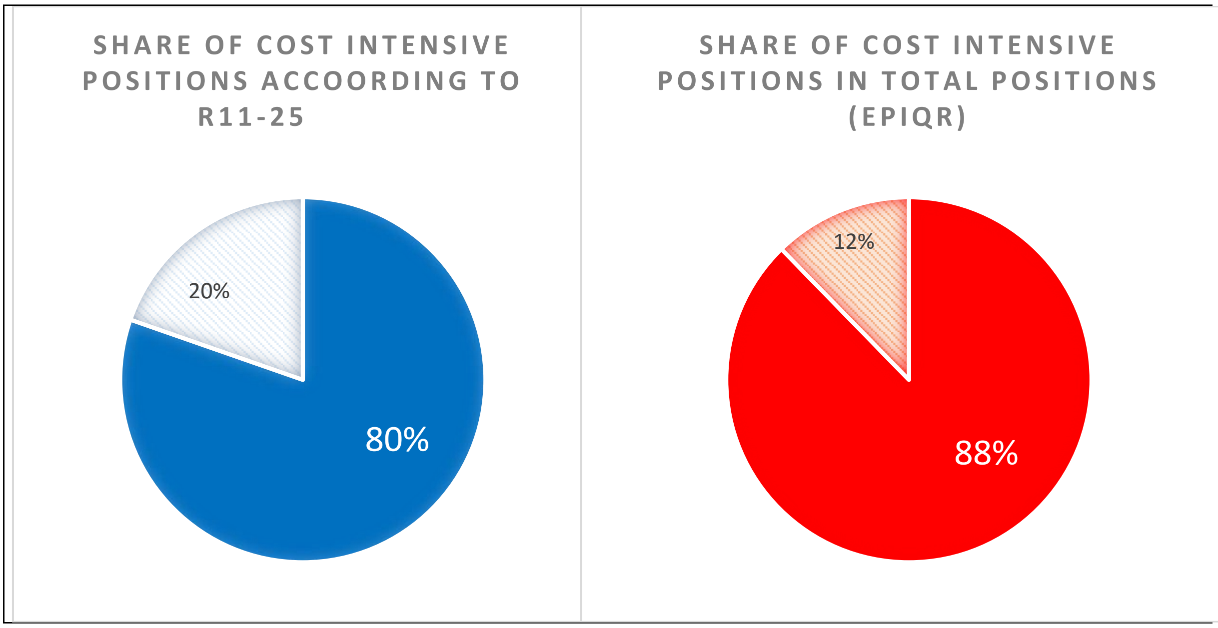
On the overview table shown above sometimes epiqr costs seems to be cheaper and some time the Finnish estimated position sum is cheaper. As shown before the Invoice Position sum of Finland are not reliable, because probably some positions are missing so the invoice position sum shows more a minimum cost level than a complete calculation.

While the position costs in sum are quite similar, a further view into single or a few summed-up positions is made for the buildings were the detailed cost estimation were available. Starting with the comparison of Palkkatillankatu (according to the RA-O of cost estimation) it could be seen very fast, that the most cost intensive elements are the same than the ones shown with the cost estimation in epiqr. And these most cost intensive six positons end up to contribute around 80% of the costs. If we compare them to the costs calculated in epiqr, we realize, that they are pretty much the same.



Picture 21: Comparison of epiqr® and Palkkatilankatu cost.

The differences in the windows cost can be explained because of the different construction (as shown before). All other cost show a difference of less than +/- 10%. **This is a very good proof that the epiqr® methodology can be applied also in Finland without major changes.**

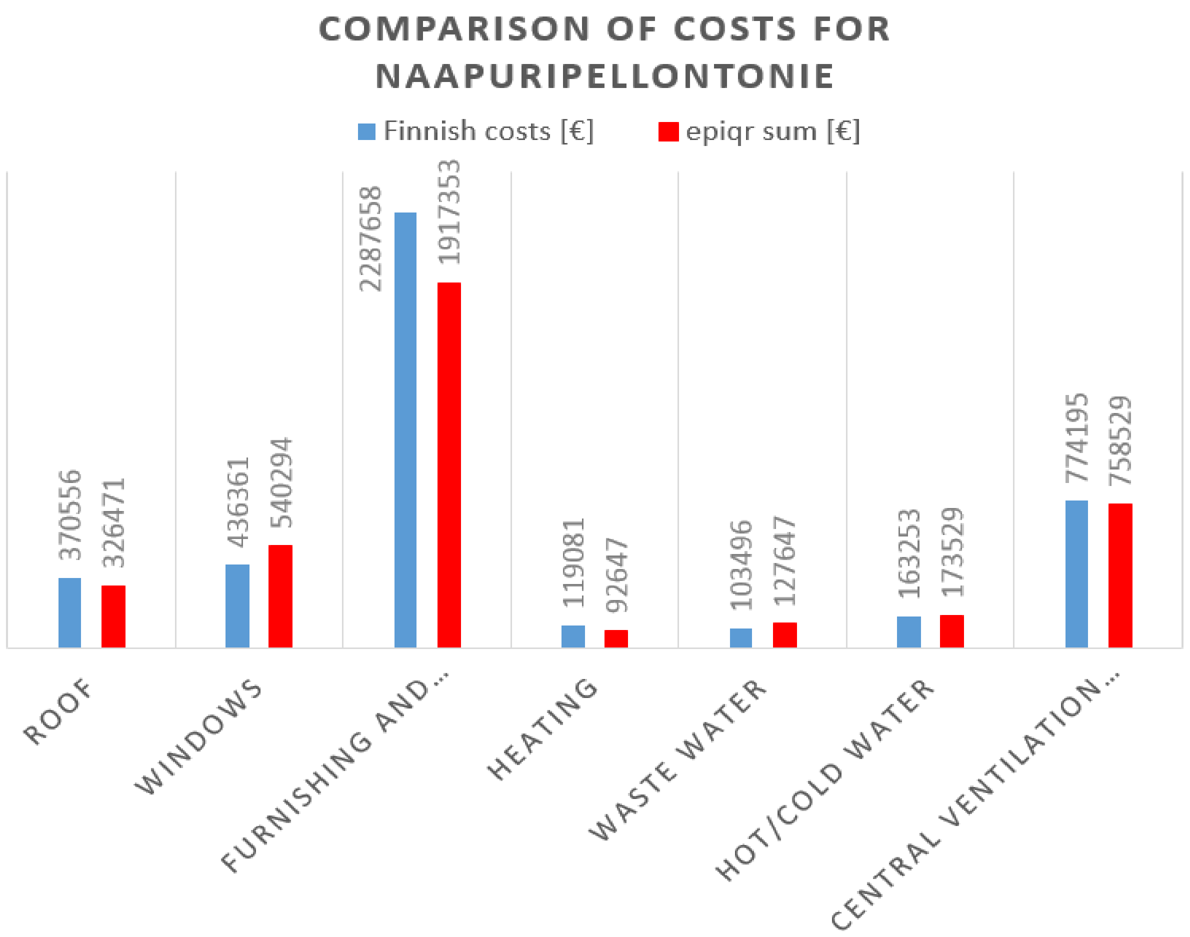


Picture 22: Comparison of the share of the most cost intensive positions in Finland and in the epiqr® system.

According to the Finnish calculation the 6 most cost intensive positions contribute to the total cost with 80% while these positions contribute with 88% in the epiqr® system. The difference is caused by the fact that in the Finnish estimated positon sum also the renovation of the Sauna took part, while this higher costs were not planable with epiqr®.

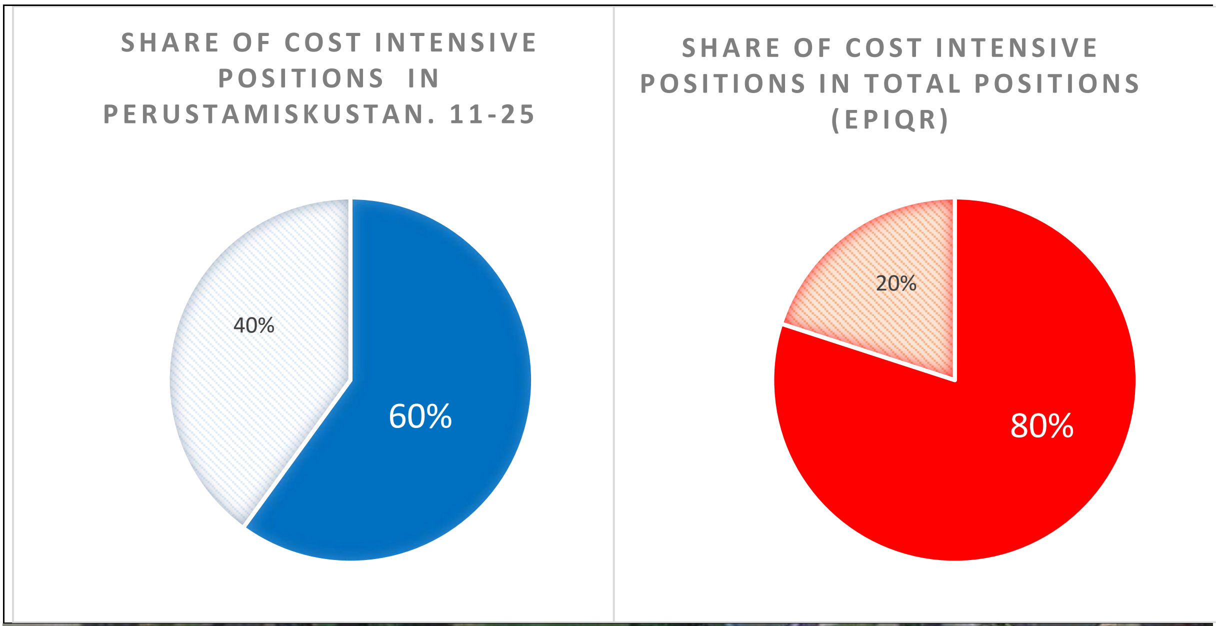
In the addition to Palkkatilankatu we can compare with Naapuripellontie the costs for interior works, like the refurbishment of surfaces and the equipment and the different technical installations, because this is the main focus of the renovation in the building.

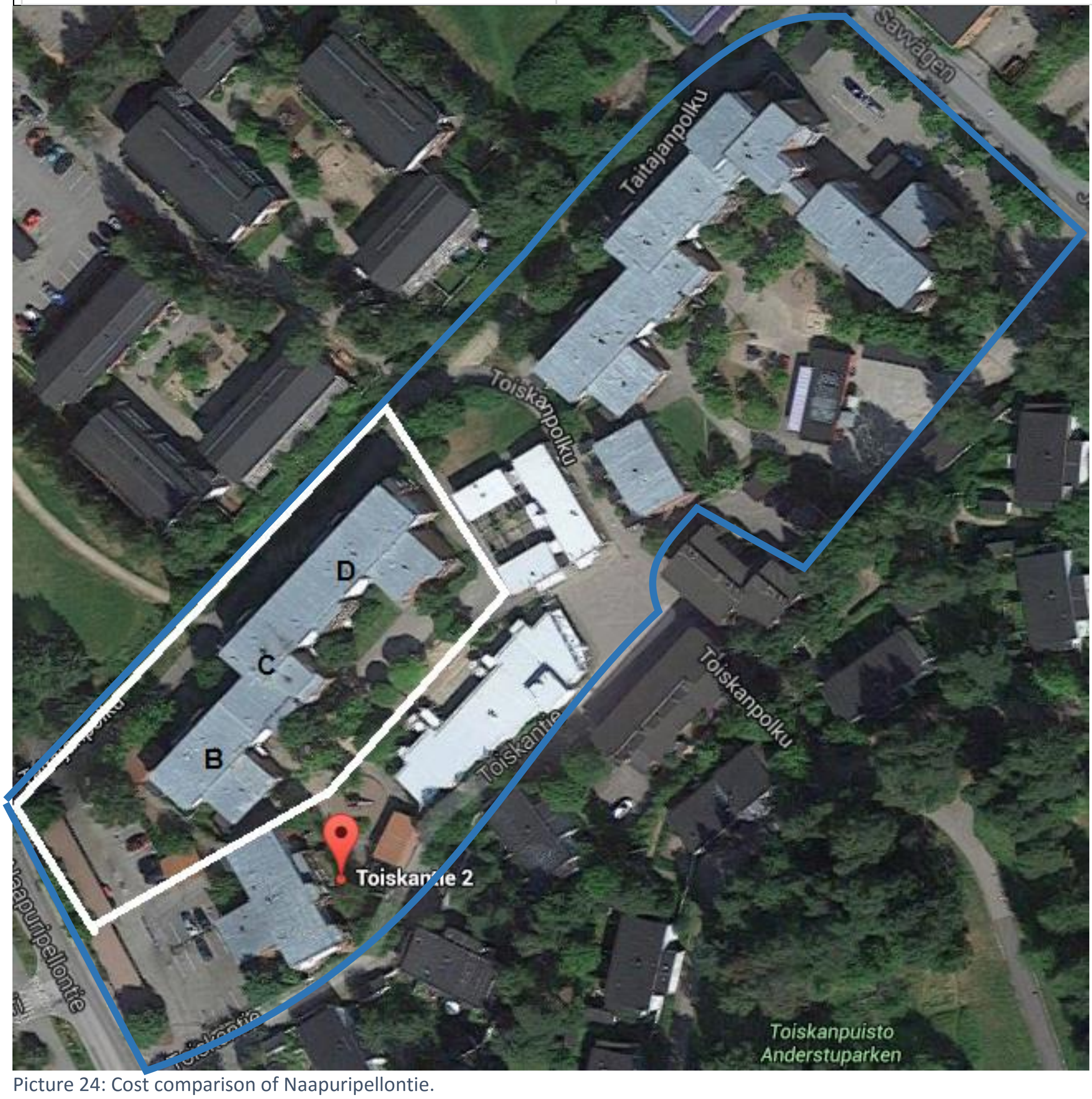
Because of the different ways of summing up, we cannot compare all the different positions of "Perustamiskustannukset" of Naapuripellontie in single positions, but we summed up all the positions which are take part in the interior works (furnishing and indoor surfaces) and compared them with all costs epiqr provides for the different indoor areas. As a result, the Finnish cost estimation would be 20% more expensive. The same summary strategy was used for the comparison of the ventilation system and the elevator because technic and related restructuring are shown in different positions and finally end up with the following cost comparison:



Picture 23: Comparison of Finnish cost and epiqr® cost for individual interior building components.

In Naapuripellontie more small cost positions were available, the seven most cost intensive points are shown above. The reason why the costs for the furnishing and indoor renovation are nearly 20% higher could be caused by the higher effort for the common spaces (as shown before). But in the sum of the compared costs of 11-25 of the "Perustamiskustannukset" of Naapuripellontie are less than 10% higher. This can again be argued with the higher effort for the Sauna and related facilities and the higher effort for the bathroom installations in the apartments. The remaining differences are partly caused by some renovation of the bomb shelter and the renewing of the environment (e.g.: hardscapes) which were not planned in detail, as just a part of the apartment complex was surveyed and an extrapolation for the exterior area hadn't be done separately.





Picture 24: Cost comparison of Naapuripellontie.

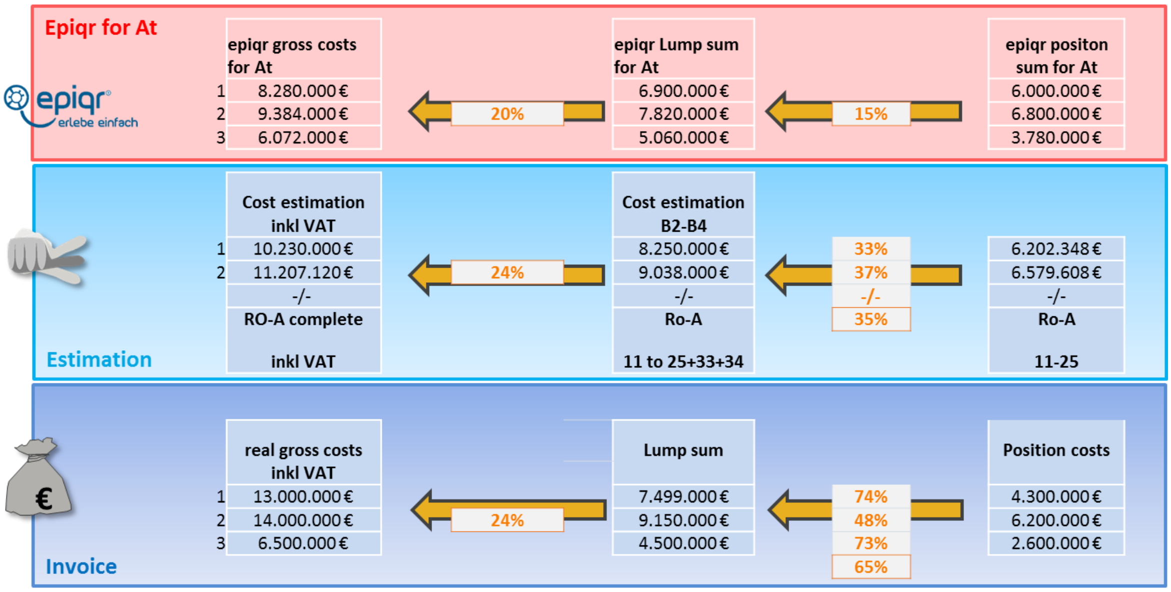
There are only a few missing elements that regard the Finnish local characteristics, like shown before (e.g. scaffolding, the MSE-windows, sauna areas, bomb shelter and special fittings) that are not yet covered by epiqr®. All other building components are already covered and epiqr® is able to estimate the Costs of 11-25 very well.

4.3. Fi-At cost differences in planning management and site service

If we compare the Austrian (on basis of epiqr) and the Finnish costs (delivered from cost estimation) for the same buildings as far as possible into the details, we see not one big difference in the main causing position cost of the refurbishment.

But in difference to the Austrian way, a lot of additional costs are coming on top to the position costs. Epiqr® estimates the additional costs for managing the building process and material in typical cases with 15% on top of the Position costs. Costs like the transportation and scaffolding are already part of the calculated unit costs or a position for its own and does not need to be assumed later.

The complete "sum up" for the lump sum is shown in the diagram below. According to cost estimation therefore costs get because of the management and site service positions around 20% higher than the Austrian ones.



Picture 25: Comparison of cost according to epiqr and Finnish estimations and invoices.

One point which can cause this difference in planning costs is the different type of allocation the building contractors and the trades. In Austrian project partners divide into different trades and allocate the trades each for itself by their own. But in Finland normally the whole renovation is allocated to one company (main contractor) who controls and organizes further contractors for single trades or works himself. Which way is the more cost efficient way could not be found in this research, there are too much factors which were not able to be examined here. You have to take a further view at the renovation time, the manpower of the housing association and you need to study how you can calculate the additional costs down to the position costs for Finland or out of the position costs for Austria.

5. Conclusion and further impulses

If you compare just the costs for Fi measures, you see values in the same range for the Position costs. Beside a few missing special elements (Sauna, bomb shelters, etc.) epiqr® can be applied in Finland at full customer satisfaction.

Cost differences were analyzed in different dimension. First it was shown that in the surveyed buildings different construction elements according to their country specific habits are used. Here especially the windows and exterior walls lead up to high differences in effort and cost. If you keep in mind the last shown comparison of the additional management costs coming on top of the unit costs the Fi-positions will even get more expensive but it also is shown that Finland has often a higher standard. As example a linear upscaling for the windows is done in the table below.

Cost origin	Unit costs	Add. cost-%	Scaled unit costs	Average unit costs
Palkkatilankatu	715 €/m²	33	950 €/m²	780 €/m²
Naapuripellontie	450 €/m²	37	616 €/m²	
Epiqr® (same U-value)	600 €/m²	15	690 €/m²	690€/m²

Table 5: Upscaling of cost for windows.

The degree of interventions showed that the state of all buildings is similar. If you divide it into different components you see a better state for the Finnish buildings. Main reason is that insulation in Fi-buildings were already obligatory in the building year. The insulation standard of Finnish buildings would be still satisfactory in Austria. On average the Finnish modernization measure with Austrian prices are 55% more expensive than the measure-package for Austria. To make a reliable research in this field more buildings need to be taken into account. The age of the building should be as similar as possible and for each building a real renovation should be planned - then it would be more reliable to compare the differences in measure.

The additional management costs and fees need to be adjusted because there we see the main difference of in total average 25%. There is a need for a deeper study of construction management costs and their origin, as these could be distributed to single cost positions and the reasons could be studied more in detail. One scope of a further analysis could be to examine the contract process between the countries in detail. In Austria you have a lot of competitive because of the smaller amount of working packages which are tendered by the housing owner. It is possible that the contest between the contractors is higher than because more building companies are able to make an offer.

Even if both countries are on a similar state of development and living comfort there are differences caused by the environment which need to be analyzed in detail. There are probably reasons why Finnish concrete garage floors have not coating, why a rear-ventilated exterior wall is planned or why the purposed energetic quality of the exterior envelope is different. We need to identify and understand first the reason before we can recommend another way of doing it. As shown before a lot of challenges in building and refurbishing houses are solved in both countries in a different way (e.g. windows, walls). These might be imitable but demands may not be the same. Building of them are existed because of the specific advantages and possibilities which are unique. So if you want to compare costs of different construction elements you have to take into account if the material and the way of construction is available in the other country and how often it is used and if it really causes the complete same function.