

Universidad Politécnic de Catalunya  
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# **Sustainability Assessment Model of Mass Housing's Interior Rehabilitation**

**Economic, environmental, and social impacts of interior rehabilitation scenarios in Iranian MHs. The case  
of Ekbatan, Tehran, Iran**

## **Appendix**

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## **APPENDIX OF CHAPTER 3**

**A novel model for sustainability assessment of MHS' interior rehabilitation in Iran**

## Appendix of chapter 3

### Appendix 3.A. Experts' panel qualification

According to the defined set of specific expertise requirements – see section 3.2 –, the author, first, created a list of qualified experts with the specific expertise requirements. Secondly, based on the defined relative point system – see table 3.1 –, fifteen experts who had achieved more than 30 points were selected as the final expert panel members as indicated in Table 3.A.1.

Table 3.A.1. The qualified experts based on the defined set of specific expertise requirements and relative point system

Experts' No.		Professional address or resume	Advanced degrees		Years of experience			Sustainability expert	Book	Journal article	Patent	Licensed Architect			Building construction regulations	MH regulations	Architectural prize	Interior designing or retrofitting project	New construction materials or techniques	Total score
			Master	PhD	Academia	construction	Municipality					First	Second	Third						
1	Hamed Banirazi Mojdagh	University Polytechnic of Catalonia (UPC)	2	-	0.5	15	8	2	-	-	-	5	3	1	3	3	5	1.5	4	44.5
2	Noordin Abohasani	Tehran University of Art	2	-	1	8	-	2	-	3	-	-	-	1	3	3	-	13.5	4	40.5
3	Rima Fayyaz	Tehran University of Art	-	4	9.5	0	5	5	3	8	-	5	-	-	3	3	-	-	4	49.5
4	Amin Hosseini	University Polytechnic of Catalonia (UPC)	-	4	2	12	-	5	3	4	-	-	3	-	3	-	5	3	-	44
5	Sina Memarian	Tehran University	2	-	-	9	-	5	-	3	-	-	3	-	3	-	-	12	4	41
6	Hamed Kamelina	Ferdowsi University of Mashhad	-	4	6.5	14	-	5	3	2	-	5	-	-	3	-	5	15	4	64.5
7	Mohammad Kharrazi	Cofounder and Chief Executive Officer at SEPID Group	-	4	5	21	4	5	3	2	-	5	-	-	3	-	-	13.5	4	67.5
8	Iman Khayat	Tehran University of Art	2	-	1	10	1	2	-	4	-	-	-	1	3	-	5	9	4	40
9	Leila Nikmunesb	Ferdowsi University of Mashhad	2	-	-	6	8	2	-	1	-	-	3	-	3	3	-	6	-	34
10	Mostafa Habibi	Tehran University	2	-	-	6	2	5	3	1	-	-	-	1	3	-	-	4.5	4	31.5
11	Oriol Pons	University Polytechnic of Catalonia (UPC)	-	4	6	13	0	5	3	12	6	-	-	-	-	-	-	7.5	4	60.5
12	Ali Schizadeh	Concordia University Montreal	2	2	2	7	0	2	-	1	-	-	3	-	3	-	5	7.5	4	36.5
13	Ali Omid	Tehran University	2	-	-	8	-	5	-	3	3	-	3	-	-	-	-	9	4	37
14	Mojaba Mahdaviinia	Tehran University of Art	-	4	7	-	-	5	1	7	-	5	-	-	3	-	-	12	4	48
15	Ahmad askari	Tarbiat Modares University	2	-	1	8	-	2	-	3	-	-	-	1	3	3	-	12	4	39

It is worthy to mention that since the Delphi questionnaire was conducted in April 2020, the obtained scores by experts belong to the mentioned period.



## Appendix 3.B. Value function of the defined indicators

### 3.B.1. Value function of $I_1$ . Initial rehabilitation cost

In the case of Indicator  $I_1$ , to determine **the tendency** of the value function, as long as satisfaction decreases if the rehabilitation cost increases, this indicator has a **decreasing tendency** value function.

Also, **the minimum and maximum** ( $X_{min}$ ,  $X_{max}$ ) rehabilitation cost in terms of €/m<sup>2</sup> were determined after over-viewing the **costs of 17 different rehabilitated projects in Ekbatan, the annual report of the Central Bank of Iran** ([https://www.cbi.ir/default\\_en.aspx](https://www.cbi.ir/default_en.aspx)), **the market values of the residential rehabilitation projects in Tehran** (<https://khedmatazma.com/subservice/building-repairs-and-reconstruction>, <https://seaart.ir/>, <https://sanjagh.pro>, [https://www.jadvalzarb.com/base/tools\\_119](https://www.jadvalzarb.com/base/tools_119), <https://www.arianparax.com/>), and **consulting with constructors and construction practitioners**. According to the abovementioned data, the rehabilitation cost in terms of €/m<sup>2</sup> for a residential building in Tehran has been reported between 50 €/m<sup>2</sup> –  $X_{min}$  – to 200 €/m<sup>2</sup> –  $X_{max}$ .

Moreover, as **the rehabilitation cost is significantly important** for the owners and has a **direct effect on their decisions** on whether or not to rehabilitate their apartments (Ahmad & Thaheem, 2018), the objective is to reduce this cost. In other words, **small changes in the rehabilitation cost cause significant differences in the owners' satisfaction**. Regarding all the above-mentioned points, as this indicator is **crucial**, the shape of its value function has been defined as **convex**.

To determine the value function **parameters**, national guidelines and reports like the report published by **the Central Bank of Iran (CBI)** besides the **Housing Rehabilitation Loan Programs (HRLPs)** offered by the government, banks, and private financial entities have been over-viewed. According to the **CBI's report (2018-2019)** ([https://www.cbi.ir/default\\_en.aspx](https://www.cbi.ir/default_en.aspx)), **the average rehabilitation cost** for a residential building in Tehran has been reported as 125 €/m<sup>2</sup>. Also, the **HRLPs** have a significant impact on stakeholders' decisions regarding rehabilitation or even their satisfaction with rehabilitation costs. These HRLPs help owners to provide rehabilitation costs up to 105 €/m<sup>2</sup> with a low interest of 9% – in comparison with the average other loans' interest of 29 % in Iran – with a payback period of 3 to 5 years. Therefore, as the value function was convex, a P value higher than 1 has been defined as P = 2, and K = 0.05. Also, according to the mentioned report and loan programs, the value of C has been adopted as the average of these two amounts which is equal to C=115. The shape of the value function of the  $I_1$  is shown in **Figure 3.B.1**.

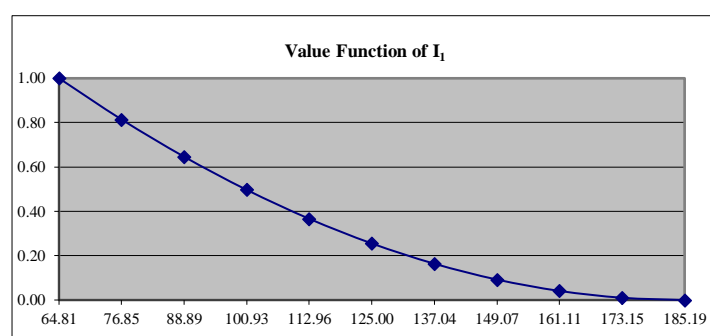


Figure 3.B.1. The value function of  $I_1$

### 3.B.2. Value function of $I_2$ . Maintenance cost

In the case of  $I_2$ , as same as  $I_1$ , **the tendency** of the value function is **decreasing** because as long as the costs increase the satisfaction decrease.

Also, after over-viewing the **costs of 17 different rehabilitated projects in Ekbatan, the market values of the residential building maintenance in Tehran** (<https://khedmatazma.com/subservice/building-repairs-and-reconstruction>, <https://seaart.ir/>, <https://sanjagh.pro>, [https://www.jadvalzarb.com/base/tools\\_119](https://www.jadvalzarb.com/base/tools_119), <https://www.arianparax.com/>), and **consulting with constructors and construction practitioners**, the maintenance cost over 50 years of

building lifespan in terms of  $\text{€}/\text{m}^2 \cdot 50\text{yrs}$  for a residential building in Tehran has been reported between  $70 \text{ €}/\text{m}^2 \cdot 50\text{yrs} - X_{min}$  to  $200 \text{ €}/\text{m}^2 \cdot 50\text{yrs} - X_{max}$ .

Moreover, as **the maintenance costs are important** for the owners and allow them to **control their expenses during the building's lifetime**, the objective is to reduce these costs. Therefore, the shape of this value function has been defined as **convex**. In this regard, the lowest costs are demanded to obtain higher satisfaction.

To determine the value function **parameters**, as the value function was convex, a P value higher than 1 has been defined as  $P = 1.5$ ,  $K = 0.1$ . Also, according to overviewing the 17 different rehabilitated projects in Ekbatan (Aleph-1) and the market values of the residential maintenance in Tehran, the value of C has been adopted as  $C = 135$ . The shape of the value function of  $I_2$  is shown in [Figure 3.B.2](#).

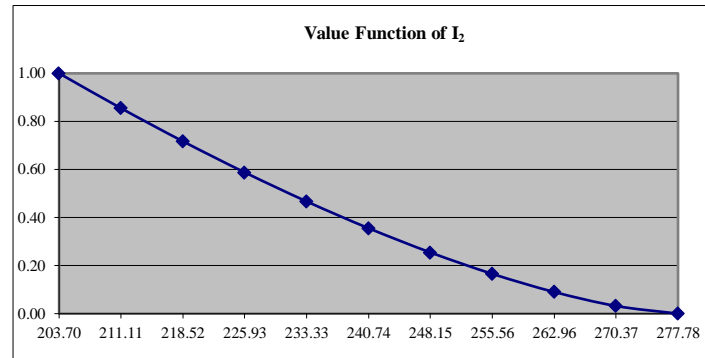


Figure 3.B.2. The value function of  $I_2$

### 3.B.3. Value function of $I_3$ . Demolition cost

As same as the two previous indicators, the value function **tendency** of  $I_3$  is **decreasing** because as long as the costs increase the satisfaction decrease.

Also, after overviewing the **different rehabilitated projects in Ekbatan** and **consulting with constructors and construction practitioners**, the **minimum and maximum values** ( $X_{min}$ ,  $X_{max}$ ) of  $I_3$  have been reported as 8 and 12  $\text{€}/\text{m}^2$  respectively.

Moreover, as the demolition cost has a smaller contribution regarding the rehabilitation and maintenance costs, this indicator has less importance and its value function shape has been defined as **concave**. Therefore, **as decreasing concave value function** has been assigned to the  $I_3$ , it is not necessary to have the lowest demolition costs to achieve higher satisfaction.

Since a concave shape has been defined for the value function in the previous stage, a P value lower than 1 should be assigned. In this regard, the values  $P = 0.7$ ,  $K = 0.15$  and  $C = 10$  have been adopted. The shape of the  $I_3$  value function is presented in [Figure 3.B.3](#).

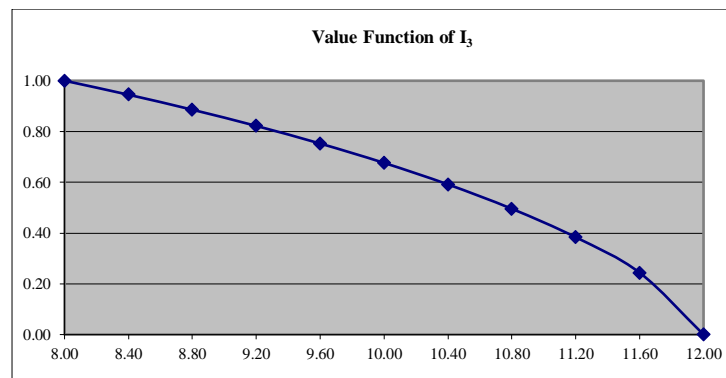


Figure 3.B.3. The value function of  $I_3$

### 3.B.4. Value function of $I_4$ . Property added-value

Since there is a direct relationship between the property added-value and owner's satisfaction, the value function tendency of  $I_4$  is **increasing**.

Also, after **consulting with 9 real estate experts/agencies in Ekbatan** and overviewing **four real estate websites** in Iran (<https://ihome.ir/>, <https://kilid.com/>, <https://shabesh.com/>, <https://divar.ir/s/tehran/buy-apartment/>), the obtained prices of Aleph-1 apartments are from 92,259 € up to 118,333 €. Therefore, regarding the collected data, by interior rehabilitation of an apartment, its price can increase up to 26,074 € – the difference between the obtained minimum and maximum prices. In this regard, **the minimum and maximum values** ( $X_{min}$ ,  $X_{max}$ ) of  $I_4$  have been determined as 0 and 26,074 € for each apartment unit respectively.

Moreover, as **the property added-value is significantly important for the owners** and it is one of **the main reasons for rehabilitation**, the objective is to increase the mentioned value. Therefore, the shape of this value function has been defined as **convex**. In this regard, a higher property added-value is demanded to obtain a higher satisfaction

Since a convex shape has been defined for the  $I_4$  value function, a P value higher than 1 should be assigned. In this regard, the values  $P = 1.5$  and  $K = 0.10$  have been adopted. Also, according to the collected data from the real estate experts and websites, the value of C is adopted as the average of obtained amounts which is equal to  $C = 9017$ . The shape of the  $I_4$  value function is presented in **Figure 3.B.4**.

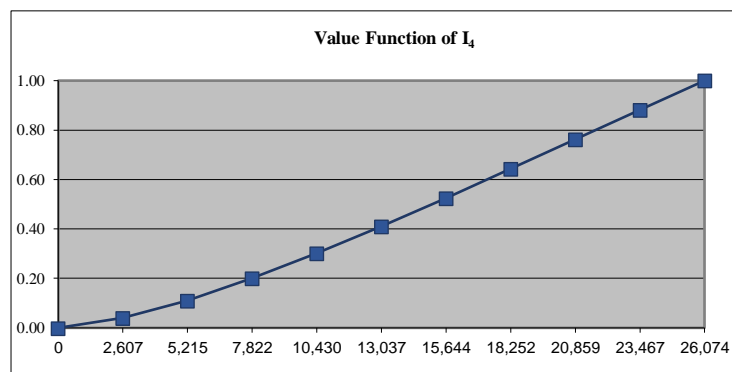


Figure 3.B.4. The value function of  $I_4$

### 3.B.5. Value function of $I_5$ . Rehabilitation process time

**The tendency** of the  $I_5$  value function is **decreasing** because as long as the rehabilitation process time increases the satisfaction decreases.

After overviewing the **rehabilitation process time of 17 different rehabilitated projects in Ekbatan** and **consulting with constructors and construction practitioners**, the **minimum and maximum values** ( $X_{min}$ ,  $X_{max}$ ) of  $I_5$  have been reported as 20 and 60 days respectively.

Since during the rehabilitation process the inhabitants should stay in another place for awhile, their satisfaction has a direct relationship with their expenses – e.g., renting another place to stay. As their expenses are constant and the rehabilitation process of the defined sample of the study – Aleph-1 with an area of 54 m<sup>2</sup> – does not take a long period, the satisfaction decreases steadily. Therefore, a linear function has been defined for this indicator.

To determine the value function **parameters**, as the value function is linear,  $P = 1$ ,  $K = 0$ , and  $C = 40$  have been assigned. The shape of the value function of  $I_5$  is shown in **Figure 3.B.5**.

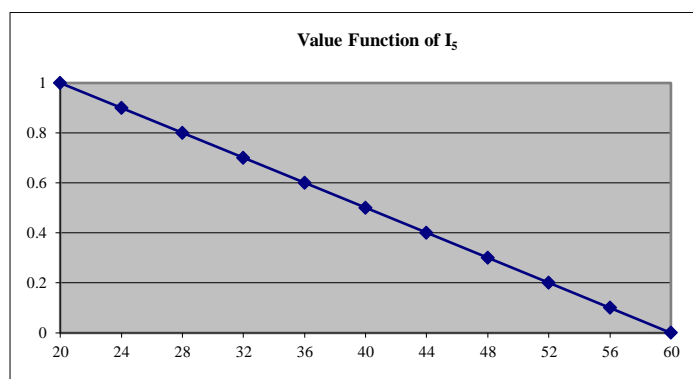


Figure 3.B.5. The value function of I<sub>5</sub>

Table 3.B.1. Values of the effective parameters for the value functions of each economic indicator

	Unit	Shape	X <sub>max</sub>	X <sub>min</sub>	C <sub>i</sub>	K <sub>i</sub>	P <sub>i</sub>	References
I <sub>1</sub> . Rehabilitation cost	€/m <sup>2</sup>	DCx	200	50	115	0.05	2.00	( <a href="https://www.cbi.ir/default_en.aspx">https://www.cbi.ir/default_en.aspx</a> , <a href="https://khedmatazma.com/subservice/building-repairs-and-reconstruction">https://khedmatazma.com/subservice/building-repairs-and-reconstruction</a> , <a href="https://seart.ir/">https://seart.ir/</a> , <a href="https://sanjagh.pro">https://sanjagh.pro</a> , <a href="https://www.jadvalzarb.com/base/tools_119">https://www.jadvalzarb.com/base/tools_119</a> , <a href="https://www.arianparax.com/">https://www.arianparax.com/</a> )
I <sub>2</sub> . Maintenance cost	€/m <sup>2</sup> .50yrs	DCx	200	70	135	0.10	1.50	( <a href="https://khedmatazma.com/subservice/building-repairs-and-reconstruction">https://khedmatazma.com/subservice/building-repairs-and-reconstruction</a> , <a href="https://seart.ir/">https://seart.ir/</a> , <a href="https://sanjagh.pro">https://sanjagh.pro</a> , <a href="https://www.jadvalzarb.com/base/tools_119">https://www.jadvalzarb.com/base/tools_119</a> , <a href="https://www.arianparax.com/">https://www.arianparax.com/</a> )
I <sub>3</sub> . Demolition cost	€/m <sup>2</sup>	DCv	12	8	10	0.15	0.70	( <a href="https://khedmatazma.com/subservice/building-repairs-and-reconstruction">https://khedmatazma.com/subservice/building-repairs-and-reconstruction</a> , <a href="https://seart.ir/">https://seart.ir/</a> , <a href="https://sanjagh.pro">https://sanjagh.pro</a> , <a href="https://www.jadvalzarb.com/base/tools_119">https://www.jadvalzarb.com/base/tools_119</a> , <a href="https://www.arianparax.com/">https://www.arianparax.com/</a> )
I <sub>4</sub> . Property added-value	€/m <sup>2</sup> .AU	ICx	26074	0	9017	0.10	1.50	( <a href="https://home.ir/">https://home.ir/</a> , <a href="https://kild.com/">https://kild.com/</a> , <a href="https://shabesh.com/">https://shabesh.com/</a> , <a href="https://divar.ir/s/tehran/buy-apartment/">https://divar.ir/s/tehran/buy-apartment/</a> )
I <sub>5</sub> . Rehabilitation process time	Day	DL	60	20	40	0.0	1.00	( <a href="https://khedmatazma.com/subservice/building-repairs-and-reconstruction">https://khedmatazma.com/subservice/building-repairs-and-reconstruction</a> )

Legend: DCx: Decreasing Convex; DL: Decreasing Linear; DCv: Decreasing Concave; ICx: Increasing convex; IL: Increasing Linear; ICv: Increasing concave; IS: Increasing S-shape; DS: Decreasing S-shape; AU: Apartment Unit.

### 3.B.6. Value functions of I<sub>6</sub>, I<sub>7</sub>, and I<sub>8</sub>. Embodied Energy (EE), Embodied Carbon (EC), and Embodied Water (EW)

The **tendencies** of the I<sub>6</sub>, I<sub>7</sub>, and I<sub>8</sub> value functions are **decreasing** because as long as these indicators' values increase the satisfaction decrease.

According to several studies (S. Bardhan, 2011; Suchandra Bardhan & Choudhuri, 2016; Choudhuri & Roy, 2015; Dilsiz, Felkner, Habert, & Nagy, 2019; Fernando & Ekundayo, 2018; Heravi & Abdolvand, 2019; Hu, 2020; Klemeš, 2015; McCormack, Treloar, Palmowski, & Crawford, 2007; Monahan & Powell, 2011; Syngros, Balaras, & Koubogiannis, 2017), a wide range of EE, EC, and EW values based on their adopted analysis method, research boundaries, type of buildings, geographic locations, and construction types have been reported. These studies revealed the EE values between 1300 to 7300 MJ/m<sup>2</sup>, EC values between 50 to 450 kgCO<sub>2</sub>/m<sup>2</sup>, and EW from 2000 to 5000 l/m<sup>2</sup> for rehabilitation of residential buildings for a study period of 50 years.

**EE, EC, and EW do not receive the necessary/adequate attention** from decision-makers in Iran. Also, due to the present economic situation of Iran, **the house owners prefer to choose materials with a lower price** to reduce the rehabilitation cost, and mostly **the environmental impacts of materials are neglected**. In this regard, **to start encouraging people and promote these issues, concave** value functions have been defined; which means small initial improvements are highly valued. Therefore, **as decreasing concave value functions** have been assigned to the I<sub>6</sub> to I<sub>8</sub>, it is not necessary to have the lowest impacts to achieve higher satisfaction.

Since convex shapes have been defined for these indicators, P values higher than 1 should be assigned. In this regard, the value function **parameters** for I<sub>6</sub>: P = 0.8, K = 0.1, and C = 3250; for I<sub>7</sub>: P = 0.7, K = 0.6, and C = 250; and for I<sub>8</sub>: P = 0.6, K = 1, and C = 3500 have been adopted. The shapes of I<sub>6</sub>, I<sub>7</sub>, and I<sub>8</sub> value functions are presented in [Figures 3.B.6 to 3.B.8](#).

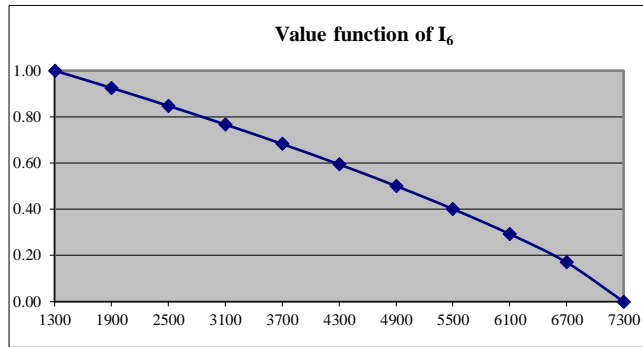


Figure 3.B.6. The value function of  $I_6$

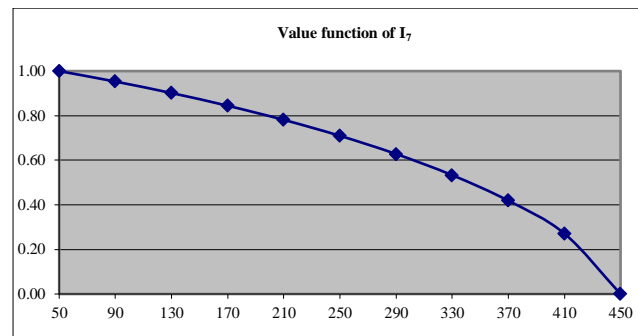


Figure 3.B.7. The value function of  $I_7$

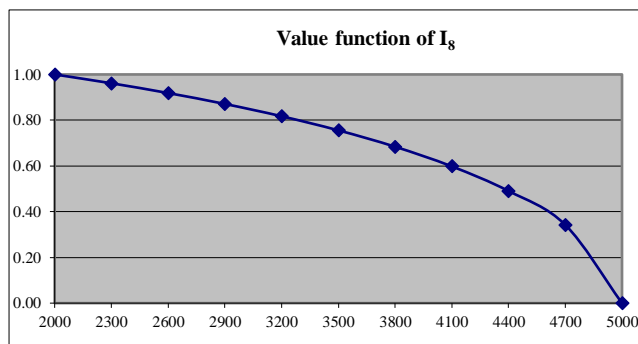


Figure 3.B.8. The value function of  $I_8$

### 3.B.7. Value functions of $I_9$ and $I_{12}$ . Construction Waste (CW) and Demolition Waste (DW)

In the case of indicators  $I_9$  and  $I_{12}$ , **the tendencies** of their value functions are **decreasing** because as long as these indicators' values increase the satisfaction decrease.

Based on several studies (Han, Tomonori, Rieko, Masato, & Ken, 2020; Khoshand & Khanlari, 2020; Llatas, 2010, 2013; Mihai, 2019; Sáez, Merino, & Porrás-amores, 2012; Santa et al., 2018; Zheng et al., 2017), the average values for CW and DW have been reported as 21.38 kg/m<sup>2</sup> and 338.7 kg/m<sup>2</sup> respectively. Also, some of these studies (Han et al., 2020; Llatas, 2010, 2013) determined that the CWs' values vary from 10 to 50 kg/m<sup>2</sup> and DWs' ones from 150 to 750 kg/m<sup>2</sup> for rehabilitation of residential buildings.

As **CW and DW do not receive the necessary/adequate attention** from decision-makers in Iran, **in order to encourage them and promote these issues**, concave value functions have been defined; which means small initial improvements are highly valued. Since decreasing concave value functions have been adopted for the  $I_9$  and  $I_{12}$ , for obtaining higher satisfaction it is not necessary to have the lowest indicators' values.

As concave shapes have been defined for the mentioned value functions in the previous stage, P values lower than 1 should be assigned. In this regard, the values  $P = 0.6$ ,  $K = 1$ , and  $C = 21.38$  for  $I_9$  and  $P = 0.8$ ,  $K = 1$  and  $C = 450$  for  $I_{12}$  have been adopted. The shapes of the  $I_9$  and  $I_{12}$  value functions are presented respectively in Figures 3.B.9 and 3.B.10.

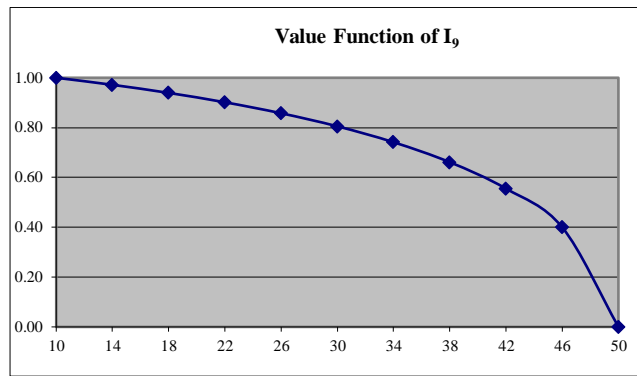


Figure 3.B.9. The value function of  $I_9$

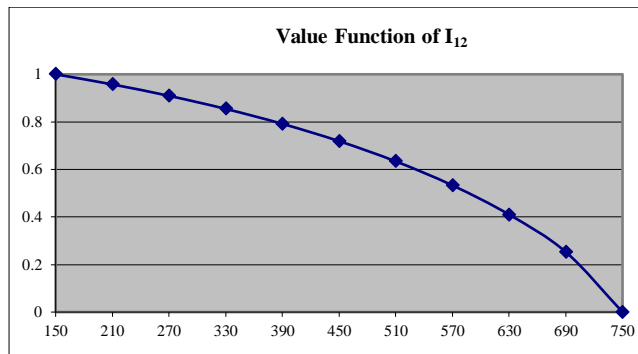


Figure 3.B.10. The value function of  $I_{12}$

### 3.B.8. Value functions of $I_{10}$ and $I_{11}$ . Operational Energy (OE) and Operational Carbon (OC)

As same as the other environmental indicators, **the tendencies** of  $I_{10}$  and  $I_{11}$  value functions are **decreasing** because since these indicators' values increase the satisfaction decrease.

According to the chapter 19<sup>th</sup> of the **National Regulations for Buildings of Iran** published by the Ministry of Roads and Urban Development of Iran (<https://www.mrud.ir/en/en-us/>), entitled “Energy conservation”, for energy efficiency in buildings and **the standard ISIRI 14253** published by the Institute of Standards and Industrial Research of Iran (ISIRI) (<http://standard.isiri.gov.ir/SearchEn.aspx>), entitled “Residential building criteria for energy consumption and energy labeling instruction”, **the OE and OC values of residential buildings in Tehran** have been reported **between 0 to 95 kWh/m<sup>2</sup>/year** and **0 to 75 kgCO<sub>2</sub>/m<sup>2</sup>/year** respectively. It is worthy to mention that if **the OE and OC values** of a residential building **exceed the aforementioned values**, the Institute of Standards and Industrial Research of Iran (ISIRI) will **not give that building any energy and carbon labeling**.

The contribution/share of the residential building sector in Iran accounts for 40% of consumed energy and 33% of CO<sub>2</sub> emissions (Iran construction engineering organization, <http://www.irceo.net/fullstory.aspx?id=5278>, 2014.). **Among the life cycle phases** of conventional residential buildings, **the operational phase has a substantial contribution** to environmental impacts, in particular on the Operational Energy (OE) and Operational Carbon (OC) (Beccali, Cellura, Fontana, Longo, & Mistretta, 2013; Cárdenas, Muñoz, & Fuentes, 2011; Kamali & Hewage, 2016; Quale, Eckelman, Williams, Sloditskie, & Zimmerman, 2012; Sartori & Hestnes, 2007; Scheuer, Keoleian, & Reppe, 2003; SETAC-Europe, Kotaji, Schuurmans, & Edwards, 2003; Su, Tian, Shao, & Zhao, 2020; Su & Zhang, 2016). Therefore, as **these indicators are the most important/crucial environmental indicators**, the shapes of their value functions have been defined as **convex**. In this regard, the lowest impacts are demanded to obtain higher satisfaction.

The value function **parameters** for  $I_{10}$ :  $P = 2.5$ ,  $K = 0.05$ , and  $C = 47.5$ ; and for  $I_{11}$ :  $P = 2.5$ ,  $K = 0.05$ , and  $C = 37.5$  have been adopted. **Figures 3.B.11** and **3.B.12** present the shapes of  $I_{10}$  and  $I_{11}$  value functions.

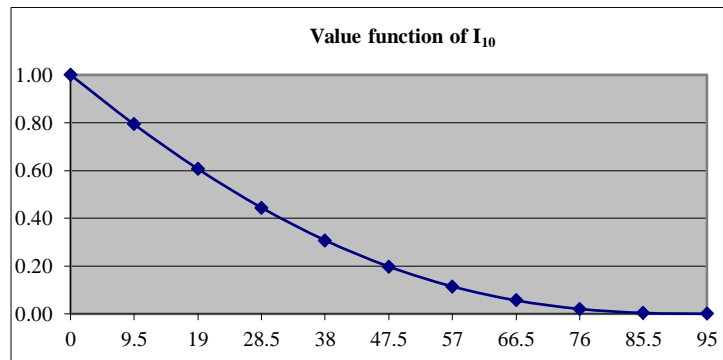


Figure 3.B.11. The value function of  $I_{10}$

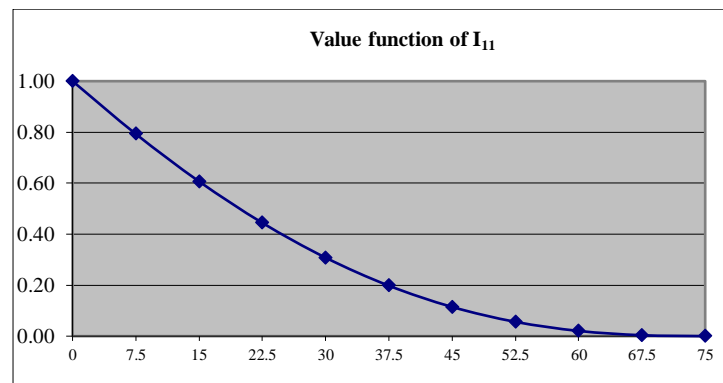


Figure 3.B.12. The value function of  $I_{11}$

Table 3.B.2. Values of the effective parameters for the value functions for each environmental indicator

	Unit	Shape	$X_{max}$	$X_{min}$	$C_i$	$K_i$	$P_i$	References
I <sub>6</sub> . Embodied Energy (EE)	MJ/m <sup>2</sup>	DCx	1300	7300	3250	0.10	0.80	(Dilsiz, Felkner, Habert, & Nagy, 2019; Fernando & Ekundayo, 2018; Hu, 2020; Klemeš, 2015; Monahan & Powell, 2011; Syngros, Balaras, & Koubogiannis, 2017)
I <sub>7</sub> . Embodied Carbon (EC)	kgCO <sub>2</sub> /m <sup>2</sup>	DCx	50	450	250	0.60	0.70	(Dilsiz, Felkner, Habert, & Nagy, 2019; Fernando & Ekundayo, 2018; Hu, 2020; Klemeš, 2015; Monahan & Powell, 2011; Syngros, Balaras, & Koubogiannis, 2017)
I <sub>8</sub> . Embodied Water (EW)	l/m <sup>2</sup>	DCx	2000	5000	3500	1.00	0.60	(Suchandra Bardhan & Choudhuri, 2016; Choudhuri & Roy, 2015; Heravi & Abdolvand, 2019; McCormack et al., 2007)
I <sub>9</sub> . Construction Waste (CW)	kg/m <sup>2</sup>	DCv	10	50	21.86	1.00	0.60	(Han et al., 2020; Llatas, 2010, 2013)
I <sub>10</sub> . Operational Energy (OE)	kWh/m <sup>2</sup> /yr.	DCv	0	95	47.5	0.05	2.50	The National Regulations for Buildings of Iran ( <a href="https://www.mrud.ir/en/en-us/">https://www.mrud.ir/en/en-us/</a> ), The standard ISIRI 14253( <a href="http://standar.isiri.gov.ir/SearchEn.aspx">http://standar.isiri.gov.ir/SearchEn.aspx</a> )
I <sub>11</sub> . Operational Carbon (OC)	kgCO <sub>2</sub> /m <sup>2</sup> /yr.	DCx	0	75	37.5	0.05	2.50	The National Regulations for Buildings of Iran ( <a href="https://www.mrud.ir/en/en-us/">https://www.mrud.ir/en/en-us/</a> ), The standard ISIRI 14253( <a href="http://standar.isiri.gov.ir/SearchEn.aspx">http://standar.isiri.gov.ir/SearchEn.aspx</a> )
I <sub>12</sub> . Demolition Waste (DW)	kg/m <sup>2</sup>	DCx	150	750	450	1.00	0.80	(Han et al., 2020; Llatas, 2010, 2013)

Legend: DCx: Decreasing Convex; DL: Decreasing Linear; DCv: Decreasing Concave; ICx: Increasing convex; IL: Increasing Linear; ICv: Increasing concave; IS: Increasing S-shape; DS: Decreasing S-shape.

### 3.B.9. Value functions of $I_{13}$ to $I_{19}$

In the case of all social indicators –  $I_{13}$  to  $I_{19}$  –, **the tendencies** of their value functions are **increasing** because as long as these indicators' values increase the satisfaction increases as well.

A questionnaire was designed and conducted to obtain **the values of the social indicators** which are **the Ekbatan inhabitants' satisfaction level** by using a **five-point Likert scale** – where **5** represents the highest satisfaction ( $X_{max}$ ) and **1** represents the lowest one ( $X_{min}$ ).

The **value functions' shapes** of the social indicators have been defined as **convex** due to the following reasons:

1) Several studies (Karji, Woldesenbet, Khanzadi, & Tafazzoli, 2019; Meijer, Itard, & Sunikka-Blank, 2009; Mustafa, 2016; Thuvander, Femenías, Mjörnell, & Meiling, 2012; van der Flier & Thomsen, 2006) revealed that **the main driver/reason behind the interior rehabilitation activities** of residential buildings is **social issues** such as functionality and adequacy spaces, user comfort, and psychological and aesthetic aspect of space. These issues are not only **crucial for the inhabitants** that live in the apartments but also are **substantial for the owners** who want to sell or rent their apartments. In other words, social

indicators affect social sustainability performance and economic ones. Therefore, for **obtaining higher satisfaction** values **it is necessary** to have **higher inhabitants' satisfaction**.

2) The Likert-scale questionnaire captures the **intensity of respondents' satisfaction** for a given question or item (Likert, 1932; James Carifio and Rocco J. Perla, 2007) in which 5 represents strongly satisfied, 4 represents satisfied, 3 represents neutral, 2 represents dissatisfied, and 1 represents strongly dissatisfied. According to **the aforementioned scoring/evaluating** system of Likert, **the values less than 3 account as dissatisfaction**. As social indicators are crucial, **inhabitant's dissatisfaction** regarding them **causes discomfort** and **even the need for rehabilitation more frequently**. Therefore, the less inhabitants' satisfaction penalizes severely with lower values. Therefore, the value functions' shapes of the social indicators should be defined as convex.

The value function **parameters and shapes of the social indicators** have been shown in Table 3.B.4 and Figures 3.B.13 to 3.B.19 respectively. It is worthy to mention that, although all social indicators are crucial, the **experts have assigned different weights** to them based on **their importance** – see section 3.2, Table 3.2. In this regard, different values of  $K_i$  and  $P_i$  have been adopted for the mentioned indicators to define their importance. According to (Viñolas, Cortés, Marques, Josa, & Aguado, 2009), (Aларcon, Aguado, Manga, & Josa, 2011), and (San-Jose Lombera & Garrucho Aprea, 2010), **the more crucial indicator is, the greater P value should be adopted** and its **value function's shape tends to become more convex**. For instance, for  $I_{13}$  and  $I_{19}$  those are more crucial, the greater P values have been assigned. On the contrary, for  $I_{16}$  to  $I_{18}$  **smaller P values** have been assigned and **their value functions' shapes tend from convex to linear**.

Table 3.B.3. Values of the effective parameters for the value functions for each social indicator

	Unit	Shape	$X_{max}$	$X_{min}$	$C_i$	$K_i$	$P_i$
$I_{13}$ .Functionality of the physical space	Points	ICx	5	1	3	0.50	2.50
$I_{14}$ .Adequate spaces & storages	Points	ICx	5	1	3	0.40	2.00
$I_{15}$ .Thermal comfort	Points	ICx	5	1	3	0.50	2.00
$I_{16}$ .Indoor air quality	Points	ICx	5	1	3	0.50	1.50
$I_{17}$ .Lighting comfort	Points	ICx	5	1	3	0.50	1.50
$I_{18}$ .Acoustic comfort	Points	ICx	5	1	3	0.50	1.50
$I_{19}$ . Aesthetic & building beauty	Points	ICx	5	1	3	0.40	2.50

Legend: DCx: Decreasing Convex; DL: Decreasing Linear; DCv: Decreasing Concave; ICx: Increasing convex; IL: Increasing Linear; ICv: Increasing concave; IS: Increasing S-shape; DS: Decreasing S-shape; AU: Apartment Unit.

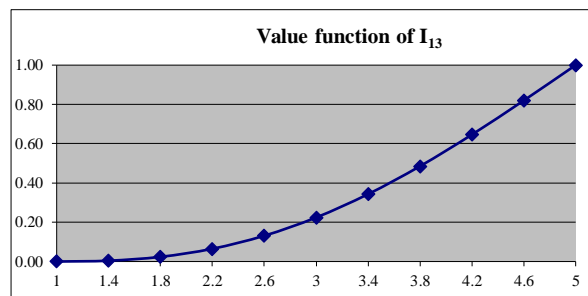


Figure 3.B.13. The value function of  $I_{13}$

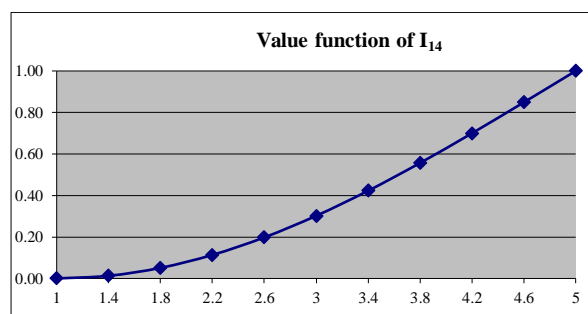


Figure 3.B.14. The value function of  $I_{14}$



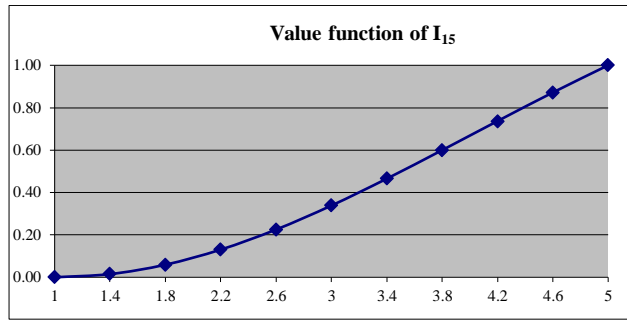


Figure 3.B.15. The value function of  $I_{15}$

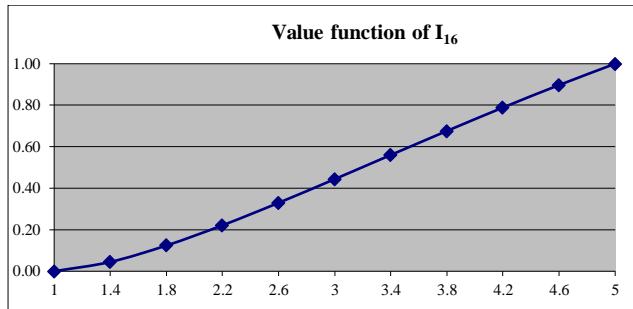


Figure 3.B.16. The value function of  $I_{16}$

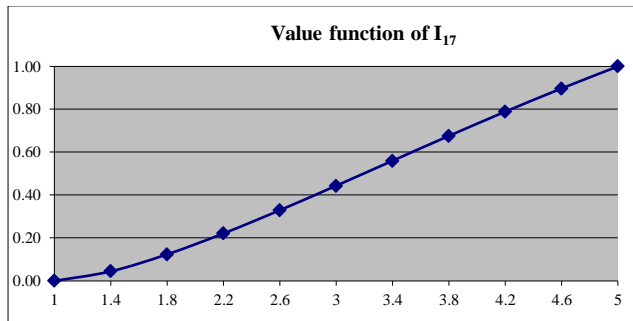


Figure 3.B.17. The value function of  $I_{17}$

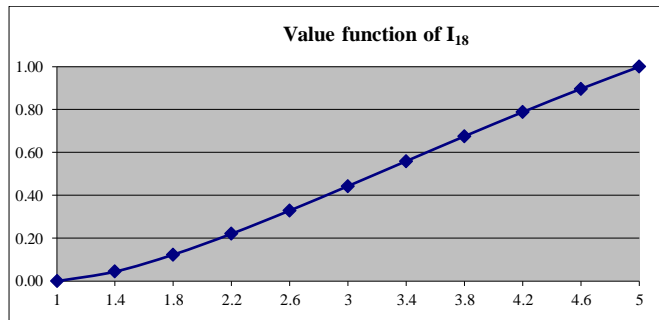


Figure 3.B.18. The value function of  $I_{18}$

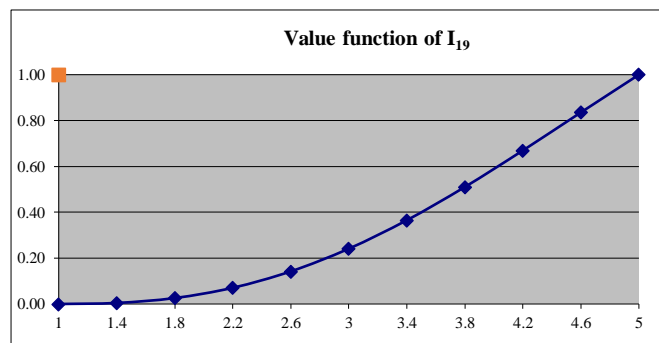


Figure 3.B.19. The value function of  $I_{19}$



## APPENDIX OF CHAPTER 4

Overview of the selected case study: Ekbatan MH,  
Tehran, Iran

## Appendix of chapter 4

### Appendix 4.A. Studying different apartment types in the first 15 Blocks (except blocks 3 and 5) of Phase-2

In the first 15 Blocks – except blocks 3 and 5 – of Phase-2, there are 20 different apartment unit types which were named by Persian Alphabet. Also, these 20 types are categorized into 5 main groups: *Aleph*, *Be*, *Gim*, *Dal*, and *He* which have been explained in the following paragraphs.

#### a) Aleph group

The *Aleph* group includes apartment types named *Aleph-1*, *Aleph-2*, *Aleph-3*, and *Aleph-4*. These types were built on a single floor and have one bedroom. Each type of *Aleph-3* and *-4* has a balcony and they are located only on pilots of each block. Also, *Aleph-1* is located on the odd floors while *Aleph-2* is located only on the first floor of each block. Although *Aleph-3* and *Aleph-4* types are very similar, *Aleph-4* has more length in comparison with *Aleph-3*.

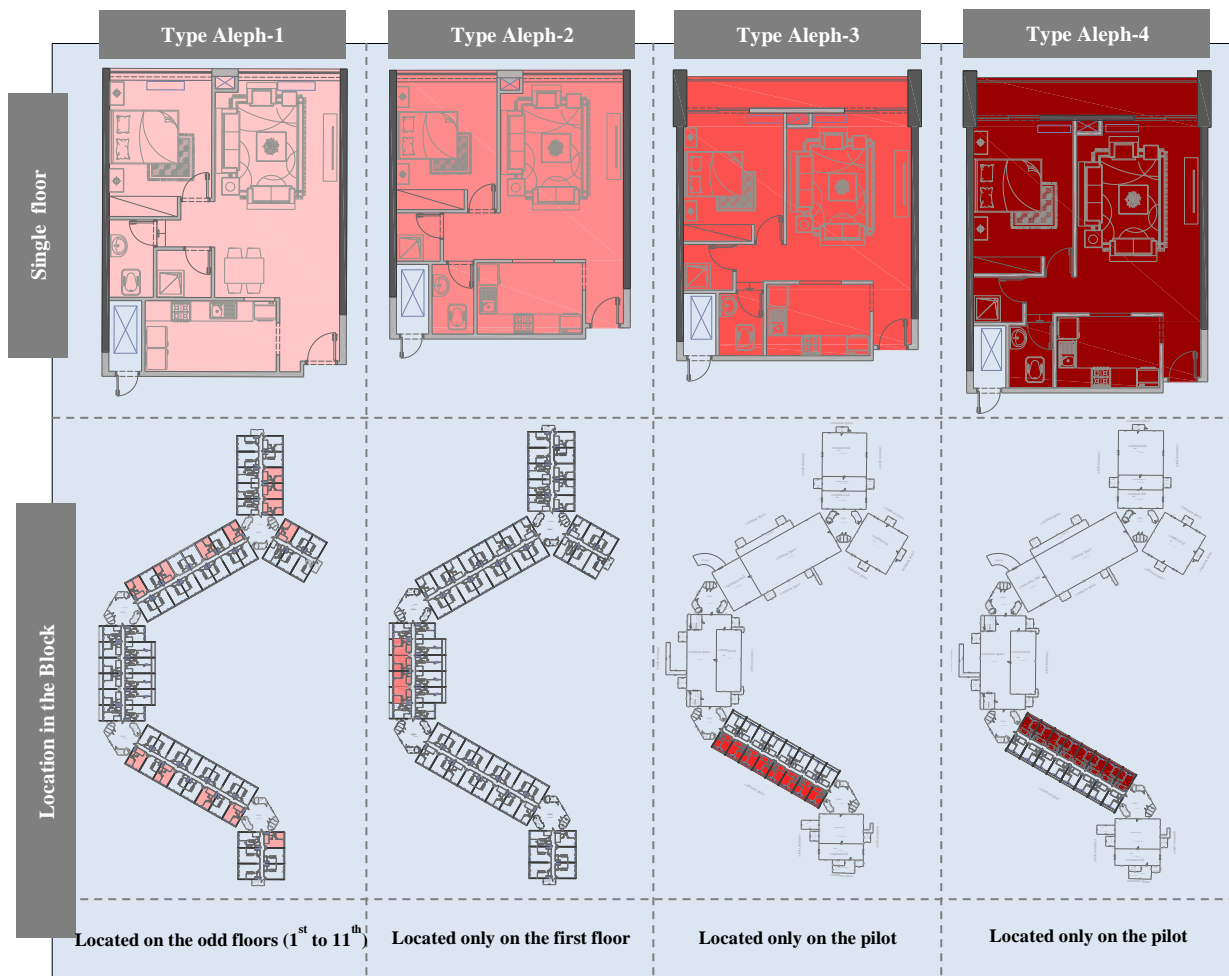


Figure 4.A.1. Typology of Aleph group

#### b) Be group

The *Be* group has 6 different types – *Be-1* to *6* – that all of them were built on a single floor and have one bedroom. All *Be-1*, *Be-2*, *Be-3*, and *Be-4* types are located on the odd floors, and in all of them, next to their principal doors, there are neighbor's doors which are the entrances of other types on the upper floor. For instance, the door of *B-6* is next to the door of *Be-2* and the door of *Be-5* is beside the door of *Be-3*. *Be-4* is the biggest type among *Be* types and has a balcony. *Be-2* and *Be-3* types and *Be-5* and *Be-6* types are very similar to each other and the only difference between these types is that *Be-2* and *Be-5* have more length in comparing with *Be-3* and *Be-6* respectively. It is worthy to note that type *Be-2* and *Be-3* are located only on the first floor, and type *Be-5* and *Be-6* are located only on the second floor.

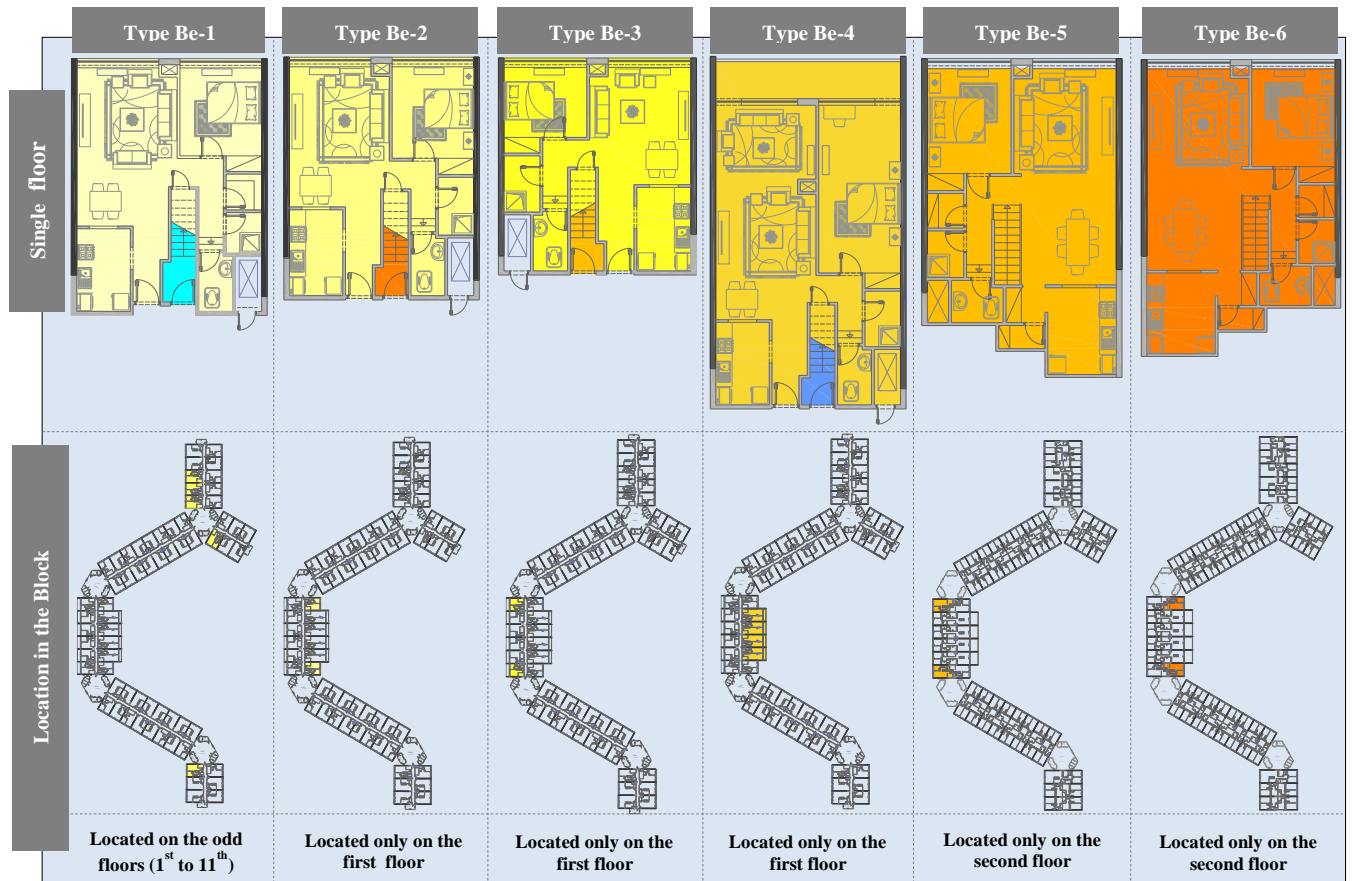


Figure 4.A.2. Typology of *Be* group

### c) Gim group

The *Gim* group has 4 different types – *Gim-1* to *Gim-4* – and all of them have two bedrooms. Apartments of this group were built on double floors (duplex) and they are accessible from the odd floors. On their first floor, there are a living room, kitchen, and bathroom and on their second-floor bedrooms, services, and a small living room were designed. In this group, type *Gim-3* is the biggest one. Although the first floor of *Gim-1* and *Gim-4* are very similar, the second floor of *Gim-1* is slightly bigger than *Gim-4*. Also, *Gim-2* and *Gim-3* are exactly similar on their first floor while they have a different architectural plan on their second floor.

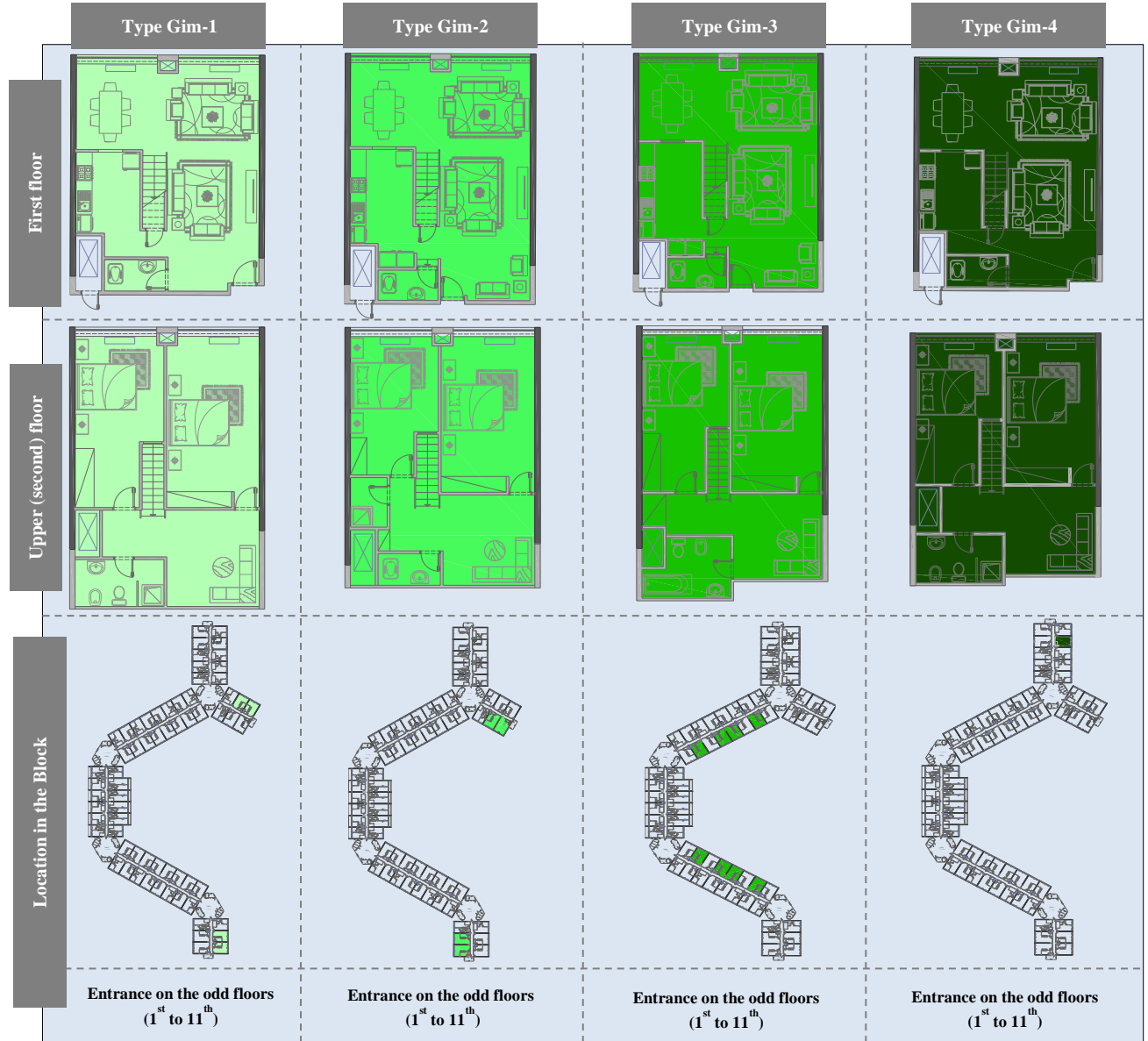


Figure 4.A.3. Typology of *Gim* group

### d) Dal group

The *Dal* group has two different types – *Dal-1* and *Dal-2* – and these types have three bedrooms. While these types of apartments were built on a single floor, their entrances are located on the lower floors and they are accessible from odd floors. In this group, *Dal-2* is bigger than *Dal-1* and it has a balcony. It is worthy to note that *Dal-2* is located only on the second floor.

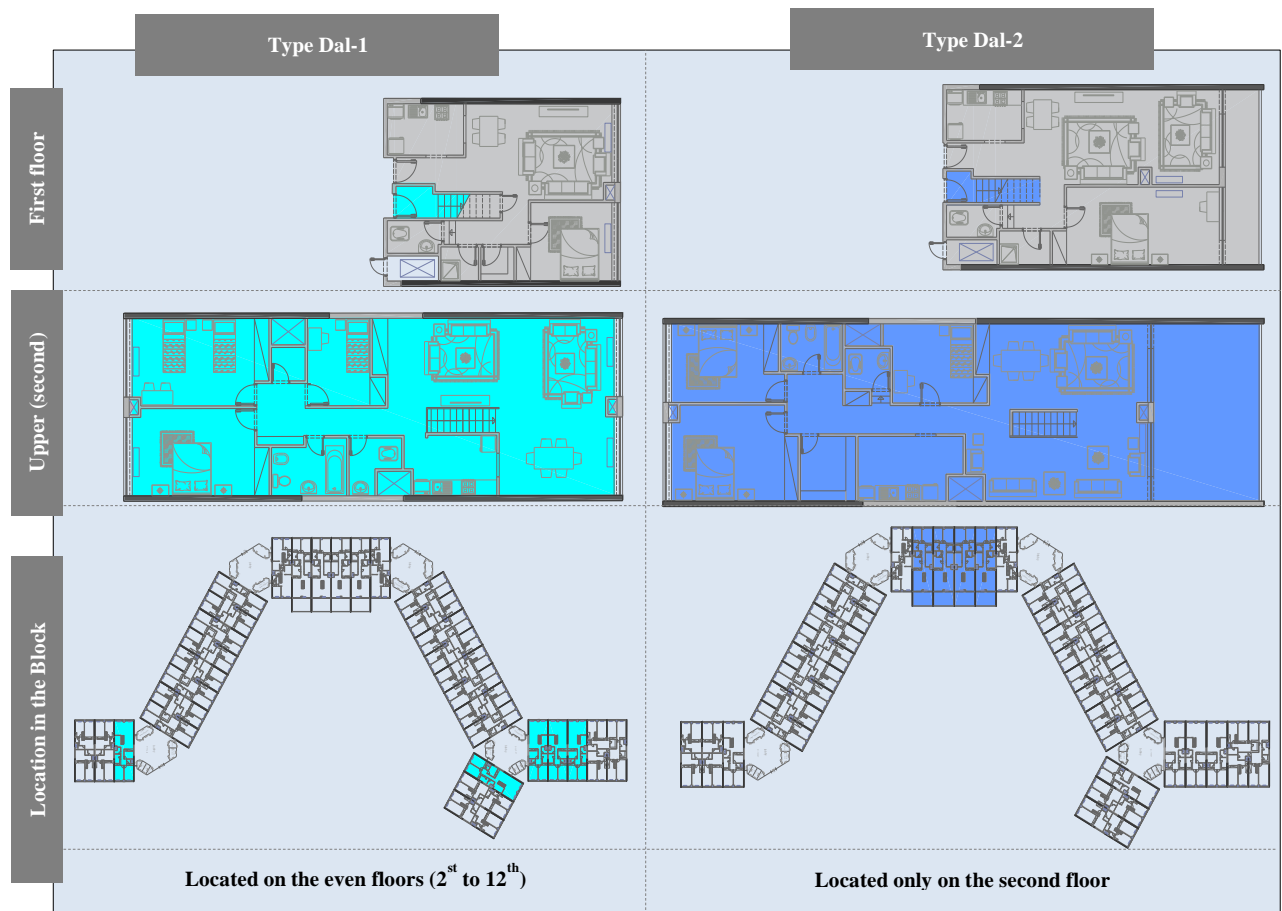


Figure 4.A.4. Typology of *Dal* group

### e) He group

The *He* group has 4 different types – *He-1* to *He-4* – and all of them have three bedrooms. Apartments of *He* Group were built on double floors (duplex) which are accessible from the odd floors. On their first floor, there are a living room, a kitchen, and a bathroom and on their second floor, three bedrooms, a service, and a small living room. It is worthy to note that *He-1* type is the biggest apartment type in Phase-2. *He-1* and *He-4* types are very similar on their first floor while *He-1* is slightly bigger than *He-4* on their second floors. Also, *He-2* and *He-3* types are exactly similar on their first floor while they have a different architectural plan on their second floor.

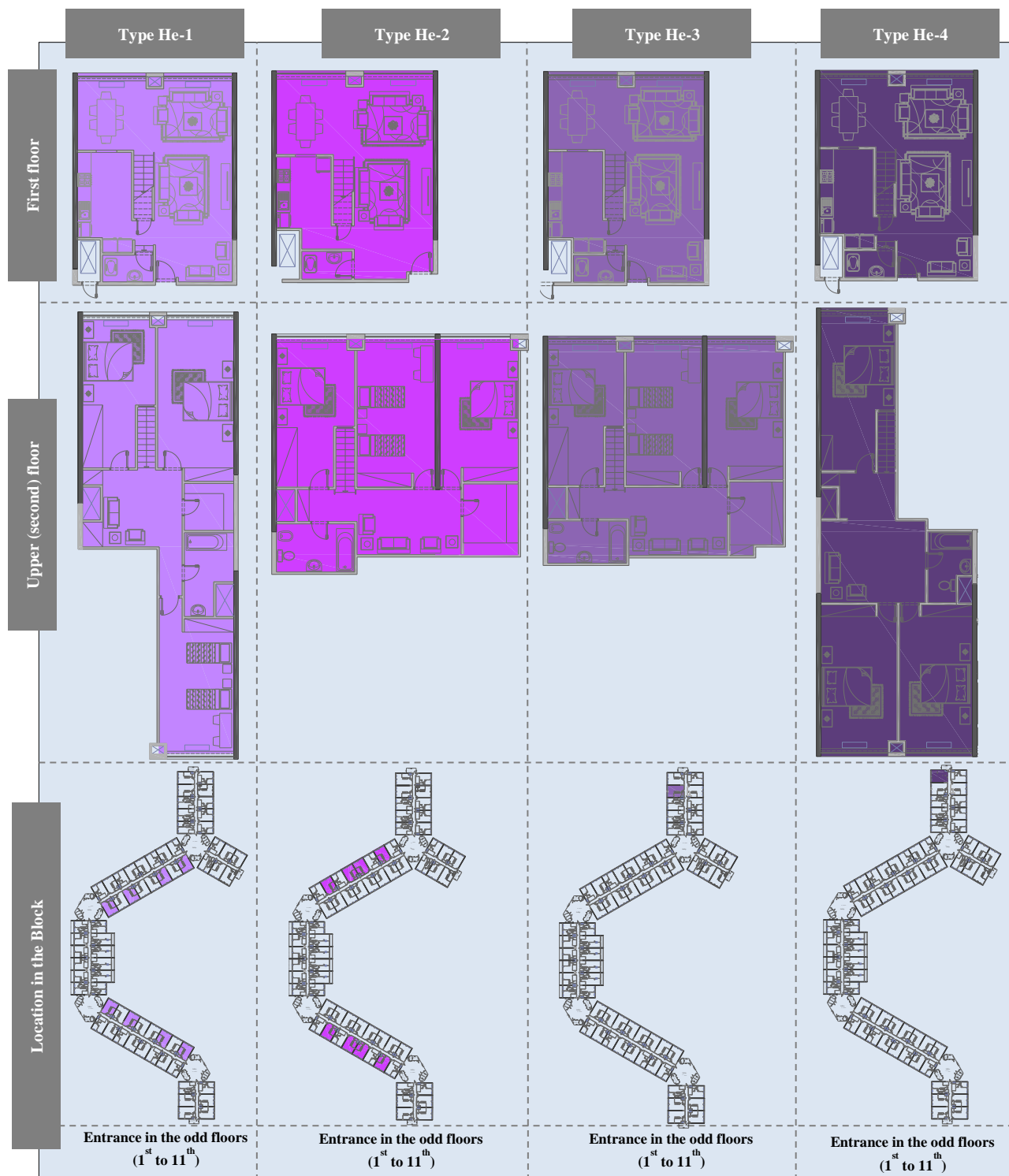


Figure 4.A.5. Typology of *He* group

## h) Summary of different apartment types in the first 15 Blocks (except blocks 3 and 5) of phase 2

To summarize, Table 4.A.1 shows the architectural characteristics – areas, useful areas, states, number of bedrooms, and other architectural spaces – of each apartment unit type besides some of their statistical data – the total number, the total area, and percentage of the number of each type.

Table 4.A.1. Architectural characteristics and statistical data of different apartment types in the first 15 blocks – except blocks 3 and 5 – of Phase-2

Phase 2: Blocks 1 to 15 (except 3 and 5)											
Group	Type	Area (m <sup>2</sup> )	Useful Area (m <sup>2</sup> )	State (duplex /single floor)	Bedroom/s	Balcony	Bathroom	Total Number of each type	Percentage of number of each type	Total area of each type (m <sup>2</sup> )	Percentage of area of each type
Aleph	Aleph-1	59,33	54.13	S	1	×	1	1144	20,81%	75,881.52	11,81%
	Aleph-2	60,11	54.70	S	1	×	1	52	0,95%	3,125.72	0,49%
	Aleph-3	63,4	57.69	S	1	✓	1	145	2,64%	9,193	1,43%
	Aleph-4	69,81	63.52	S	1	✓	1	145	2,64%	10,122.45	1,58%
Be	Be 1	68,92	62.71	S	1	×	1	412	7,49%	28,395.04	4,42%
	Be 2	63,12	57.43	S	1	×	1	26	0,47%	1,641,12	0,26%
	Be 3	56,81	51.69	S	1	×	1	26	0,47%	1477,06	0,23%
	Be 4	93,37	84.96	S	1	×	1	52	0,95%	4855,24	0,76%
	Be 5	81	73.71	S	1	×	1	26	0,47%	2106	0,33%
	Be 6	73,35	66.74	S	1	×	1	26	0,47%	1907,1	0,30%
Gim	Gim-1	127,69	116.19	D	2	×	2	392	7,13%	50054,48	7,79%
	Gim-2	132,55	120.62	D	2	×	2	392	7,13%	51959,6	8,09%
	Gim-3	133,83	121.78	D	2	×	2	660	12,00%	88327,8	13,74%
	Gim-4	127,34	115.87	D	2	×	2	72	1,31%	9168,48	1,43%
Dal	Dal-1	130,56	118.8	S	3	×	2	412	7,49%	53790,72	8,37%
	Dal-2	156,31	142.24	S	3	✓	2	52	0,95%	8128,12	1,26%
He	He-1	168,9	135.69	D	3	×	2	660	12,00%	111474	17,35%
	He-2	161,8	147.23	D	3	×	2	660	12,00%	106788	16,62%
	He-3	167,72	152.62	D	3	×	2	72	1,31%	12075,84	1,88%
	He-4	169,38	154.13	D	3	×	2	72	1,31%	12195,36	1,90%
<b>Total</b>								<b>5498</b>	<b>100,00%</b>	<b>642666,65</b>	<b>100,00%</b>





## **APPENDIX OF CHAPTER 6**

**Application of the proposed MIVES-Delphi model on the defined existing rehabilitation scenarios: scenarios 1 to 3**

# Appendix of chapter 6

## Appendix 6.A. Initial rehabilitation cost (I<sub>1</sub>) of scenarios 1 to 3

### 6.A.1) Initial demolition cost of scenario 1

Table 6.A.1. Initial demolition cost of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)	DWC (euro)	IDC
Gypsum Block	Gypsum Block 666*500*60	Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	2.99	0.18								
	Total Gypsum block 666*500*60	Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	2.99	0.18								
Ceramic tile	Ceramic tile 200*200*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02								
		kitchen Wall no.2	Walls	6	2.45	0.01								
		kitchen Wall no.3	Walls	6	3.92	0.02								
		kitchen Wall no.4	Walls	6	1.57	0.01								
		Wall WC no.1	Walls	6	5.33	0.03								
		Wall WC no.2	Walls	6	3.05	0.02								
		Wall WC no.3	Walls	6	4.04	0.02								
		Wall WC no.4	Walls	6	2.96	0.02								
		Bathroom Wall no.1	Walls	6	3.92	0.02								
		Bathroom Wall no.2	Walls	6	3.23	0.02								
	Bathroom Wall no.3	Walls	6	2.04	0.01									
	Bathroom Wall no.4	Walls	6	3.28	0.02									
	Total Ceramic tile 200*200*6 mm	Walls	6	39.71	0.24	1700	408	10505-8	6330/m2	251364.3				
	Ceramic tile 350*350*10 mm	WC Floor	Floor	10	2.99	0.03								
Bathroom Floor		Floor	10	2.13	0.02									
kitchen Floor		Floor	10	8.74	0.09									
Bedroom Floor		Floor	10	10.31	0.1									
Livingroom Floor		Floor	10	29.46	0.29									
Total ceramic tile 350*350*10 mm	Floor	10	53.63	0.54	1900	1026	10505-8	6330/m2	355566.9					
Wood (MDF)	Cabinet (Bottom)	Furniture	16	8.87										
	Cabinet (Top)	Furniture	16	11.22										
	Closet	Furniture	16	7.56										
	Total cabinets and closets	Furniture	16	27.65	0.32	700	224	10605	9430/m2	260739.5				
Steel	Cabinet's hinges	Furniture						2.6						
	Doors' hinges	Doors						1.9						
	Doors' handle	Doors						3.1						
	Kitchen, WC, and bathroom's taps	Furniture						12						
	Cabinets' accessories (handle & hinge)	Furniture						6.4						
	Screw	Furniture						8						
		Furniture			0.002	7850	34			3570/unit	82110			
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57									
		kitchen Wall no.2	Walls	4	0.98									
		Wall WC no.1	Walls	4	2.66									
		Wall WC no.2	Walls	4	1.52									
		Wall WC no.3	Walls	4	2.02									
		Wall WC no.4	Walls	4	1.48									
		Bathroom Wall no.1	Walls	4	3.13									
		Bathroom Wall no.2	Walls	4	2.58									
		Bathroom Wall no.3	Walls	4	1.63									
		Bathroom Wall no.4	Walls	4	2.62									
	WC Floor	Floor	4	2.99										
	Bathroom Floor	Floor	4	2.13										
	kitchen Floor	Floor	4	8.74										
	Total Bituminous waterproofing 4mm	W and F	4	34.05	0.14	1250	175	10514	2050/m2	69802.5				
Gypsum mortar	Gypsum mortar	Basic Wall 1: Gypsum Mortar Livingroom	Walls	6	3.68	0.02								
		Basic Wall 2: Gypsum Mortar-bedroom	Walls	6	3.08	0.02								
	Total Gypsum Mortar		6	6.76	0.04	1300	52	10508	5090/m2	34408.4				
Cement mortar	Cement mortar 350kg/m <sup>3</sup>	kitchen Wall no.1	Walls	10	3.92	0.04								
		kitchen Wall no.2	Walls	10	2.25	0.02								
		kitchen Wall no.3	Walls	10	3.92	0.04								
		kitchen Wall no.4	Walls	10	2.25	0.02								
		Wall WC no.1	Walls	10	5.33	0.05								
		Wall WC no.2	Walls	10	3.05	0.03								
		Wall WC no.3	Walls	10	4.04	0.04								
		Wall WC no.4	Walls	10	3.05	0.03								
		Bathroom Wall no.1	Walls	10	3.92	0.04								
		Bathroom Wall no.2	Walls	10	3.23	0.03								
	Bathroom Wall no.3	Walls	10	2.04	0.02									
	Bathroom Wall no.4	Walls	10	3.28	0.03									
	WC Floor	Floor	20	2.99	0.04									
	Bathroom Floor	Floor	20	2.13	0.04									
	kitchen Floor	Floor	20	8.74	0.17									
	Bedroom Floor	Floor	20	10.31	0.21									
	Livingroom Floor	Floor	20	29.46	0.59									
	Total Cement mortar 350 kg/m <sup>3</sup>	W and F		93.91	1.44	2100	3024	10509	14150/m2	669436.5				
	Cement mortar 150kg/m <sup>3</sup> (sloping)	WC Floor	Floor	40	2.99	0.12								
		Bathroom Floor	Floor	40	2.13	0.04								
kitchen Floor		Floor	40	8.74	0.35									
Bedroom Floor		Floor	40	10.31	0.41									
Livingroom Floor		Floor	50	29.46	1.47									
Total Cement mortar 150 kg/m <sup>3</sup>	Floor		53.64	2.36	1600	3776	10509	14150/m2	759006					
Porcelain	Toilet bowl and basin and flush	Furniture					2400	47	10801	11050/unit	33150			
Galvanized steel	Galvanized steel pipes 3/8 to 1 inches	Mechanical Eq		27.93m			7800	42	10803	2520/m	70383.6			
Plastics (PVC)	Switches & Sockets & lamps	Electrical Eq	29					3.3	010809-10	3660/unit	106140			
Mirror	Mirror	Furniture	8	0.35			2900	8.1		3900/unit	3900			
Fan coil	Fan coil	Mechanical Eq						26		54500/unit	109000			
Total initial demolition cost											2880907.7	233.57	43.28	276.86

## 6.A.2) Initial demolition cost of scenario 2

Table 6.A.2. Initial demolition cost of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total cost (Toman)	Total cost (euro)	DWC (euro)	IDC
Gypsum Block	Gypsum Block 666*500*60	Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	1.09	0.07								
		Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	0.24	0.01								
		ceiling: Gypsum Duct	Floors	60	1.95	0.12								
		Basic Wall: Gypsum block 666*500*60 Facade	Walls	60	2.99	0.18								
		Basic Wall: Gypsum block 666*500*60 Facade	Walls	60	2.99	0.18								
	Total Gypsum block 666*500*60		Walls	60	9.26	0.56	1100	616	10402	199500/m3	111720			
	Gypsum Block 666*500*100	Basic Wall: Gypsum block 666*500*100	Walls	100	1.73	0.17								
		Basic Wall: Gypsum block 666*500*100	Walls	100	0.86	0.09								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	4.08	0.41								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	3.73	0.37								
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	1.84	0.18									
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	1.54	0.15									
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	9.29	0.93									
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	0.92	0.09									
Total Gypsum block 666*500*100		Walls	100	23.99	2.4	1100	2640	10402	199500/m3	478800				
Cement Block	Cement Block 400*200*100	Basic Wall 1: Cement Block 400*200*100	Walls	100	4.58	0.46								
		Basic Wall 2: Cement Block 400*200*100	Walls	100	2.58	0.26								
		Basic Wall 3: Cement Block 400*200*100	Walls	100	4.52	0.45								
Total cement block 400*200*100		Walls	100	11.67	1.17	1220	1427.4	10402	199500/m3	233415				
Ceramic tile	Ceramic tile 200*200*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02								
		kitchen Wall no.2	Walls	6	2.45	0.01								
		kitchen Wall no.3	Walls	6	3.92	0.02								
		kitchen Wall no.4	Walls	6	1.57	0.01								
		Wall WC no.1	Walls	6	5.33	0.03								
		Wall WC no.2	Walls	6	3.05	0.02								
		Wall WC no.3	Walls	6	4.04	0.02								
		Wall WC no.4	Walls	6	2.96	0.02								
		Bathroom Wall no.1	Walls	6	3.92	0.02								
		Bathroom Wall no.2	Walls	6	3.23	0.02								
	Bathroom Wall no.3	Walls	6	2.04	0.01									
	Bathroom Wall no.4	Walls	6	3.28	0.02									
	Total Ceramic tile 200*200*6 mm		Walls	6	39.71	0.24	1700	408	10505-8	6330/m2	251364.3			
	Ceramic tile 350*350*10 mm	WC Floor	Floor	10	2.99	0.03								
		Bathroom Floor	Floor	10	2.13	0.02								
kitchen Floor		Floor	10	8.74	0.09									
Bedroom Floor		Floor	10	10.31	0.1									
Livingroom Floor		Floor	10	29.46	0.29									
Total ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	10505-8	6330/m2	355566.9				
Glass	Glass	Single Glazed 6mm	Window	1* 3mm	1.07									
	Total		Window		1.07	0.003	2500	8.1		28400/m2	30388			
Galvanized steel	Galvanized steel	Galvanized steel Window frame 3 -3mm	Window	1	0.8									
	Total Galvanized steel		Window	1	0.8	0.016	7850	18.8	010701-2	51500/unit	51500			
Wood (MDF)	Door - Frame	M_Single-Flush: Bathroom Door	Doors		2.09	0.02								
	Door - Frame	M_Single-Flush: WC Door	Doors		2.09	0.02								
	Door - Frame	M_Single-Flush: Bedroom Door	Doors		2.31	0.02								
	Total frame door		Doors		6.49	0.06	700	42						
	Door - Panel/ MDF face	M_Single-Flush: Bathroom Door	Doors	10	3.66	0.04								
	Door - Panel/ MDF face	M_Single-Flush: WC Door	Doors	10	3.66	0.04								
	Door - Panel/ MDF face	M_Single-Flush: Bedroom Door	Doors	10	4.09	0.04								
	Total Door - Panel/ MDF face		Doors	10	11.41	0.11	700	77	010604-6	31000/unit	124000			
	Cabinet (Bottom)		Furniture	16	8.87									
	Cabinet (Top)		Furniture	16	11.22									
Closet		Furniture	16	7.56										
Total cabinets and closets		Furniture	16	27.65	0.32	700	224	10605	9430/m2	260739.5				
Steel	Cabinet's hinges		Furniture					2.6						
	Doors' hinges		Doors					1.9						
	Doors' handle		Doors					3.1						
	Kitchen, WC and bathroom's taps		Furniture					12						
	Cabinets' accessories (handle & hinge)		Furniture					6.4						
	Screw		Furniture					8						
	Total		Furniture			0.002	7850	34		3570/unit	82110			
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57									
	Bituminous waterproofing 4mm	kitchen Wall no.2	Walls	4	0.98									
	Bituminous waterproofing 4mm	Wall WC no.1	Walls	4	2.66									
	Bituminous waterproofing 4mm	Wall WC no.2	Walls	4	1.52									
	Bituminous waterproofing 4mm	Wall WC no.3	Walls	4	2.02									
	Bituminous waterproofing 4mm	Wall WC no.4	Walls	4	1.48									
	Bituminous waterproofing 4mm	Bathroom Wall no.1	Walls	4	3.13									
	Bituminous waterproofing 4mm	Bathroom Wall no.2	Walls	4	2.58									
	Bituminous waterproofing 4mm	Bathroom Wall no.3	Walls	4	1.63									
	Bituminous waterproofing 4mm	Bathroom Wall no.4	Walls	4	2.62									
	Bituminous waterproofing 4mm	WC Floor	Floor	4	2.99									
	Bituminous waterproofing 4mm	Bathroom Floor	Floor	4	2.13									
	Bituminous waterproofing 4mm	kitchen Floor	Floor	4	8.74									
Total Bituminous waterproofing		W and F	4	34.05	0.14	1250	175	10514	2050/m2	69802.5				
Gypsum Mortar	Gypsum Mortar	Basic Wall 1: Gypsum Mortar	Walls	6	8.17	0.05								
		Basic Wall 2: Gypsum Mortar	Walls	6	7.46	0.04								
		Basic Wall 3: Gypsum Mortar	Walls	6	3.68	0.02								
		Basic Wall 4: Gypsum Mortar	Walls	6	3.08	0.02								
		Ceiling 1: Gypsum Mortar	Ceiling	6	18.58	0.11								
		Basic Wall 5: Gypsum Mortar	Walls	6	1.84	0.01								
		Basic Wall 6: Gypsum Mortar	Walls	6	10.92	0.07								
		Basic Wall 7: Gypsum Mortar	Walls	6	3.9	0.02								
Basic Wall 8: Gypsum Mortar	Walls	6	2.73	0.02										

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total cost (Toman)	Total cost (euro)	DWC (euro)	IDC	
Cement mortar	Total Gypsum Mortar			6	60.36	0.36	1300	468	10508	0	0				
	Cement mortar 350kg/m3	kitchen Wall no.1	Walls	10	3.92	0.04									
		kitchen Wall no.2	Walls	10	2.45	0.02									
		kitchen Wall no.3	Walls	10	16.36	0.16									
		kitchen Wall no.4	Walls	10	5.45	0.05									
		Wall WC no.1	Walls	10	5.33	0.05									
		Wall WC no.2	Walls	10	3.05	0.03									
		Wall WC no.3	Walls	10	4.04	0.04									
		Wall WC no.4	Walls	10	2.96	0.03									
		Bathroom Wall no.1	Walls	10	3.92	0.04									
		Bathroom Wall no.2	Walls	10	3.23	0.03									
		Bathroom Wall no.3	Walls	10	2.04	0.02									
		Bathroom Wall no.4	Walls	10	3.28	0.03									
		Bedroom Wall no.1	Walls	10	3.92	0.04									
		Bedroom Wall no.2	Walls	10	8.56	0.08									
		WC Floor	Floor	20	2.99	0.04									
		Bathroom Floor	Floor	20	2.13	0.04									
	kitchen Floor	Floor	20	8.74	0.17										
	Bedroom Floor	Floor	20	10.31	0.21										
	Livingroom Floor	Floor	20	29.46	0.59										
	Total Cement mortar 350 kg/m3	W and F			122.14	1.71		2100	3591	10509	14150/m2	1728271			
	Cement mortar 150kg/m3 (sloping)	WC Floor	Floor	40	2.99	0.12									
		Bathroom Floor	Floor	40	2.13	0.04									
kitchen Floor		Floor	40	8.74	0.35										
Bedroom Floor		Floor	40	10.31	0.41										
Livingroom Floor		Floor	50	29.46	1.47										
Total Cement mortar 150 kg/m3	Floor			53.64	2.36		1600	3776	10509	14150/m2	759006				
Filler	Filler	WC Floor	Floor	180	2.99	0.54									
	Total	Floor	180	2.99	0.54		1700	918	10509	14150/m2	42308.5				
Porcelain	Toilet bowl and basin and flush		Furniture					2400	47	10801	11050/unit	33150			
Galvanized steel	Galvanized steel pipes 3/8 to 1 inches		Mechanica Eq		27.93m		7800	42	10803	2520/m	70383.6				
Plastics (PVC)	Switches & Sockets & lamps		Electrical Eq	29				3.3	010809-10	3660/unit	106140				
Mirror	Mirror		Furniture	8	0.35		2900	8.1		3900/unit	3900				
	Removing stairs		Floor	2m			1700	52	10501	11900/m	23800				
Fan coil	Fan coil		Mechanica Eq					26		54500/unit	109000				
Total demolition cost												4921475.3	328.10	72.49	400.59

### 6.A.3) Initial demolition cost of scenario 3

Table 6.A.3. Initial demolition cost of scenario 3

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total cost (Toman)	Total cost (euro)	DWC (euro)	IDC
Gypsum Block	Gypsum Block 666*500*60	Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	1.09	0.07								
		Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	0.24	0.01								
		ceiling: Gypsum Duct	Floors	60	1.95	0.12								
		Basic Wall: Gypsum block 666*500*60 Facade	Walls	60	2.99	0.18								
		Basic Wall: Gypsum block 666*500*60 Facade	Walls	60	2.99	0.18								
	Total Gypsum block 666*500*60	Walls	60	9.26	0.56		1100	616	10402	199500/m3	111720			
	Gypsum Block 666*500*100	Basic Wall: Gypsum block 666*500*100	Walls	100	1.73	0.17								
		Basic Wall: Gypsum block 666*500*100	Walls	100	0.86	0.09								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	4.08	0.41								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	3.73	0.37								
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	1.84	0.18									
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	1.54	0.15									
Basic Wall: Gypsum block 666*500*100 Interior		Walls	100	9.29	0.93									
Total Gypsum block 666*500*100	Walls	100	23.99	2.4		1100	2640	10402	199500/m3	47880				
Cement Block	Cement Block 400*200*100	Basic Wall 1: Cement Block 400*200*100	Walls	100	4.58	0.46								
		Basic Wall 2: Cement Block 400*200*100	Walls	100	2.58	0.26								
		Basic Wall 3: Cement Block 400*200*100	Walls	100	4.52	0.45								
	Total cement block 400*200*100	Walls	100	11.67	1.17		1220	1427.4	10402	199500/m3	233415			
Ceramic tile	Ceramic tile 200*200*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02								
		kitchen Wall no.2	Walls	6	2.45	0.01								
		kitchen Wall no.3	Walls	6	3.92	0.02								
		kitchen Wall no.4	Walls	6	1.57	0.01								
		Wall WC no.1	Walls	6	5.33	0.03								
		Wall WC no.2	Walls	6	3.05	0.02								
		Wall WC no.3	Walls	6	4.04	0.02								
		Wall WC no.4	Walls	6	2.96	0.02								
		Bathroom Wall no.1	Walls	6	3.92	0.02								
		Bathroom Wall no.2	Walls	6	3.23	0.02								
		Bathroom Wall no.3	Walls	6	2.04	0.01								
		Bathroom Wall no.4	Walls	6	3.28	0.02								
		Total Ceramic tile 200*200*6 mm	Walls	6	39.71	0.24		1700	408	10505-8	6330/m2	251364.3		
	Ceramic tile 350*350*10 mm	WC Floor	Floor	10	2.99	0.03								
		Bathroom Floor	Floor	10	2.13	0.02								
		kitchen Floor	Floor	10	8.74	0.09								
		Bedroom Floor	Floor	10	10.31	0.1								
Livingroom Floor		Floor	10	29.46	0.29									

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m²)	Volume (m³)	Density (Kg/m³)	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total cost (Toman)	Total cost (euro)	DWC (euro)	IDC	
	Total ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	10505-8	6330/m2	355566.9				
Glass	Glass	Single Glazed 6mm	Window	1* 3mm	1.07										
	Glass	Double Glazed	Window	2*3mm	1.15										
	Glass	Double Glazed	Window	2*3mm	1.39										
	Glass	Double Glazed	Window	2*3mm	1.15										
	Glass	Double Glazed	Window	2*3mm	1.39										
	Glass	Double Glazed	Window	2*3mm	1.15										
		Total				8.45	0.05	2500	125		28400/m2	242536			
Galvanized steel	Galvanized steel	Galvanized steel Window frame 1 -3mm	Window	3	2.24										
	Galvanized steel	Galvanized steel Window frame 2 -3mm	Window	3	2.24										
	Galvanized steel	Galvanized steel Window frame 3 -3mm	Window	1	0.8										
		Total Galvanized steel		Window	7	5.28	0.016	7850	125.6	010701-2	51500/unit	360500			
Wood (MDF)	Door - Frame	M_Single-Flush: Bathroom Door	Doors		2.09	0.02									
	Door - Frame	M_Single-Flush: WC Door	Doors		2.09	0.02									
	Door - Frame	M_Single-Flush: Bedroom Door	Doors		2.31	0.02									
		Total frame door			6.49	0.06	700	42							
	Door - Panel/ MDF face	M_Single-Flush: Bathroom Door	Doors	10	3.66	0.04									
	Door - Panel/ MDF face	M_Single-Flush: WC Door	Doors	10	3.66	0.04									
	Door - Panel/ MDF face	M_Single-Flush: Bedroom Door	Doors	10	4.09	0.04									
		Total Door - Panel/ MDF face		Doors	10	11.41	0.11	700	77	010604-6	31000/unit	93000			
		Cabinet (Bottom)		Furniture	16	8.87									
		Cabinet (Top)		Furniture	16	11.22									
		Closet		Furniture	16	7.56									
	Total cabinets and closets		Furniture	16	27.65	0.32	700	224	10605	9430/m2	260739.5				
Steel	Cabinet's hinges		Furniture					2.6							
	Doors' hinges		Doors					1.9							
	Doors' handle		Doors					3.1							
	Kitchen, WC and bathroom's taps		Furniture					12							
	Cabinets' accessories (handle & hinge)		Furniture					6.4							
	Screw		Furniture					8							
			Furniture			0.002	7850	34		3570/unit	82110				
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57										
		kitchen Wall no.2	Walls	4	0.98										
		Wall WC no.1	Walls	4	2.66										
		Wall WC no.2	Walls	4	1.52										
		Wall WC no.3	Walls	4	2.02										
		Wall WC no.4	Walls	4	1.48										
		Bathroom Wall no.1	Walls	4	3.13										
		Bathroom Wall no.2	Walls	4	2.58										
		Bathroom Wall no.3	Walls	4	1.63										
		Bathroom Wall no.4	Walls	4	2.62										
		WC Floor	Floor	4	2.99										
		Bathroom Floor	Floor	4	2.13										
		kitchen Floor	Floor	4	8.74										
			Total Bituminous waterproofing 4mm		W and F	4	34.05	0.14	1250	175	10514	2050/m2	69802.5		
Gypsum Mortar	Gypsum Mortar	Basic Wall 1: Gypsum Mortar	Walls	6	8.17	0.05									
		Basic Wall 2: Gypsum Mortar	Walls	6	7.46	0.04									
		Basic Wall 3: Gypsum Mortar	Walls	6	3.68	0.02									
		Basic Wall 4: Gypsum Mortar	Walls	6	3.08	0.02									
		Ceiling 1: Gypsum Mortar	Ceiling	6	18.58	0.11									
		Basic Wall 5: Gypsum Mortar	Walls	6	1.84	0.01									
		Basic Wall 6: Gypsum Mortar	Walls	6	10.92	0.07									
		Basic Wall 7: Gypsum Mortar	Walls	6	3.9	0.02									
		Basic Wall 8: Gypsum Mortar	Walls	6	2.73	0.02									
		Basic Wall 9: Gypsum Mortar	Walls	6	3.62	0.02									
		Basic Wall 10: Gypsum Mortar	Walls	6	5.09	0.03									
	Total Gypsum Mortar			6	69.07	0.42	1300	546	10508	5090/m2	0				
Cement mortar	Cement mortar 350kg/m3	kitchen Wall no.1	Walls	10	3.92	0.04									
		kitchen Wall no.2	Walls	10	2.45	0.02									
		kitchen Wall no.3	Walls	10	16.36	0.16									
		kitchen Wall no.4	Walls	10	5.45	0.05									
		Wall WC no.1	Walls	10	5.33	0.05									
		Wall WC no.2	Walls	10	3.05	0.03									
		Wall WC no.3	Walls	10	4.04	0.04									
		Wall WC no.4	Walls	10	2.96	0.03									
		Bathroom Wall no.1	Walls	10	3.92	0.04									
		Bathroom Wall no.2	Walls	10	3.23	0.03									
		Bathroom Wall no.3	Walls	10	2.04	0.02									
		Bathroom Wall no.4	Walls	10	3.28	0.03									
		Bedroom Wall no.1	Walls	10	3.92	0.04									
		Bedroom Wall no.2	Walls	10	8.56	0.08									
		WC Floor	Floor	20	2.99	0.04									

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total cost (Toman)	Total cost (euro)	DWC (euro)	IDC
		Bathroom Floor	Floor	20	2.13	0.04								
		kitchen Floor	Floor	20	8.74	0.17								
		Bedroom Floor	Floor	20	10.31	0.21								
		Livingroom Floor	Floor	20	29.46	0.59								
		Total Cement mortar 350 kg/m3	Wall and Floor			122.14	1.71	2100	3591	10509	14150/m2	1728281		
	Cement mortar 150kg/m3 (sloping)	WC Floor	Floor	40	2.99	0.12								
		Bathroom Floor	Floor	40	2.13	0.04								
		kitchen Floor	Floor	40	8.74	0.35								
		Bedroom Floor	Floor	40	10.31	0.41								
		Livingroom Floor	Floor	50	29.46	1.47								
Total Cement mortar 150 kg/m3	Floor			53.64	2.36	1600	3776	10509	14150/m2	759006				
Filler	Filler	WC Floor	Floor	180	2.99	0.54								
		Total	Floor	180	2.99	0.54	1700	918	10509	14150/m2	42308.5			
Porcelain	Toilet bowl and basin		Furniture				2400	47	10801	11050/unit	33150			
Galvanized steel	Galvanized steel pipes 3/8 to 1 inches		Mechanical Eq		27.93m		7800	42	10803	2520/m	70383.6			
Plastics (PVC)	Switches & Sockets & lamps		Electrical Eq	29				3.3	010809-10	3660/unit	106140			
Mirror	Mirror		Furniture	8	0.35		2900	8.1		3900/unit	3900			
	Removing stairs		Floor	2m			1700	52	10501	11900/m	23800			
Fan coil	Fan coil		Mechanical Eq					26		54500/unit	109000			
Total initial demolition cost											5415523	361.03	73.87	434.90

DWC = Disposal waste cost, IDC = Initial demolition cost

### 6.A.4) Construction cost of scenario 1

Table 6.A.4. Construction cost of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)		
Gypsum Block	Gypsum Block 666*500*60	Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	3.09	0.18								
		Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	3.67	0.18								
		Total Gypsum block 666*500*60	Walls	60	5.99	0.36	1100	396	10417	127500/m2	762450			
Cement mortar	Cement mortar 150kg/m3 (sloping)	WC Floor	Floor	40	2.99	0.12								
		Bathroom Floor	Floor	40	2.13	0.04								
		kitchen Floor	Floor	40	8.74	0.35								
		Bedroom Floor	Floor	40	10.31	0.41								
		Livingroom Floor	Floor	50	29.46	1.47								
		Total Cement mortar 150 kg/m3	Floor			53.64	2.36	1600	3776	080202-210105	482750/m3	1139290		
	Cement mortar 350kg/m3	Cement mortar 350kg/m3	kitchen Wall no.1	Walls	10	3.92	0.04							
			kitchen Wall no.2	Walls	10	2.25	0.02							
			kitchen Wall no.3	Walls	10	3.92	0.04							
			kitchen Wall no.4	Walls	10	2.25	0.02							
			Wall WC no.1	Walls	10	5.33	0.05							
			Wall WC no.2	Walls	10	3.05	0.03							
			Wall WC no.3	Walls	10	4.04	0.04							
			Wall WC no.4	Walls	10	3.05	0.03							
			Bathroom Wall no.1	Walls	10	3.92	0.04							
			Bathroom Wall no.2	Walls	10	3.23	0.03							
			Bathroom Wall no.3	Walls	10	2.04	0.02							
			Bathroom Wall no.4	Walls	10	3.28	0.03							
			WC Floor	Floor	20	2.99	0.04							
			Bathroom Floor	Floor	20	2.13	0.04							
kitchen Floor	Floor	20	8.74	0.17										
Bedroom Floor	Floor	20	10.31	0.21										
Livingroom Floor	Floor	20	29.46	0.59										
Total Cement mortar 350 kg/m3	W and F			93.91	1.44	2100	3024	080202-210105	482750/m3	695160				
Ceramic	Ceramic tile 200*200*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02								
		kitchen Wall no.2	Walls	6	2.45	0.01								
		kitchen Wall no.4	Walls	6	1.57	0.01								
		Wall WC no.1	Walls	6	5.33	0.03								
		Wall WC no.2	Walls	6	3.05	0.02								
		Wall WC no.3	Walls	6	4.04	0.02								
		Wall WC no.4	Walls	6	2.96	0.02								
		Bathroom Wall no.1	Walls	6	3.92	0.02								
		Bathroom Wall no.2	Walls	6	3.23	0.02								
		Bathroom Wall no.3	Walls	6	2.04	0.01								
		Bathroom Wall no.4	Walls	6	3.28	0.02								
		Total Ceramic tile 200*200*6 mm	Walls	6	39.71	0.24	1700	408	200125	101500/m2	4030565			
		Ceramic tile 350*350*10 mm	Ceramic tile 350*350*10 mm	WC Floor	Floor	10	2.99	0.03						
				Bathroom Floor	Floor	10	2.13	0.02						
Bedroom Floor	Floor			10	10.31	0.1								
Livingroom Floor	Floor			10	29.46	0.29								
kitchen Floor	Floor			10	8.74	0.09								
Total Ceramic tile 350*350*10 mm	Floor	10	53.63	0.54	1900	1026	200325-411805	104750/m2	5617742.5					
Gypsum Mortar	Gypsum Mortar-10 mm	kitchen Wall no.1	Walls	10	7.84	0.08								
		kitchen Wall no.2	Walls	10	2.45	0.05								
		Bathroom Wall no.1	Walls	10	7.86	0.08								

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in ICMPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)
Gypsum Mortar-6 mm		Bathroom Wall no.2	Walls	10	6.46	0.06						
		Bedroom Wall no.1	Walls	10	7.84	0.08						
		Bedroom Wall no.2	Walls	10	17.12	0.17						
		WC Ceiling	Ceiling	6	2.99	0.0179						
		Bathroom Ceiling	Ceiling	6	2.13	0.0127						
		kitchen Ceiling	Ceiling	6	8.74	0.0524						
		Bedroom Ceiling	Ceiling	6	10.31	0.0618						
		Livingroom Ceiling	Ceiling	6	29.46	0.1767						
	Total Gypsum Mortar				103.2	0.8417	1300	1094.3	180207	37500/m2	3870000	
Gypsum Mortar	Gypsum Mortar	Basic Wall: Walls Finishing	Walls	1	118.83	0.12						
		Basic Ceiling	Ceiling	1	54.51	0.05						
		Total Gypsum Mortar				173.34	0.17	1300	221	180207	17750/m2	3076785
Wallpaper	Wallpaper- 0.53*10m	Basic Wall	Walls		3.89							
		Basic Wall	Walls		2.74							
		Basic Wall	Walls		3.01							
		Basic Wall	Walls		0.8							
		Basic Wall	Walls		1.78							
		Basic Wall	Walls		8.46							
		Basic Wall	Walls		0.8							
		Basic Wall	Walls		2.98							
		Basic Wall	Walls		8.74							
		Basic Wall	Walls		0.54							
		Basic Wall	Walls		2.36							
		Basic Wall	Walls		0.26							
		Basic Wall	Walls		2.27							
		Basic Wall	Walls		2.98							
		Basic Wall	Walls		1.78							
		Basic Wall	Walls		0.8							
		Basic Wall	Walls		3.01							
		Basic Wall	Walls		3.05							
		Basic Wall	Walls		5.14							
		Basic Wall	Walls		1.42							
		Basic Wall	Walls		0.28							
		Basic Wall	Walls		1.86							
		Basic Wall	Walls		10.39							
		Basic Wall	Walls		1.32							
		Basic Wall	Walls		5.11							
		Basic Wall	Walls		5.66							
		Basic Wall	Walls		11.8							
Basic Wall	Walls		0.83									
Basic Wall	Walls		2.96									
Basic Wall	Walls		21.81									
	Total wallpaper	Walls			118.83		950	165	250508	135000/m2	16042050	
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	250502	25300/m2	1379103	
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57							
		kitchen Wall no.2	Walls	4	0.98							
		Wall WC no.1	Walls	4	2.66							
		Wall WC no.2	Walls	4	1.52							
		Wall WC no.3	Walls	4	2.02							
		Wall WC no.4	Walls	4	1.48							
		Bathroom Wall no.1	Walls	4	3.13							
		Bathroom Wall no.2	Walls	4	2.58							
		Bathroom Wall no.3	Walls	4	1.63							
		Bathroom Wall no.4	Walls	4	2.62							
		WC Floor	Floor	4	2.99							
		Bathroom Floor	Floor	4	2.13							
		kitchen Floor	Floor	4	8.74							
	Total Bituminous waterproofing 4mm	Total	Walls and Floor	4	34.05	0.14	1250	175	130203-411701	61950/m2	2109397.5	
Wood (MDF)		Cabinet (Bottom)	Furniture	16	8.87							
		WC furniture	Furniture	16	2.78							
		Cabinet (Top)	Furniture	16	11.22							
		Closet	Furniture	16	7.56							
		Total MDF 16 mm	Furniture	16	30.43	0.49	780	379.7	190801	116100/m2	3532923	
		MDF 50mm counter tops	Furniture	50	3.23	0.22	780	171.6	190909	272000/m2	878560	
		Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71	0.021	700	29.3	191104	17000/m	896070
steel	Doors' accessories (handle & hinge)	Furniture	4+12 units							76000/unit	304000	
	All cabinets and closet accessories	Furniture	48 units				7850	22.3		22500/unit	1080000	
Mirror	WC's mirror	Furniture	6	0.35	0.003	2900	9			115000	115000	
Fan coil	Saravel-TE02-200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					31			2677000	
	Saravel-TE04-400 CFM-16100 BTU/hr	122*60*21 cm	Mechanical Eq					37			3175000	
Pipes and tabs	Installations and pipes	Galvanized steel pipes	Mechanical Eq	43.19m			8880	67.5		25000/m	1079750	
	Kitchen.WC.Bathroom		Furniture								1575000	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lam ps				33	10817	10220/unit	457000	
Porcelain	Toilet bowl-Morvarid model	76.5*41.5*72.5/6litre	Furniture					45		1950000/unit	1950000	
	Basin	67*42	Furniture					12		670000/unit	670000	
Home appliances	Sink-Alborz steel L-110	52*112	Furniture					9		685000/unit	685000	
	Stove	Mahyar-3023	Furniture					89		1188000/unit	1188000	
	Hood	Bimax B1002U Size 90cm-680m3/h	Furniture					19		730000/unit	730000	

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)
Total construction cost											55845846	3723.06

## 6.A.5) Construction cost of scenario 2

Table 6.A.5. Construction cost of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)	
Cement mortar	Cement mortar 150kg/m3 (sloping)	WC Floor	Floor	40	2.99	0.12							
		Bathroom Floor	Floor	40	2.13	0.04							
		kitchen Floor	Floor	40	8.74	0.35							
		Bedroom Floor	Floor	40	10.31	0.41							
		Livingroom Floor	Floor	50	29.46	1.47							
	Total Cement mortar 150 kg/m3		Floor		53.64	2.36	1600	3776	080202-210105	482750/m3	1139290		
	Cement mortar 350kg/m3	kitchen Wall no.1	Walls		3.92	0.16							
		kitchen Wall no.2	Walls		2.45	0.09							
		Wall WC no.1	Walls		5.33	0.11							
		Wall WC no.2	Walls		3.05	0.06							
		Wall WC no.3	Walls		4.04	0.08							
		Wall WC no.4	Walls		2.96	0.06							
		Bathroom Wall no.1	Walls		3.92	0.12							
		Bathroom Wall no.2	Walls		3.23	0.1							
		Bathroom Wall no.3	Walls		2.04	0.04							
		Bathroom Wall no.4	Walls		3.28	0.07							
		Livingroom Wall no.1	Walls		3.92	0.12							
		Bedroom Wall no.1	Walls		3.92	0.12							
		Bedroom Wall no.2	Walls		8.56	0.39							
		WC Floor	Floor		2.99	0.03							
Bathroom Floor		Floor		2.13	0.04								
kitchen Floor	Floor		8.74	0.17									
Total Cement mortar 350 kg/m3		Wall and Floor		122.19	2.84	2100	5964	080202-210105	482750/m3	1371010			
Brick	Hollow brick block 190*180*8 mm	Wall WC no.1	Walls	80	5.33	0.43							
		Wall WC no.2	Walls	80	3.05	0.24							
		kitchen Wall no.1-2	Walls	80	4.42	0.35							
		Livingroom wall no.1	Walls	80	3.92	0.31							
		Bedroom Wall no.1	Walls	80	3.92	0.31							
		Bedroom Wall no.2	Walls	80	12.66	1.01							
		Total Hollow brick block 190*180*8 mm		Walls	80	33.3	2.66	1300	3458	110401	936800/m3	2491888	
		Ceramic	Ceramic tile 400*600*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02					
kitchen Wall no.2	Walls			6	2.45	0.01							
Wall WC no.1	Walls			6	5.33	0.03							
Wall WC no.2	Walls			6	3.05	0.02							
Wall WC no.3	Walls			6	4.04	0.02							
Wall WC no.4	Walls			6	2.96	0.02							
Bathroom Wall no.1	Walls			6	3.92	0.02							
Bathroom Wall no.2	Walls			6	3.23	0.02							
Bathroom Wall no.3	Walls			6	2.04	0.01							
Bathroom Wall no.4	Walls			6	3.28	0.02							
Total Ceramic tile 400*600*6 mm			Walls	6	34.22	0.21	1700	357	200125	122500/m2	4191950		
Ceramic tile 500*500*10 mm	WC Floor		Floor	10	2.99	0.03							
	Bathroom Floor		Floor	10	2.13	0.02							
	kitchen Floor		Floor	10	8.74	0.09							
Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	1900	266	200325-411805	131750/m2	1826055			
Parquet	Direct Pressure Laminate (DPL)-10mm thickness	Bedroom Floor	Floor	8	10.31	0.08							
		Livingroom Floor	Floor	8	29.46	0.24							
			Floor	8	39.77	0.32	1160	371.2	191501	185000/m2	7357450		
Gypsum Mortar	Gypsum Mortar-10 mm	kitchen Wall no.1	Walls	10	7.84	0.08							
		kitchen Wall no.2	Walls	10	2.45	0.05							
		Bathroom Wall no.1	Walls	10	7.86	0.08							
		Bathroom Wall no.2	Walls	10	6.46	0.06							
		Bedroom Wall no.1	Walls	10	7.84	0.08							
		Bedroom Wall no.2	Walls	10	17.12	0.17							
	Gypsum Mortar-6 mm	WC Ceiling	Ceiling	6	2.99	0.01794							
		Bathroom Ceiling	Ceiling	6	2.13	0.01278							
		kitchen Ceiling	Ceiling	6	8.74	0.05244							
		Bedroom Ceiling	Ceiling	6	10.31	0.06186							
Livingroom Ceiling		Ceiling	6	29.46	0.17676								
Total Gypsum Mortar				103.2	0.84178	1300	1094.314	180207	37500/m2	3870000			
Clay plaster	Clay plaster, thickness 15mm	kitchen Wall no.1	Walls	15	8.84	0.13							
		Bathroom Wall no.1	Walls	15	5.33	0.08							
		Bathroom Wall no.2	Walls	15	3.23	0.05							
		Bedroom and Livingroom Wall no.1	Walls	15	7.84	0.12							
		Bedroom Wall no.2	Walls	15	25.32	0.38							
Total Clay plaster		Walls		50.56	0.76	1600	1216	180203	22700/m2	1147712			
Double Coat paint	Double coat plastic paint	Basic Wall	Walls		3.89								
		Basic Wall	Walls		2.74								
		Basic Wall	Walls		3.01								
		Basic Wall	Walls		0.8								



Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in ICMPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)	
		Basic Wall	Walls		1.78								
		Basic Wall	Walls		8.46								
		Basic Wall	Walls		0.8								
		Basic Wall	Walls		2.98								
		Basic Wall	Walls		8.74								
		Basic Wall	Walls		0.54								
		Basic Wall	Walls		2.36								
		Basic Wall	Walls		0.26								
		Basic Wall	Walls		2.27								
		Basic Wall	Walls		2.98								
		Basic Wall	Walls		1.78								
		Basic Wall	Walls		0.8								
		Basic Wall	Walls		3.01								
		Basic Wall	Walls		3.05								
		Basic Wall	Walls		5.14								
		Basic Wall	Walls		1.42								
		Basic Wall	Walls		0.28								
		Basic Wall	Walls		1.86								
		Basic Wall	Walls		10.39								
		Basic Wall	Walls		1.32								
		Basic Wall	Walls		5.11								
		Basic Wall	Walls		5.66								
		Basic Wall	Walls		11.8								
		Basic Wall	Walls		0.83								
		Basic Wall	Walls		2.96								
		Basic Wall	Walls		21.81								
		Total walls painting	Walls	23.85 liter	118.83		1200	28.4	250502	25300/m2	3006399		
		Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51	1200	13.3	250502	25300/m2	1379103		
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57								
		kitchen Wall no.2	Walls	4	0.98								
		Wall WC no.1	Walls	4	2.66								
		Wall WC no.2	Walls	4	1.52								
		Wall WC no.3	Walls	4	2.02								
		Wall WC no.4	Walls	4	1.48								
		Bathroom Wall no.1	Walls	4	3.13								
		Bathroom Wall no.2	Walls	4	2.58								
		Bathroom Wall no.3	Walls	4	1.63								
		Bathroom Wall no.4	Walls	4	2.62								
		WC Floor	Floor	4	2.99								
		Bathroom Floor	Floor	4	2.13								
		kitchen Floor	Floor	4	8.74								
	Total Bituminous waterproofing 4mm	Walls and Floor	4	34.05	0.14	1250	175	130203-411701	61950/m2	2109397.5			
Wood (MDF)	Door - Panel/ MDF face	M_Single-Flush: Bathroom Door	Doors	10	3.66	0.04							
	Door - Panel/ MDF face	M_Single-Flush: WC Door	Doors	10	3.66	0.04							
	Door - Panel/ MDF face	M_Single-Flush: Bedroom Door	Doors	10	4.09	0.04							
		Total Door -frame	Doors	7	16.54m	0.05	700	36	190103-412501	58300/m	964282		
		Total Door-Hollow-core panel/ MDF	Doors	10	11.44 m2	0.11	700	77	190202	89600/m2	1025024		
		Closet	Furniture	16	16.12								
		Shoe boxes	Furniture	16	14.31								
		WC furniture	Furniture	16	2.93								
		Cabinets	Furniture	16	41.76								
		Total MDF 16 mm	Furniture	16	75.12	0.94	700	658	190802	141500/m2	10629480		
		MDF 50mm countertops	Furniture	50	6.76	0.22	780	171.6	190902	385000/m2	2602600		
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	26.35m	0.021	700	14.7	191104	17000/m	447950		
steel	All cabinets and closet accessories	Furniture	48 units				7850	22.3		29500/unit	1416000		
	Doors' accessories (handle & hinge)	Furniture	3+9 units				7850	8.5		105000/unit	315000		
Mirror	Shoes box's mirror	Furniture	8	2.05	0.02	2900	58			575000	575000		
	Closets' mirror	Furniture	8	3.84	0.03	2900	87			715000	715000		
	WC's mirror	Furniture	6	0.35	0.003	2900	9			178000	178000		
	Total mirror	Furniture		6.24	0.053	2900	154						
Fan coil	Saravel-TE02-200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					31			2677000		
	Saravel-TE04-400 CFM-16100 BTU/hr	122*60*21 cm	Mechanical Eq					37			3175000		
Pipes and tabs	Installations and pipes	PVC pipes	Mechanical Eq	43.19m			1467	17.3		25000/m	1079750		
	Kitchen.WC.Bathroom		Furniture								2750000		
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	27ss+16lamps				33	010813-14	18660/unit	742000		
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45		2250000/unit	2250000		
	Basin and toilet furniture	67*42	Furniture					21		1570000/unit	1570000		
Home appliances	Sink-Alborz steel L-735	52*116	Furniture					10		1050000/unit	1050000		
	Stove	Sinjer SDG 519 Gas Hob	Furniture					17.4		1820000/unit	1820000		
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture					17		1465000/unit	1465000		
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	30	5.8	140111	17000/m2	103700		
	Total construction cost							18534			67441040.5	4496.07	

### 6.A.6) Construction cost of scenario 3

Table 6.A.6. Construction cost of scenario 3

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in ICMPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)	
Cement mortar	Cement mortar 150kg/m3 (sloping)	WC Floor	Floor	40	2.99	0.12							
		Bathroom Floor	Floor	40	2.13	0.04							
		kitchen Floor	Floor	40	8.74	0.35							
		Bedroom Floor	Floor	40	10.31	0.41							
		Livingroom Floor	Floor	50	29.46	1.47							
	Total Cement mortar 150 kg/m3	Floor		53.64	2.39	1600	3776	080202-210105	482750/m3	1153772.5			
	Cement mortar 350kg/m3	kitchen Wall no.1	Walls		3.92	0.04							
		kitchen Wall no.2	Walls		2.45	0.02							
		Wall WC no.1	Walls		5.33	0.05							
		Wall WC no.2	Walls		3.05	0.03							
		Wall WC no.3	Walls		4.04	0.04							
		Wall WC no.4	Walls		2.96	0.03							
		Bathroom Wall no.1	Walls		3.92	0.04							
		Bathroom Wall no.2	Walls		3.23	0.03							
		Bathroom Wall no.3	Walls		2.04	0.02							
		Bathroom Wall no.4	Walls		3.28	0.03							
		WC Floor	Floor		2.99	0.02							
		Bathroom Floor	Floor		2.13	0.04							
		kitchen Floor	Floor		8.74	0.17							
		Bedroom Floor	Floor		10.31	0.21							
		Livingroom Floor	Floor		29.46	0.59							
Total Cement mortar 350 kg/m3	W and F		87.85	1.41	2100	2961	080202-210105	482750/m3	680677.5				
Ceramic	Ceramic tile 400*600*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02							
		kitchen Wall no.2	Walls	6	2.45	0.01							
		Wall WC no.1	Walls	6	5.33	0.03							
		Wall WC no.2	Walls	6	3.05	0.02							
		Wall WC no.3	Walls	6	4.04	0.02							
		Wall WC no.4	Walls	6	2.96	0.02							
		Bathroom Wall no.1	Walls	6	3.92	0.02							
		Bathroom Wall no.2	Walls	6	3.23	0.02							
		Bathroom Wall no.3	Walls	6	2.04	0.01							
	Bathroom Wall no.4	Walls	6	3.28	0.02								
	Total Ceramic tile 400*600*6 mm	Walls	6	34.22	0.21	1700	357	200125	122500/m2	4191950			
	Ceramic tile 500*500*10 mm	WC Floor	Floor	10	2.99	0.03							
		Bathroom Floor	Floor	10	2.13	0.02							
		kitchen Floor	Floor	10	8.74	0.09							
		Bedroom Floor	Floor	10	10.31	0.1							
Livingroom Floor		Floor	10	29.46	0.29								
Total Ceramic tile 500*500*10 mm	Floor	10	53.63	0.54	1900	1026	200325-411805	131750/m2	7065752.5				
Gypsum Mortar	Gypsum Mortar	Basic Wall: Walls Finishing	Walls	6	5.14	0.03							
		Basic Wall: Walls Finishing	Walls	6	1.42	0.01							
		Basic Wall: Walls Finishing	Walls	6	0.28	0							
		Basic Wall: Walls Finishing	Walls	6	1.86	0.01							
		Basic Ceiling: Knauf Finish	Ceiling	6	10.39	0.06							
		Basic Wall: Walls Finishing	Walls	6	1.32	0.01							
		Basic Wall: Walls Finishing	Walls	6	5.11	0.03							
		Basic Wall: Walls Finishing	Walls	6	5.66	0.03							
		Basic Wall: Walls Finishing	Walls	6	11.8	0.07							
		Basic Wall: Walls Finishing	Walls	6	0.83	0							
		Basic Wall: Walls Finishing	Walls	6	2.96	0.02							
		Basic Ceiling: Knauf Finish	Ceiling	6	21.81	0.13							
		Basic Wall: Knauf Finish	Walls	3	4.19	0.01							
		Basic Wall: Knauf Finish	Walls	3	2.74	0.01							
		Basic Wall: Knauf Finish	Walls	3	3.01	0.01							
		Basic Wall: Knauf Finish	Walls	3	0.8	0							
		Basic Wall: Knauf Finish	Walls	3	1.78	0.01							
		Basic Ceiling: Knauf Finish	Walls	3	8.46	0.03							
		Basic Wall: Knauf Finish	Walls	3	0.8	0							
		Basic Wall: Knauf Finish	Walls	3	2.98	0.01							
		Basic Ceiling: Knauf Finish	Ceiling	3	8.99	0.03							
Basic Wall: Knauf Finish	Walls	3	0.54	0									
Basic Wall: Knauf Finish	Walls	3	2.36	0.01									
Basic Wall: Knauf Finish	Walls	3	0.26	0									
Total Gypsum Mortar			105.49	0.52	1300	676	180207	37500/m2	3955875				
Steel	Knauf Steel Stud	Basic Wall: Knauf-KSW10.L1C7	Walls	1.2	0.8								
		Basic Wall: Knauf-KSW10.L1C7	Walls	1.2	9.23								
		Basic Wall: Knauf-KSW10.L1C7	Walls	1.2	4.21								
		Basic Wall: Knauf-KSW10.L1C7	Walls	1.2	2.48								
		Basic Wall: Knauf-KSW10.L1C7	Walls	1.2	2.27								
		Basic Wall: Knauf-Single	Walls	1.2	2.98								
		Basic Wall: Knauf-Single	Walls	1.2	1.78								
		Basic Wall: Knauf-Single	Walls	1.2	0.8								
		Basic Wall: Knauf-Single	Walls	1.2	3.01								
		Basic Wall: Knauf-Single	Walls	1.2	3.05								
		Total Knauf steel stud			1.2	30.61	0.036	7800	280.8				
		Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	23.78 m <sup>2</sup>	0.03	7800	234				
		Fiberglass	Self-Tapping Screw TB 3.5 x 35 mm			200 pcs/pack		7800	0.85			43500	
Plasterboard	MastaShield Plasterboard	Basic Wall: Knauf-KSW10.L1C7	Walls	12	1.6								
		Basic Wall: Knauf-KSW10.L1C7	Walls	12	18.47								
		Basic Wall: Knauf-KSW10.L1C7	Walls	12	8.43								
		Basic Wall: Knauf-KSW10.L1C7	Walls	12	4.97								
		Basic Wall: Knauf-KSW10.L1C7	Walls	12	4.54								

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)		
	MastaShield Plasterboard	Basic Wall: Knauf-Single	Walls	12	2.98									
	MastaShield Plasterboard	Basic Wall: Knauf-Single	Walls	12	1.78									
	MastaShield Plasterboard	Basic Wall: Knauf-Single	Walls	12	0.8									
	MastaShield Plasterboard	Basic Wall: Knauf-Single	Walls	12	3.01									
	MastaShield Plasterboard	Basic Wall: Knauf-Single	Walls	12	3.05									
	Total wall's plasterboard		Walls	12	49.63	0.6	760	425.6	180901-2	112500/m2	5583375			
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	760	212.8	180903-4	98500/m2	2342330			
Double Coat paint	Double coat plastic paint	Basic Wall: Knauf Finish	Walls		4.19									
		Basic Wall: Knauf Finish	Walls		2.74									
		Basic Wall: Knauf Finish	Walls		3.01									
		Basic Wall: Knauf Finish	Walls		0.8									
		Basic Wall: Knauf Finish	Walls		1.78									
		Basic Wall: Knauf Finish	Walls		8.46									
		Basic Wall: Knauf Finish	Walls		0.8									
		Basic Wall: Knauf Finish	Walls		2.98									
		Basic Wall: Knauf Finish	Walls		8.99									
		Basic Wall: Knauf Finish	Walls		0.54									
		Basic Wall: Knauf Finish	Walls		2.36									
		Basic Wall: Knauf Finish	Walls		0.26									
		Basic Wall: Knauf Finish	Walls		2.27									
		Basic Wall: Knauf-Single	Walls		2.98									
		Basic Wall: Knauf-Single	Walls		1.78									
		Basic Wall: Knauf-Single	Walls		0.8									
		Basic Wall: Knauf-Single	Walls		3.01									
		Basic Wall: Knauf-Single	Walls		3.05									
		Basic Wall: Walls Finishing	Walls		5.14									
		Basic Wall: Walls Finishing	Walls		1.42									
		Basic Wall: Walls Finishing	Walls		0.28									
		Basic Wall: Walls Finishing	Walls		1.86									
		Basic Wall: Walls Finishing	Walls		10.39									
		Basic Wall: Walls Finishing	Walls		1.32									
		Basic Wall: Walls Finishing	Walls		5.11									
		Basic Wall: Walls Finishing	Walls		5.66									
		Basic Wall: Walls Finishing	Walls		11.8									
Basic Wall: Walls Finishing	Walls		0.83											
Basic Wall: Walls Finishing	Walls		2.96											
Basic Wall: Walls Finishing	Walls		21.81											
	Total walls painting		Walls	23.88 liter	119.38		1200	28.6	250502	25300/m2	3020314			
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78		1200	12.9	250502	25300/m2	1360634			
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57									
		kitchen Wall no.2	Walls	4	0.98									
		Wall WC no.1	Walls	4	2.66									
		Wall WC no.2	Walls	4	1.52									
		Wall WC no.3	Walls	4	2.02									
		Wall WC no.4	Walls	4	1.48									
		Bathroom Wall no.1	Walls	4	3.13									
		Bathroom Wall no.2	Walls	4	2.58									
		Bathroom Wall no.3	Walls	4	1.63									
		Bathroom Wall no.4	Walls	4	2.62									
		WC Floor	Floor	4	2.99									
		Bathroom Floor	Floor	4	2.13									
		kitchen Floor	Floor	4	8.74									
		Total Bituminous- 4mm	Total	W and F	4	34.05	0.14	1250	175	130203-411701	61950/m2	2109397.5		
		Glass	Glass	Double Glazed	Window	2*3mm	1.15							
			Glass	Double Glazed	Window	2*3mm	1.39							
			Glass	Double Glazed	Window	2*3mm	1.15							
Glass	Double Glazed		Window	2*3mm	1.15									
Glass	Double Glazed		Window	2*3mm	1.39									
Glass	Double Glazed		Window	2*3mm	1.15									
Total					7.38	0.05	2500	125	240102	63300/m2				
UPVC	UPVC	UPVC Window frame 1.7 mm	Window	1.7	3.6									
	UPVC	UPVC Window frame 1.7 mm	Window	1.7	3.6									
	Total Aluminum		Window	1.7	7.2	0.018	2700	48.6	231102	728000/m2	5241600			
Wood	Door - Panel/ HDF face	M_Single-Flush: Bathroom Door	Doors	10	3.66	0.04								
	Door - Panel/ HDF face	M_Single-Flush: WC Door	Doors	10	3.66	0.04								
	Door - Panel/ HDF face	M_Single-Flush: Bedroom Door	Doors	10	4.09	0.04								
	Total Door -frame		Doors	7	16.54m	0.05	700	36	190103-412501	58300/m	964282			
	Total Door - Hollow-core panel// HDF face		Doors	10	11.44 m2	0.11	700	77	190203	94500/m2	1081080			
	Closet		Furniture	16	17.51									
	Shoe boxes		Furniture	16	6.56									
	WC furniture		Furniture	16	2.86									
	Cabinets		Furniture	16	36.46									
	Total MDF		Furniture	16	63.39	1.01	780	791	190802	141500/m2	8969685			
Total High gloss door(shoe boxes, cabinets...)		Furniture	16	13.54	0.22	780	171.6	190902	212000/m2	2870480				
Corian solid surface countertops		Furniture	12	3.57	0.043	1780	76.54		1350000/m2	4819500				
Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	27.5m	0.021	700	14.7	191104	17000/m	467500				
All cabinets and closet accessories		Furniture	58 units			7850	22.3		29500/unit	1711000				
Doors' accessories (handle & hinge)		Furniture	3+9 units			7850	8.5		105000	315000				
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29		375000	375000			
	WC's mirror		Furniture	6	0.35	0.003	2900	10		178000	178000			
	Total mirror		Furniture	8	1.55	0.013	2900	39						
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15		68000/panel	1972000			
Package	Iranradiator-ECO24FF	79*40*34cm/Thermal capacity 20636 kcal/h	Mechanical Eq					29		4640000	4640000			
Pipes	Installations and pipes	Neo pipes- PVC pipes	Mechanical Eq	51.64m			1467	19.3		25000/m	1291000			

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IC MPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)
Split	General split-GENERAL GNR-24WN	24000Btu/hr	Mechanical Eq					44		12842000	12842000	
Copper	Copper pipe		Mechanical Eq	5m						69000/m	345000	
Glass wool	3cm thickness and density 24kg/m <sup>3</sup>		Walls	30	6.1	0.183	24	4.4	140111	12150/m <sup>2</sup>	74115	
Pipes and tabs	Kitchen, WC, and Bathroom		Mechanical Eq								3350000	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21lamps				19	010813-14	18660/unit	785000	
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45		2250000/unit	2250000	
	Basin and toilet furniture	67*42	Furniture					21		1570000/unit	1570000	
Home appliances	Sink-Alborz steel L-735	52*116	Furniture					10		1050000/unit	1050000	
	Stove	Sinjer SDG 519 Gas Hob	Furniture					17.4		1820000/unit	1820000	
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m <sup>3</sup> /h	Furniture					17		1465000/unit	1465000	
Total construction cost								11902			91993520	6132.90

Consequently, the value of the initial rehabilitation cost for each defined scenario has been calculated in [Table 6.A.7](#).

Table 6.A.7. The value of initial rehabilitation costs for scenarios 1 to 3

Initial rehabilitation costs	Scenario 1 (€)	Scenario 2 (€)	Scenario 3 (€)
a) Apartment evacuation cost	55.56	55.56	55.56
b) Initial demolition Cost	276.86	400.59	434.90
c) Designing cost	234.36	330.48	330.48
d) Construction cost	3723.06	4496.07	6132.90
e) Apartment repatriation cost	55.56	55.56	55.56
<b>Total initial rehabilitation cost</b>	<b>4345.40</b>	<b>5338.26</b>	<b>7009.40</b>

## Appendix 6.B. Maintenance cost (I2) of scenarios 1 to 3

### 6.B.1) Maintenance cost of scenario 1

Table 6.B.1. Maintenance cost of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Demolition cost per unit (Toman)	Demolition cost (Toman)	Construction cost per unit (Toman)	Construction price (Toman)	Maintenance cost for each time (Toman)	Life expectancy (Year)	Numbers of rehabilitation during 50 years	Total maintenance cost for 50 years	Total price (euro)	Total price (€/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	27.54	2.75	199500/m2	548625	984500/m3	2707375	3256000	75	0.00	0		
Cement mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	14150/m2	759006	482750/m3	1139290	1898296	25	1.00	1898296		
	Total Cement mortar 350 kg/m3	Total Cement mortar 350 kg/m3	Wall and Floor		122.14	1.91	14150/m2	1728281	482750/m3	922052.5	2650333.5	20	1.50	3975500		
Ceramic tile	Total Ceramic tile 20*20*6 mm		Walls	6	39.71	0.24	6330/m2	251364.3	101500/m2	4030565	4281929.3	20	1.50	6422894		
	Total Ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	6330/m2	339477.9	104750/m2	5617742.5	5957220.4	25	1.00	5957220		
Gypsum block	Total Gypsum block		wall	100	36.63	3.19	5090/m2	186446.7	127500/m2	4670325	4856771.7	60	0.00	0		
Gypsum Mortar	Total Gypsum Mortar	Basic Ceiling	Ceiling	1	54.51	0.05	0	0	17750/m2	967552.5	967552.5	15	2.33	2257623		
Wallpaper	Wallpaper- 0.53*10m	Total wallpaper	Walls		118.83		9750/m2	1158592.5	135000/m2	16042050	17200642.5	12	3.17	54468701		
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		0	0	25300/m2	1379103	1379103	15	2.33	3217907		
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	2050/m2	69802.5	61950/m2	2109397.5	2179200	30	0.67	1452800		
Wood (MDF)	Cabinet (Bottom)		Furniture	16	8.87		9430/m2	83644.1	116100/m2	1029807	1113451.1	14	2.57	2863160		
	WC closet		Furniture	16	2.78		9430/m2	26215.4	116100/m2	322758	348973.4	10	4.00	1395894		
	Cabinet (Top)		Furniture	16	11.22		9430/m2	105804.6	116100/m2	1302642	1408446.6	14	2.57	3621720		
	Closet		Furniture	16	7.56		9430/m2	71290.8	116100/m2	877716	949006.8	35	0.43	406717		
	MDF 50mm countertops		Furniture	50	3.23	0.22	9430/m2	30458.9	272000/m2	878560	909018.9	14	2.57	2337477		
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71m	0.021	1050/m	55345.5	17000/m	896070	951415.5	25	1.00	951416		
stainless steel	Doors' accessories (handle & hinge)		Furniture	4+12 units			3570/unit	60000	76000/unit	304000	364000	10	4.00	1456000		
	All cabinets and closet accessories		Furniture	48 units			3570/unit	171360	22500/unit	1080000	1251360	10	4.00	5005440		
Mirror	WC's mirror		Furniture	6	0.35	0.003	3900/unit	3900	115000	115000	118900	20	1.50	178350		
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq				54500/unit	54500		2677000	2731500	12	3.17	8649750		
	Saravel-TE04 400 CFM-16100 BTU/hr	122*60*21 cm	Mechanical Eq				54500/unit	54500		3175000	3229500	12	3.17	10226750		
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19m			2520/m	88539.5	25000/m	1079750	1168289.5	25	1.00	1168290		
	Kitchen.WC.Bathroom		Furniture				3570/unit	14280		1575000	1589280	12	3.17	5032720		
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lamps			3660/unit	120780	10220/unit	457000	577780	6	7.33	4237053		
Porcelain	Toilet bowl-Morvarid model	76.5*41.5*72.5/6litre	Furniture				11050/unit	11050	1950000/unit	1950000	1961050	20	1.50	2941575		
	Basin	67*42	Furniture				11050/unit	11050	670000/unit	670000	681050	15	2.33	1589117		
Home appliances	Sink-Alborz steel L-110	52*112	Furniture				0	0	685000/unit	685000	685000	10	4.00	2740000		
	Stove	Mahyar-3023	Furniture				0	0	1188000/unit	1188000	1188000	10	4.00	4752000		
	Hood	Bimax B1002U Size 90cm-680m3/h	Furniture				0	0	730000/unit	730000	730000	10	4.00	2920000		
Doors	Total frame door		Doors		16.54m	0.05	4150/m	68641	58300/m	964282	1032923	20	1.50	1549385		
	Total Door - Panel/ MDF face		Doors	10	11.44 m <sup>2</sup>	0.11	31000/unit	124000	89600/m2	1025024	1149024	20	1.50	1723536		
Stair	Stairs	Removing stairs		Floor	2m		11900/m	23800	67500/m	135000	158800	15	2.33	370533		
Window	Total Galvanized steel		Window	7	8.25		51500/unit	360500	405000/m2	3341250	3701750	30	0.67	2467833		
Total maintenance cost														148235656	9,882.38	183.01

## 6.B.2) Maintenance cost of scenario 2

Table 6.B.2. Maintenance cost of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Demolition cost per unit	Demolition cost	Construction cost per unit	Construction price (Toman)	Maintenance cost for each time	Life expectancy	Numbers of rehabilitation during 50 years	Total maintenance cost for 50 years (Toman)	Total price (euro)	Total price (€/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	199500/m3	315210	984500/m3	1555510	1870720	75	0.00	0		
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	5090/m2	11859.7	127500/m2	297075	308934.7	60	0.00	0		
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	14150/m2	759006	482750/m3	1139290	1898296	30	0.67	1265531		
	Total Cement mortar 350 kg/m3		Wall and Floor		122.66	3.04	14150/m2	1735639	482750/m3	1467560	3203199	40	0.25	800800		
Brick	Total Hollow brick block 190*180*8 mm	Total Hollow brick block 190*180*8 mm	Walls	80	33.3	2.66	199500/m3	530670	936800/m3	2491888	3022558	70	0.00	0		
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	6030/m2	206346.6	122500/m2	4191950	4398296.6	30	0.67	2932198		
	Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	6030/m3	83575.8	131750/m2	1697850	1781425.8	40	0.25	445356		
Parquet	Direct Pressure Laminat (DPL)-8mm thickness		Floor	8	39.77	0.32	5950/m2	236631.5	185000/m2	7357450	7594081.5	25	1.00	7594082		
Gypsum Mortar	Total Gypsum Mortar				103.2	0.95	0	0	37500/m2	3870000	3870000	10	4.00	15480000		
Clay plaster	Total Clay plaster	Clay plaster, thickness 15mm	Walls		50.56	0.76	0	0	22700/m2	1147712	1147712	75	0.00	0		
Double Coat paint	Total walls painting		Walls	23.85 liter	118.83		0	0	25300/m2	3006399	3006399	7	6.14	18467880		
	Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51		0	0	25300/m2	1379103	1379103	15	2.33	3217907		
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	2050/m2	69802.5	61950/m2	2109397.5	2179200	30	0.67	1452800		
Wood (MDF)	Total Door -frame		Doors	7	16.54 m	0.05	4150/m	68641	58300/m	964282	1032923	25	1.00	1032923		
	Total Door - Hollow-core panel/ MDF face		Doors	10	11.44 m2	0.11	31000/unit	93000	89600/m2	1025024	1118024	25	1.00	1118024		
	Closet		Furniture	16	16.12		9430/m2	152011.6	141500/m2	2280980	2432991.6	50	0.00	0		
	WC's furniture		Furniture	16	2.93		9430/m2	27629.9	141500/m2	414595	442224.9	25	1.00	442225		
	Shoe boxes		Furniture	16	14.31		9430/m2	134943.3	141500/m2	2024865	2159808.3	50	0.00	0		
	Cabinets		Furniture	16	41.76		9430/m2	393796.8	141500/m2	5909040	6302836.8	25	1.00	6302837		
	MDF 50mm countertops		Furniture	50	6.76	0.22	9430/m2	63746.8	385000/m2	2602600	2666346.8	25	1.00	2666347		
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm		Decorative	13	26.35 m	0.021	1050/m	27669.6	17000/m	447950	475619.6	25	1.00	475620	
stainless steel	All cabinets and closet accessories		Furniture	48 units			3570/unit	180000	29500/unit	1416000	1596000	15	2.33	3724000		
	Doors' accessories (handle & hinge)		Furniture	3+9 units			3570/unit	45000	105000/unit	315000	360000	15	2.33	840000		
Mirror	Shoes box's mirror		Furniture	8	2.05	0.02	3900/m2	7995	575000	575000	582995	35	0.43	249855		
	Closets' mirror		Furniture	8	3.84	0.03	3900/m2	14976	715000	715000	729976	35	0.43	312847		
	WC's mirror		Furniture	6	0.35	0.003	3900/m2	1365	178000	178000	179365	20	1.50	269048		
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq				54500/unit	54500		2677000	2731500	12	3.17	8649750		
	Saravel-TE04 400 CFM- 16100 BTU/hr	122*60*21 cm	Mechanical Eq				54500/unit	54500		3175000	3229500	12	3.17	10226750		
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19 m			2520/m	1079750	25000/m	1079750	2159500	25	1.00	2159500		
	Kitchen.WC.Bathroom		Furniture				3570/unit	14280		2750000	2764280	25	1.00	2764280		
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	27ss+16lamps			3660/unit	157380	18660/unit	742000	899380	10	4.00	3597520		
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture				11050/unit	11050	2250000/unit	2250000	2261050	35	0.43	969021.4286		
	Basin	67*42	Furniture				11050/unit	11050	1570000/unit	1570000	1581050	35	0.43	677592.8571		
	Sink-Alborz steel L-735	52*116	Furniture				0	0	1050000/unit	1050000	1050000	20	1.50	1575000		

Home appliances	Stove	Sinjer SDG 519 Gas Hob	Furniture				0	0	182000/unit	182000	182000	15	2.33		4246666.667										
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture				0	0	1465000/unit	1465000	1465000	15	2.33		3418333.333										
Window	Total Galvanized steel		Window	7	7.2		51500/unit	360500	405000/m2	2916000	3276500	30	0.67		2184333										
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	2050/m2	12505	17000/m2	103700	116205	30	0.67		77470										
Total maintenance cost																							109636495	7,309.10 €	135.35 €

### 6.B.3) Maintenance cost of scenario 3

Table 6.B.3. Maintenance cost of scenario 3

Material Name	Material Description	Family and Type	Category	Thickness (mm)	Area (m²)	Volume (m³)	Demolition cost per unit	Demolition cost	Construction cost per unit	Construction price (Toman)	Maintenance cost for each time	Life expectancy	Numbers of rehabilitation during 50 years	Total maintenance cost for 50 years	Total price (euro)	Total price (€/m2)
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	199500/m3	315210	984500/m3	1555510	1870720	75	0.00	0		
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	5090/m2	11859.7	127500/m2	297075	308934.7	60	0.00	0		
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	14150/m2	759006	482750/m3	1139290	1898296	40	0.25	474574		
	Total Cement mortar 350 kg/m3		Wall and Floor		87.85	1.61	14150/m2	1243077.5	482750/m3	777227.5	2020305	50	0.00	0		
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	6030/m2	206346.6	122500/m2	4191950	4398296.6	40	0.25	1099574		
	Total Ceramic tile 500*500*10 mm		Floor	10	53.63	0.54	6030/m3	323388.9	131750/m2	6569675	6893063.9	50	0.00	0		
Gypsum Mortar	Total Gypsum Mortar				105.49	0.57	0	0	17750/m2	1872447.5	1872447.5	10	4.00	7489790		
Steel	Self Tapping Screw TB 3.5 x 35 mm			200 pcs/pack			0	0		43500	43500	50	0.00	0		
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m			1 role - 90m			0	0		38700	38700	50	0.00	0		
Plasterboard	Total wall's plasterboard		Walls	12	49.63	0.6	5090/m2	252616.7	112500/m2	5583375	5835991.7	50	0.00	0		
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	5090/m2	121040.2	98500/m2	2342330	2463370.2	50	0.00	0		
Double Coat paint	Total walls painting		Walls	23.88 liter	119.38	0	0		25300/m2	3020314	3020314	7	6.14	18553357		
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78	0	0		25300/m2	1360634	1360634	15	2.33	3174813		
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	2050/m2	69802.5	61950/m2	2109397.5	2179200	30	0.67	1452800		
UPVC	Total UPVC	UPVC window	Window		7.2	0.065	1467	360500	728000/m2	5241600	5602100	25	1.00	5602100		
Wood	Total Door -frame		Doors	7	16.54 m	0.05	4150/m	68641	58300/m	964282	1032923	30	0.67	688615		
	Total Door - Hollow-core panel/ HDF face		Doors	10	11.44 m2	0.11	31000/unit	354640	94500/m2	1081080	1435720	30	0.67	957147		
	Closet		Furniture	16	17.51		9430/m2	163543.4	141500/m2	2477665	2641208.4	50	0.00	0		
	WC furniture		Furniture	16	2.86		9430/m2	26712.4	141500/m2	404690	431402.4	25	1.00	431402		
	Shoe boxes		Furniture	16	6.56		9430/m2	61270.4	141500/m2	928240	989510.4	50	0.00	0		
	Cabinets		Furniture	16	36.46		9430/m2	340536.4	141500/m2	5159090	5499626.4	25	1.00	5499626		
	Total High gloss door(shoe boxes, cabinets,...)		Furniture	16	13.54	0.22	9430/m2	126463.6	212000/m2	2870480	2996943.6	50	0.00	0		
	Corian solid surface countertops		Furniture	12	3.57	0.043	18750/m2	66937.5	1350000/m2	4819500	4886437.5	20	1.50	7329656		
Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	27.5 m	0.021	1050/m	28875	17000/m	467500	496375	25	1.00	496375			
stainless Steel	All cabinets and closet accessories		Furniture	58 units			3570/unit	217500	29500/unit	1711000	1928500	15	2.33	4499833		
	Doors' accessories (handle & hinge)		Furniture	3+9 units			3570/unit	45000	105000	315000	360000	15	2.33	840000		
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	3900/m2	4680	375000	375000	379680	35	0.43	162720		

	WC's mirror		Furniture	6	0.35	0.003	3900/m2	1365	178000	178000	179365	20	1.50	269048		
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			54500/unit	109000	68000/panel	1972000	2081000	40	0.25	520250		
Package	Iranradiator-ECO24FF	79*40*34cm/Thermal capacity 20636 kcal/h	Mechanical Eq				125000/unit	125000	4640000	4640000	4765000	40	0.25	1191250		
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			2520/m	105493	25000/m	1291000	1396493	50	0.00	0		
Split and compressor	General split-GENERAL GNR-24WN	24000Btu/hr	Mechanical Eq				125000/unit	125000	12842000	12842000	12967000	20	1.50	19450500		
Copper	Copper pipe		Mechanical Eq	5m			2050/m	10250	69000/m	345000	355250	20	1.50	532875		
Glass wool	3cm thickness and density 24kg/m3		Walls	30	6.1	0.183	2050/m2	12505	12150/m2	74115	86620	30	0.67	57747		
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				3570/unit	14280		3350000	3364280	30	0.67	2242853		
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21lamps			3660/unit	157380	18660/unit	742000	899380	10	4.00	3597520		
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture				11050/unit	11050	2250000/unit	2250000	2261050	35	0.43	969021		
	Basin and toilet furniture	67*42	Furniture				11050/unit	11050	1570000/unit	1570000	1581050	35	0.43	677593		
Home appliances	Sink-Alborz steel L-735	52*116	Furniture				0	0	1050000/unit	1050000	1050000	20	1.50	1575000		
	Stove	Sinjer SDG 519 Gas Hob	Furniture				0	0	1820000/unit	1820000	1820000	15	2.33	4246667		
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture				0	0	1465000/unit	1465000	1465000	15	2.33	3418333		
Total maintenance cost														97501040	€ 6,500.07	120.37 €



## Appendix 6.C. Demolition cost (I<sub>3</sub>) of scenarios 1 to 3

### 6.C.1) Demolition cost of scenario 1

Table 6.C.1. Demolition cost of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Demolition cost per unit (Toman)	Demolition cost (Toman)	Waste disposal cost (Toman)	Total demolition cost (Toman)	Total demolition cost (euro)	Total demolition cost (euro/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	27.54	2.75	1220	3355	199500/m3	548625				
Cement mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	14150/m2	759006				
	Total Cement mortar 350 kg/m3	Total Cement mortar 350 kg/m3	Wall and Floor		122.14	1.91	2100	4011	14150/m2	1728281				
Ceramic tile	Total Ceramic tile 20*20*6 mm		Walls	6	39.71	0.24	1700	408	6330/m2	251364.3				
	Total Ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	6330/m2	339477.9				
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	199500/m3	636405				
Gypsum Mortar	Total Gypsum Mortar	Basic Ceiling	Ceiling	10	54.51	0.54	1300	702	0	0				
Wallpaper	Wallpaper- 0.53*10m	Total wallpaper	Walls		118.83		950	165	9750/m2	1158592.5				
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	0	0				
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	2050/m2	69802.5				
Wood (MDF)	Cabinet (Bottom)		Furniture	16	8.87	0.14	780	110.70	9430/m2	83644.1				
	WC closet		Furniture	16	2.78	0.04	780	34.69	9430/m2	26215.4				
	Cabinet (Top)		Furniture	16	11.22	0.18	780	140.03	9430/m2	105804.6				
	Closet		Furniture	16	7.56	0.12	780	94.35	9430/m2	71290.8				
	MDF 50mm countertops		Furniture	50	3.23	0.22	780	171.60	9430/m2	30458.9				
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71m	0.021	780	29.3	1050/m	55345.5				
stainless steel	Doors' accessories (handle & hinge)		Furniture	4+12 units			8000	7	3570/unit	60000				
	All cabinets and closet accessories		Furniture	48 units			8000	28	3570/unit	171360				
Mirror	WC's mirror		Furniture	6	0.35	0.003	2900	9	3900/unit	3900				
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					31	54500/unit	54500				
	Saravel-TE04 400 CFM-16100 BTU/hr	122*60*21 cm	Mechanical Eq					37	54500/unit	54500				
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19m			8880	67.5	2520/m	88539.5				
	Kitchen.WC.Bathroom		Furniture					13	3570/unit	14280				
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lamps				13	3660/unit	120780				
Porcelain	Toilet bowl-Morvarid model	76.5*41.5*72.5/6litre	Furniture					45	11050/unit	11050				
	Basin	67*42	Furniture					12	11050/unit	11050				
Home appliances	Sink-Alborz steel L-110	52*112	Furniture					9	0	0				
	Stove	Mahyar-3023	Furniture					89	0	0				
	Hood	Bimax B1002U Size 90cm-680m3/h	Furniture					19	0	0				
Doors	Total frame door		Doors		16.54m	0.05	700	42	4150/m	68641				
	Total Door - Panel/ MDF face		Doors	10	11.44 m2	0.11	700	77	31000/unit	93000				
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm		0.05	2500	125	28400/m2	242536				
Filler	Filler		Floor		5.12	1.55	1700	2635	199500/m3	309225				
Window	Total Galvanized steel		Window	2	8.25	0.016	7850	125.6	51500/unit	360500				
Stairs	Removing stairs	Removing stairs	Floor		2m		1700	52	11900/m	23800				
Total demolition cost								21157.066		7551975	1,441,854	8,993,829	599.59	11.10

## 6.C.2) Demolition cost of scenario 2

Table 6.C.2. Demolition cost of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Demolition cost per unit (Toman)	Demolition cost (Toman)	Waste disposal cost (Toman)	Total demolition cost (Toman)	Total demolition cost (euro)	Total demolition cost (euro/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	199500/m3	315210				
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	199500/m3	636405				
Cement mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	14150/m2	759006				
	Total Cement mortar 350 kg/m3	Total Cement mortar 350 kg/m3	Wall and Floor		122.14	1.91	2100	4011	14150/m2	1728281				
Brick	Total Hollow brick block 190*180*8 mm	Total Hollow brick block 190*180*8 mm	Walls	80	33.3	2.66	1300	3458	199500/m3	530670				
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	6030/m2	206346.6				
	Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	1900	266	6030/m3	83575.8				
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	39.77	0.32	1160	371.2	5950/m2	236631.5				
Gypsum Mortar	Total Gypsum Mortar				103.2	0.95	1300	1237	0	0				
Clay plaster	Total Clay plaster	Clay plaster, thickness 15mm	Walls		50.56	0.76	1600	1216	0	0				
Double Coat paint	Total walls painting		Walls	23.85 liter	118.83		1200	28.4	0	0				
	Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	0	0				
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	2050/m2	69802.5				
Wood(MDF)	Total Door -frame		Doors	7	16.54 m	0.05	700	36	4150/m	68641				
	Total Door - Hollow-core panel/ MDF face		Doors	10	11.44 m <sup>2</sup>	0.11	700	77	31000/unit	93000				
	Closet		Furniture	16	16.12	0.26	780	201.18	9430/m2	152011.6				
	WC's furniture		Furniture	16	2.93	0.05	780	36.57	9430/m2	27629.9				
	Shoe boxes		Furniture	16	14.31	0.23	780	178.59	9430/m2	134943.3				
	Cabinets		Furniture	16	41.76	0.67	780	521.16	9430/m2	393796.8				
	MDF 50mm countertops		Furniture	50	6.76	0.34	780	263.64	9430/m2	63746.8				
Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	26.35 m	0.021	780	29.3	1050/m	27669.6					
stainless steel	All cabinets and closet accessories		Furniture	48 units			8000	32	3570/unit	180000				
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	3570/unit	45000				
Mirror	Shoes box's mirror		Furniture	8	2.05	0.02	2900	58	3900/m2	7995				
	Closets' mirror		Furniture	8	3.84	0.03	2900	87	3900/m2	14976				
	WC's mirror		Furniture	6	0.35	0.003	2900	9	3900/m2	1365				
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanica 1 Eq					31	54500/unit	54500				
	Saravel-TE04 400 CFM-16100 BTU/hr	122*60*21 cm	Mechanica 1 Eq					37	54500/unit	54500				
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanica 1 Eq	43.19 m			8880	67.5	2520/m	1079750				
	Kitchen.WC.Bathroom		Furniture					13	3570/unit	14280				
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	27ss+16lamps				19	3660/unit	157380				
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45	11050/unit	11050				
	Basin	67*42	Furniture					13	11050/unit	11050				
Home appliances	Sink-Alborz steel L-735	52*116	Furniture					10	0	0				
	Stove	Sinjer SDG 519 Gas Hob	Furniture					17.4	0	0				

	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture					17	0	0					
Window	Total Galvanized steel		Window	2	7.2	0.016	7850	106.8	51500/unit	360500					
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm	7.2	0.05	2500	125	28400/m2	242536					
Filler	Filler		Floor		2.13	1.01	1700	1717	199500/m3	201495					
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	30	5.8	2050/m2	12505					
<b>Total demolition cost</b>										24107	7976249.4	1,642,956	9,619,205	<b>641.28</b>	<b>11.88</b>

### 6.C.3) Demolition cost of scenario 3

Table 6.C.3. Demolition cost of scenario 3

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Demolition cost per unit (Toman)	Demolition cost (Toman)	Waste disposal cost (Toman)	Total demolition cost (Toman)	Total demolition cost (euro)	Total demolition cost (euro/m2)
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	199500/m3	315210				
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	199500/m3	636405				
Cement mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	14150/m2	759006				
	Total Cement mortar 350 kg/m3	Total Cement mortar 350 kg/m3	Wall and Floor		122.14	1.91	2100	4011	14150/m2	1728281				
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	6030/m2	206346.6				
	Total Ceramic tile 500*500*10 mm		Floor	10	53.63	0.54	1900	1026	6030/m3	323388.9				
Gypsum Mortar	Total Gypsum Mortar				105.49	0.57	1300	741	0	0				
Steel	Total Knauf steel stud			1.2	30.61	0.036	7800	280.8	0	0				
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	23.78 m <sup>2</sup>	0.03	7800	234	0	0				
	Self-Tapping Screw TB 3.5 x 35 mm				200 pcs/pack		7800	0.85	0	0				
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m				1 role - 90m		550	0.45	0	0				
Plasterboard	Total wall's plasterboard		Walls	12	49.63	0.6	760	425.6	5090/m2	252616.7				
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	760	212.8	5090/m2	121040.2				
Double Coat paint	Total walls painting		Walls	23.88 liter	119.38	0	1200	28.6	0	0				
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78	0	1200	12.9	0	0				
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	2050/m2	69802.5				
Glass	Total glass				7.02	0.05	2500	125	28400/m2	242536				
UPVC	Total UPVC	UPVC window	Window		7.2	0.065	1467	95.35	51500/unit	360500				
Wood	Total Door -frame		Doors	7	16.54 m	0.05	700	36	4150/m	68641				
	Total Door - Hollow-core panel/HDF face		Doors	10	11.44 m <sup>2</sup>	0.11	700	77	31000/unit	354640				
	Closet		Furniture	16	17.51	0.28	780	218.52	9430/m2	163543.4				
	WC furniture		Furniture	16	2.86	0.05	780	35.69	9430/m2	26712.4				
	Shoe boxes		Furniture	16	6.56	0.10	780	81.87	9430/m2	61270.4				
	Cabinets		Furniture	16	36.46	0.58	780	455.02	9430/m2	340536.4				
	Total High gloss door(shoe boxes, cabinets,...)		Furniture	16	13.54	0.22	780	171.60	9430/m2	126463.6				
	Corian solid surface countertops		Furniture	12	3.57	0.043	1780	76.54	18750/m2	66937.5				
Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	27.5m	0.021	780	14.7	1050/m	28875					
Stainless Steel	All cabinets and closet accessories		Furniture	58 units			8000	26.4	3570/unit	217500				
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	3570/unit	45000				
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	3900/m2	4680				

	WC's mirror		Furniture	6	0.35	0.003	2900	10	3900/m2	1365					
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	54500/unit	109000					
Package	Iranradiator-ECO24FF	79*40*34cm/Thermal capacity 20636 kcal/h	Mechanical Eq					29	125000/unit	125000					
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	19.3	2520/m	105493					
Split and compressor	General split-GENERAL GNR-24WN	24000Btu/hr	Mechanical Eq					44	125000/unit	125000					
Copper	Copper pipe		Mechanical Eq	5m				4	2050/m	10250					
Glass wool	3cm thickness and density 24kg/m3		Walls	30	6.1	0.183	24	4.4	2050/m2	12505					
Pipes and tabs	Kitchen.WC.Bathroom		Furniture					13	3570/unit	14280					
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21la mps				19	3660/unit	157380					
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45	11050/unit	11050					
	Basin and toilet furniture	67*42	Furniture					21	11050/unit	11050					
Home appliances	Sink-Alborz steel L-735	52*116	Furniture					10	0	0					
	Stove	Sinjer SDG 519 Gas Hob	Furniture					17.4	0	0					
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture					17	0	0					
Filler	Filler		Floor		2.13	1.01	1700	1717	199500/m3	201495					
<b>Total demolition cost</b>															
								20179		7403800.6	1,375,202	8,779,003	585.27	10.84	

# Appendix 6.D. Rehabilitation process time (I<sub>5</sub>) of scenarios 1 to 3

## 6.D.1) Rehabilitation process time of scenario 1

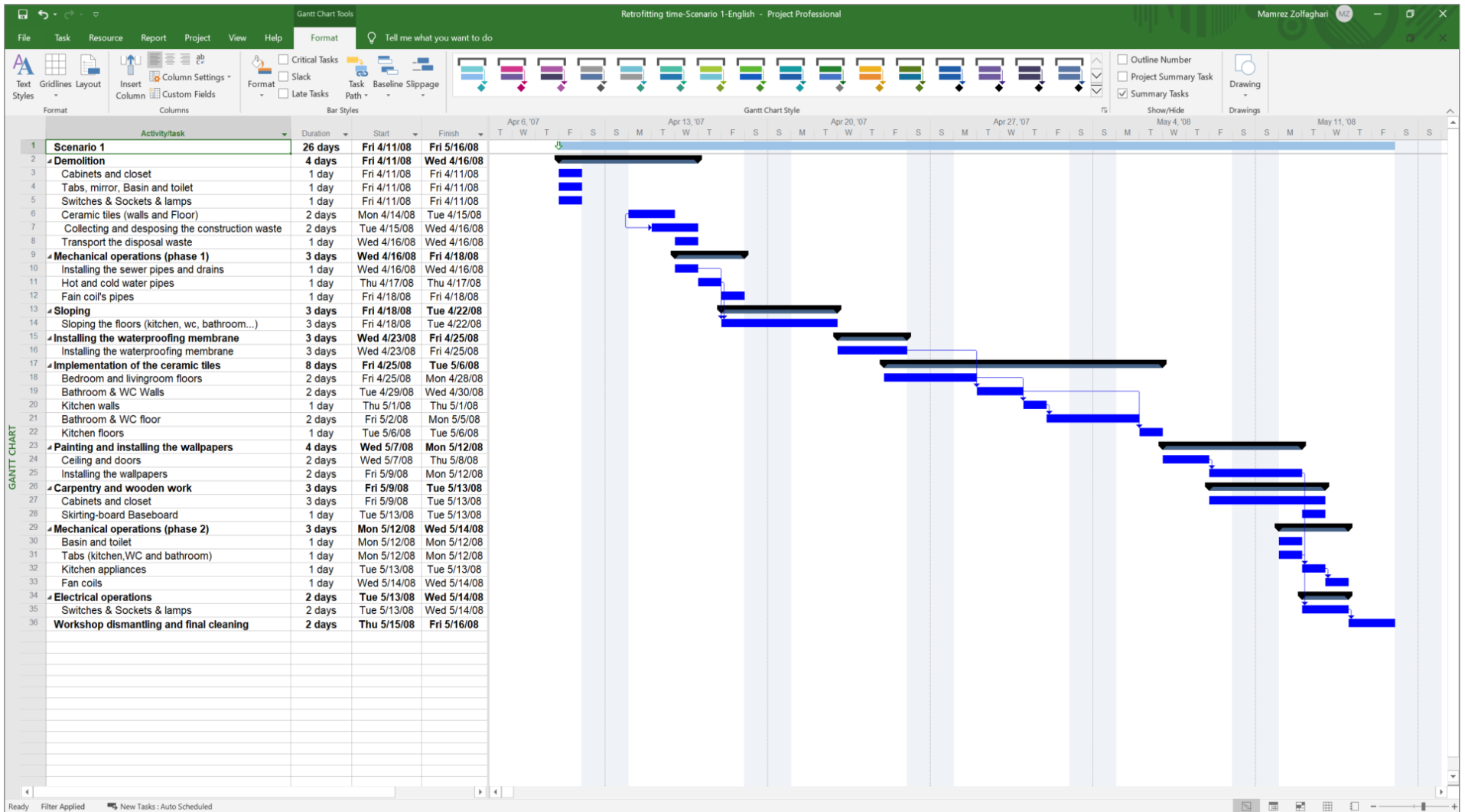


Figure 6.D.1. The rehabilitation schedule of scenario 1, developed by Microsoft Project Professional

## 6.D.2) Rehabilitation process time of scenario 2

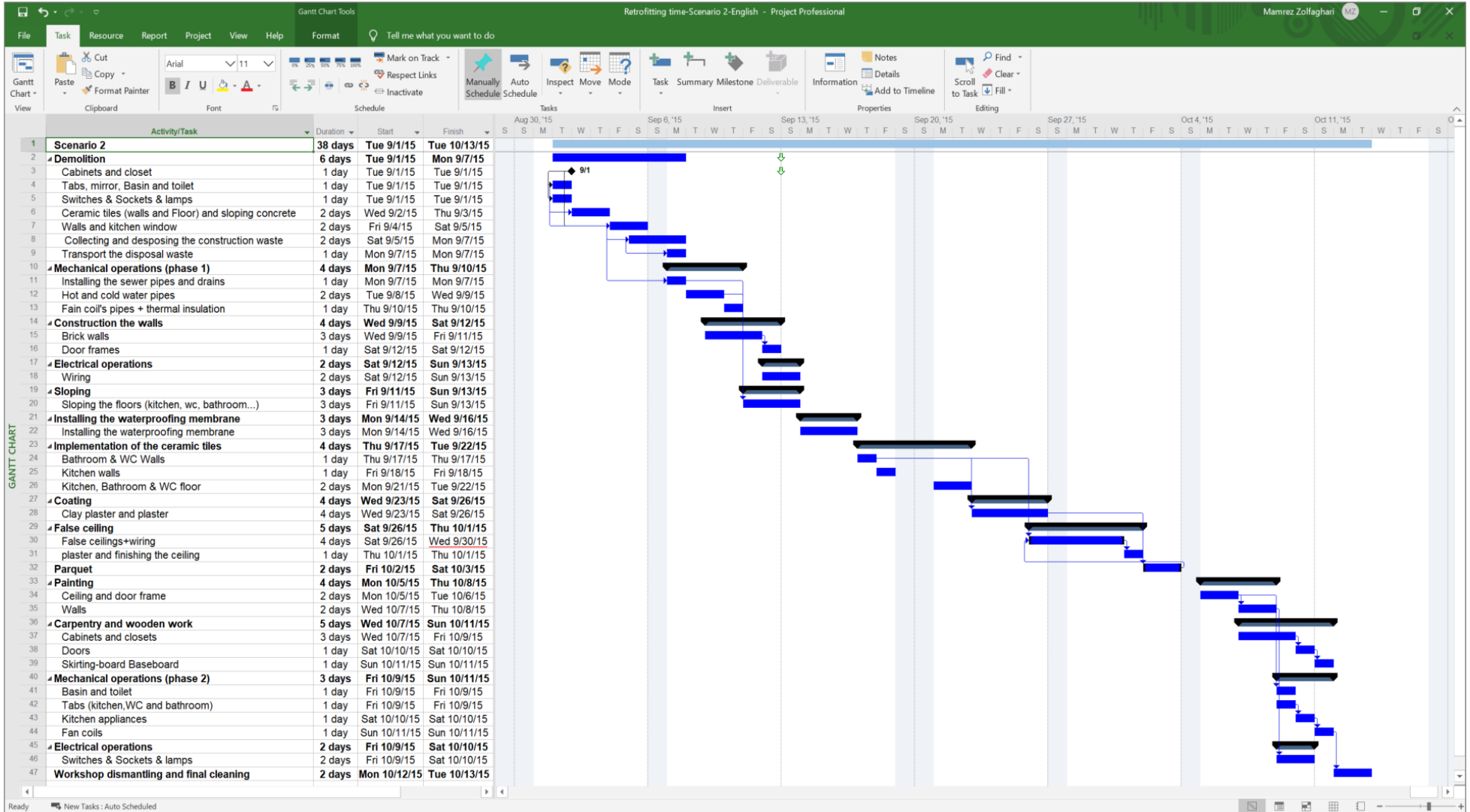


Figure 6.D.2. The rehabilitation schedule of scenario 2, developed by Microsoft Project Professional

### 6.D.3) Rehabilitation process time of scenario 3

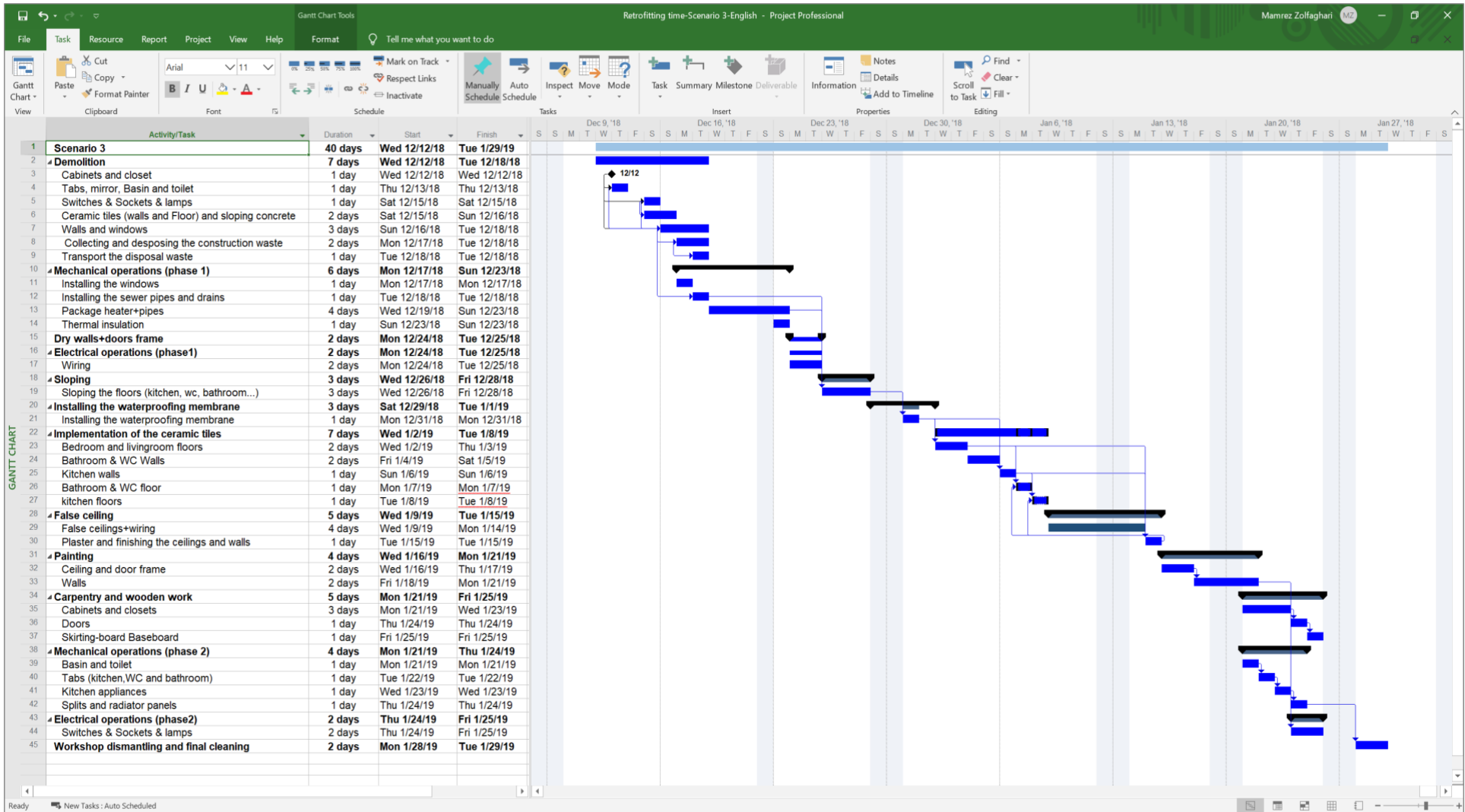


Figure 6.D.3. The rehabilitation schedule of scenario 3, developed by Microsoft Project Professional

## Appendix 6.E. Embodied Energy (EE – I<sub>6</sub>) and Embodied Carbon (EC – I<sub>7</sub>) of scenarios 1 to 3

### 6.E.1) EE and EC of scenario 1

Table 6.E.1. EE and EC of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Life expectancy	Numbers of rehabilitation during 50 years	Total applied material during 50 years	EE coefficient (MJ/kg)	EC coefficient (kgCO <sub>2</sub> /kg)	Total EE (MJ)	Total EC (kgCO <sub>2</sub> )
Cement block	Total cement block 400*200*100		Walls	100	27.54	2.75	1220	3355	75	0.67	2236.7	4.51	0.74	10087.4	1655.1
Cement mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	25	2.00	7552.0	1.33	0.22	10044.2	1661.4
	Total Cement mortar 350 kg/m3	Total Cement mortar 350 kg/m3	Wall and Floor		122.14	1.91	2100	4011	20	2.50	10027.5	0.86	0.14	8623.7	1403.9
Ceramic tile	Total Ceramic tile 20*20*6 mm		Walls	6	39.71	0.24	1700	408	20	2.50	1020.0	11	0.71	11220.0	724.2
	Total Ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	25	2.00	2052.0	12	0.78	24624.0	1600.6
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	60	0.83	2924.2	4.27	0.26	12486.2	760.3
Gypsum Mortar	Total Gypsum Mortar	Basic Ceiling	Ceiling	10	54.51	0.54	1300	702	15	3.33	2340.0	1.8	0.13	4212.0	304.2
Wallpaper	Wallpaper- 0.53*10m	Total wallpaper	Walls		118.83		950	165	12	4.17	687.5	36.4	1.93	25025.0	1326.9
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	70	2.91	3103.3	129.0
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	51	0.55	14875.0	160.4
Wood (MDF)	Cabinet (Bottom)		Furniture	16	8.87	0.14	780	110.70	14	3.57	395.3	11	-0.93	4348.8	-367.7
	WC closet		Furniture	16	2.78	0.04	780	34.69	10	5.00	173.5	11	-0.93	1908.2	-161.3
	Cabinet (Top)		Furniture	16	11.22	0.18	780	140.03	14	3.57	500.1	11	-0.93	5501.0	-465.1
	Closet		Furniture	16	7.56	0.12	780	94.35	35	1.43	134.8	11	-0.93	1482.6	-125.3
	MDF 50mm countertops		Furniture	50	3.23	0.22	780	171.60	14	3.57	612.9	11	-0.93	6741.4	-570.0
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71 m	0.021	780	29.3	25	2.00	58.6	11	-0.93	644.6	-54.5
stainless steel	Doors' accessories (handle & hinge)		Furniture	4+12 units			8000	7	10	5.00	35.0	56.7	6.15	1984.5	215.3
	All cabinets and closet accessories		Furniture	48 units			8000	28	10	5.00	140.0	56.7	6.15	7938.0	861.0
Mirror	WC's mirror		Furniture	6	0.35	0.003	2900	9	20	2.50	22.5	23.5	1.35	528.8	30.4
Fan coil	Saravel-TE02 200 CFM-7800 BTU/hr	102*60*21 cm	Mechanical Eq					68	12	4.17	283.3	1915.4	206.2	7980.8	859.2
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19m			7880	67.5	25	2.00	135.0	25.8	2.01	3483.0	271.4
	Kitchen,WC,Bathroom		Furniture				8000	13	12	4.17	54.2	56.7	6.15	3071.3	333.1
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lam ps				13	6	8.33	108.3	77.2	3.23	8363.3	349.9
Porcelain	Toilet bowl-Morvarid model	76.5*41.5*72.5/6litre	Furniture					45	20	2.50	112.5	29	1.61	3262.5	181.1
	Basin	67*42	Furniture					12	15	3.33	40.0	29	1.61	1160.0	64.4
Doors	Total frame door		Doors		16.54 m	0.05	700	42	20	2.50	105.0	11	-0.93	1155.0	-97.7
	Total Door - Panel/ MDF face		Doors	10	11.44 m <sup>2</sup>	0.11	700	77	20	2.50	192.5	11	-0.93	2117.5	-179.0
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm		0.05	2500	125	15	3.33	416.7	15	0.91	6250.0	379.2
Filler	Filler		Floor		5.12	1.55	1700	2635	70	0.71	1882.1	2.85	0.21	5364.1	395.3
Window	Total Galvanized steel		Window	2	8.25	0.016	7850	125.6	30	1.67	209.3	29.5	2.12	6175.3	443.8
Filler	Stairs	Removing stairs	Floor	2m			1700	52	15	3.33	173.3	2.85	0.21	494.0	36.4
<b>Total EE and EC</b>														<b>204,255</b>	<b>12,126</b>



## 6.E.2) EE and EC of scenario 2

Table 6.E.2. EE and EC of scenario 2

Material Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Life expectancy	Numbers of rehabilitation during 50 years	Total applied material during 50 years	EE coefficient (MJ/kg)	EC coefficient (kgCO <sub>2</sub> /kg)	Total EE (MJ)	Total EC (kgCO <sub>2</sub> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	4.51	0.74	5795.7	950.9
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	4.27	0.26	900.3	54.8
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	30	1.67	6293.3	1.33	0.22	8370.1	1384.5
	Total Cement mortar 350 kg/m3		W and F		122.66	3.04	2100	6384	40	1.25	7980.0	0.86	0.14	6862.8	1117.2
Brick	Total Hollow brick block 190*180*8 mm	Total Hollow brick block 190*180*8 mm	Walls	80	33.3	2.66	1300	3458	70	0.71	2470.0	3	0.26	7410.0	642.2
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	30	1.67	595.0	11	0.71	6545.0	422.5
	Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	1900	266	40	1.25	332.5	12	0.78	3990.0	259.4
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	39.77	0.32	1160	371.2	25	2.00	742.4	12	-0.84	8908.8	-623.6
Gypsum Mortar	Total Gypsum Mortar				103.2	0.95	1300	1237	10	5.00	6185.0	1.8	0.13	11133.0	804.1
Clay plaster	Total Clay plaster	Clay plaster, thickness 15mm	Walls		50.56	0.76	1600	1216	75	0.67	810.7	3	0.23	2432.0	186.5
Double Coat paint	Total walls painting		Walls	23.85 liter	118.83		1200	28.4	7	7.14	202.9	70	2.91	14200.0	590.3
	Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	70	2.91	3103.3	129.0
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	51	0.55	14875.0	160.4
Wood(MDF)	Total Door -frame		Doors	7	16.54 m	0.05	700	36	25	2.00	72.0	11	-0.93	792.0	-67.0
	Total Door - Hollow-core panel/ MDF face		Doors	10	11.44 m <sup>2</sup>	0.11	700	77	25	2.00	154.0	11	-0.93	1694.0	-143.2
	Closet		Furniture	16	16.12	0.26	780	201.18	50	1.00	201.2	11	-0.93	2213.0	-187.1
	WC's furniture		Furniture	16	2.93	0.05	780	36.57	25	2.00	73.1	11	-0.93	804.5	-68.0
	Shoe boxes		Furniture	16	14.31	0.23	780	178.59	50	1.00	178.6	11	-0.93	1964.5	-166.1
	Cabinets		Furniture	16	41.76	0.67	780	521.16	25	2.00	1042.3	11	-0.93	11465.6	-969.4
	MDF 50mm countertops		Furniture	50	6.76	0.34	780	263.64	25	2.00	527.3	11	-0.93	5800.1	-490.4
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	26.35 m	0.021	780	29.3	25	2.00	58.6	11	-0.93	644.6	-54.5
Stainless steel	All cabinets and closet accessories		Furniture	48 units			8000	32	15	3.33	106.7	56.7	6.15	6048.0	656.0
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	15	3.33	28.3	56.7	6.15	1606.5	174.3
Mirror	Shoes box's mirror		Furniture	8	2.05	0.02	2900	58	35	1.43	82.9	23.5	1.35	1947.1	111.9
	Closets' mirror		Furniture	8	3.84	0.03	2900	87	35	1.43	124.3	23.5	1.35	2920.7	167.8
	WC's mirror		Furniture	6	0.35	0.003	2900	9	20	2.50	22.5	23.5	1.35	528.8	30.4
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					68	12	4.17	283.3	1915.4	206.2	7980.8	859.2
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19 m			7880	67.5	25	2.00	135.0	25.8	2.01	3483.0	271.4
	Kitchen.WC.Bathroom		Furniture				8000	13	25	2.00	26.0	56.7	6.15	1474.2	159.9
Plastics (PVC)	Switches & Sockets & lamps & wire		Electrical Eq	27ss+16la mps				19	10	5.00	95.0	77.2	3.23	7334.0	306.9
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45	35	1.43	64.3	29	1.61	1864.3	103.5
	Basin	67*42	Furniture					13	35	1.43	18.6	29	1.61	538.6	29.9
Window	Total Galvanized steel		Window	2	7.2	0.016	7850	106.8	30	1.67	178.0	29.5	2.12	5251.0	377.4
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm	7.2	0.05	2500	125	30	1.67	208.3	15	0.91	3125.0	189.6
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	2.85	0.21	3495.3	257.6
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	30	5.8	30	1.67	9.7	16.6	1.28	160.5	12.4
Total EE and EC														<b>167,662</b>	<b>7,640</b>

### 6.E.3) EE and EC of scenario 3

Table 6.E.3. EE and EC of scenario 3

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Life expectancy	Numbers of rehabilitation during 50 years	Total applied material during 50 years	EE coefficient (MJ/kg)	EC coefficient (kgCO <sub>2</sub> /kg)	Total EE (MJ)	Total EC (kgCO <sub>2</sub> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	4.51	0.74	5795.7	950.9
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	4.27	0.26	900.3	54.8
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	40	1.25	4720.0	1.33	0.22	6277.6	1038.4
	Total Cement mortar 350 kg/m3		Wall and Floor		87.85	1.61	2100	3381	50	1.00	3381.0	0.86	0.14	2907.7	473.3
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	40	1.25	446.3	11	0.71	4908.8	316.8
	Total Ceramic tile 500*500*10 mm		Floor	10	53.63	0.54	1900	1026	50	1.00	1026.0	12	0.78	12312.0	800.3
Gypsum Mortar	Total Gypsum Mortar				105.49	0.57	1300	741	10	5.00	3705.0	1.8	0.13	6669.0	481.7
Steel	Total Knauf steel stud			1.2	30.61	0.036	7800	280.8	50	1.00	280.8	28.5	2.09	8002.8	586.9
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	23.78 m <sup>2</sup>	0.03	7800	234	50	1.00	234.0	28.5	2.09	6669.0	489.1
	Self Tapping Screw TB 3.5 x 35 mm			200 pcs/pack			7800	0.85	50	1.00	0.9	28.5	2.09	24.2	1.8
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m			1 role - 90m			550	0.45	50	1.00	0.5	28	1.54	12.6	0.7
Plasterboard	Total wall's plasterboard		Walls	12	49.63	0.6	760	425.6	50	1.00	425.6	6.75	0.39	2872.8	166.0
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	760	212.8	50	1.00	212.8	6.75	0.39	1436.4	83.0
Double Coat paint	Total walls painting		Walls	23.88 liter	119.38	0	1200	28.6	7	7.14	204.3	70	2.91	14300.0	594.5
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78	0	1200	12.9	15	3.33	43.0	70	2.91	3010.0	125.1
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	51	0.55	14875.0	160.4
Glass	Total glass				7.02	0.05	2500	125	25	2.00	250.0	15	0.91	3750.0	227.5
UPVC	Total UPVC window	UPVC window	Window		7.2	0.065	1467	95.35	25	2.00	190.7	69.4	3.16	13234.6	602.6
Wood	Total Door -frame		Doors	7	16.54 m	0.05	700	36	30	1.67	60.0	11	-0.93	660.0	-55.8
	Total Door - Hollow-core panel/HDF face		Doors	10	11.44 m <sup>2</sup>	0.11	700	77	30	1.67	128.3	11	-0.93	1411.7	-119.4
	Closet		Furniture	16	17.51	0.28	780	218.52	50	1.00	218.5	11	-0.93	2403.8	-203.2
	WC furniture		Furniture	16	2.86	0.05	780	35.69	25	2.00	71.4	11	-0.93	785.2	-66.4
	Shoe boxes		Furniture	16	6.56	0.10	780	81.87	50	1.00	81.9	11	-0.93	900.6	-76.1
	Cabinets		Furniture	16	36.46	0.58	780	455.02	25	2.00	910.0	11	-0.93	10010.5	-846.3
	Total High gloss door(shoe boxes, cabinets,...)		Furniture	16	13.54	0.22	780	171.60	50	1.00	171.6	11	-0.93	1887.6	-159.6
Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	27.5m	0.021	780	14.7	25	2.00	29.4	11	-0.93	323.4	-27.3	
Stainless Steel	All cabinets and closet accessories		Furniture	58 units			8000	26.4	15	3.33	88.0	56.7	6.15	4989.6	541.2
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	15	3.33	28.3	56.7	6.15	1606.5	174.3
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.4	23.5	1.35	973.6	55.9
	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.0	23.5	1.35	587.5	33.8
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanica 1 Eq	3units/29 panels			2730	39.15	40	1.25	48.9	157.1	8.78	196.4	11.0
Package	Iranradiator-ECO24FF	79*40*34cm/Thermal capacity 20636 kcal/h	Mechanica 1 Eq					29	40	1.25	36.3	832.7	79.9	1040.9	99.9
Pipes	Installations and pipes	Neo pipes	Mechanica 1 Eq	51.64m			1467	19.3	50	1.00	19.3	67.5	3.23	1302.8	62.3
Split and compressor	General split-GENERAL GNR-24WN	24000Btu/hr	Mechanica 1 Eq					44	20	2.50	110.0	1702.8	139.30	4257.0	348.3

Copper	Copper pipe		Mechanical Eq	5m				4	20	2.50	10.0	57	3.81	570.0	38.1
Glass wool	3cm thickness and density 24kg/m3		Walls	30	6.1	0.183	24	4.4	30	1.67	7.3	28	1.35	205.3	9.9
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				8000	13	30	1.67	21.7	56.7	6.15	1228.5	133.3
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21lamps				19	10	5.00	95.0	77.2	3.23	7334.0	306.9
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45	35	1.43	64.3	29	1.61	1864.3	103.5
	Basin and toilet furniture	67*42	Furniture					21	35	1.43	30.0	29	1.61	870.0	48.3
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	2.85	0.21	3495.3	257.6
<b>Total EE and EC</b>														<b>156,863</b>	<b>7,824</b>

Table 6.E.4. Embodied Energy (EE) and Embodied Carbon (EC) of scenarios 1 to 3

	Scenario 1	Scenario 2	Scenario 3
<b>I6. Embodied Energy (EE), MJ/m2</b>	3,783	3,105	2,905
<b>I7. Embodied Carbon (EC), kgCO2/m2</b>	225	141	145

## Appendix 6.F. Embodied Water (EW- I<sub>8</sub>) of scenarios 1 to 3

### 6.F.1) EW of scenario 1

Table 6.F.1. EW of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	EWC (l/kg)	EW (l)
Cement block	Total cement block 400*200*100		Walls	100	27.54	2.75	1220	3355	75	0.67	2236.7	3.937	8805.76
Cement mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	25	2.00	7552.0	2.768	20903.94
	Total Cement mortar 350 kg/m3		Wall and Floor		122.14	1.91	2100	4011	20	2.50	10027.5	3.329	33381.55
Ceramic tile	Total Ceramic tile 20*20*6 mm		Walls	6	39.71	0.24	1700	408	20	2.50	1020.0	14.453	14742.06
	Total Ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	25	2.00	2052.0	14.453	29657.56
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	60	0.83	2924.2	0.84	2456.30
Gypsum Mortar	Total Gypsum Mortar	Basic Ceiling	Ceiling	10	54.51	0.54	1300	702	15	3.33	2340.0	0.46	1076.40
Wallpaper	Wallpaper- 0.53*10m	Total wallpaper	Walls		118.83	0.1737	950	165	12	4.17	687.5	11.8	8112.50
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	4.58	203.05
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	11	3208.33
Wood (MDF)	Cabinet (Bottom)		Furniture	16	8.87	0.14	780	110.70	14	3.57	395.3	8.788	3474.32
	WC closet		Furniture	16	2.78	0.04	780	34.69	10	5.00	173.5	8.788	1524.47
	Cabinet (Top)		Furniture	16	11.22	0.18	780	140.03	14	3.57	500.1	8.788	4394.80
	Closet		Furniture	16	7.56	0.12	780	94.35	35	1.43	134.8	8.788	1184.48
	MDF 50mm countertops		Furniture	50	3.23	0.22	780	171.60	14	3.57	612.9	8.788	5385.79
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71m	0.021	780	29.3	25	2.00	58.6	8.788	514.98
steel	Doors' accessories (handle & hinge)		Furniture	4+12 units		0.0009	8000	7	10	5.00	35.0	98.64	3452.40
	All cabinets and closet accessories		Furniture	48 units		0.0035	8000	28	10	5.00	140.0	98.64	13809.60
Mirror	WC's mirror		Furniture	6	0.35	0.0031	2900	9	20	2.50	22.5	24.75	556.88
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					68	12	4.17	283.3	6665.8 l/unit	27796.39
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19m		0.0086	7880	67.5	25	2.00	135.0	98.64	13316.40
	Kitchen,WC.Bathroom		Furniture			0.0016	8000	13	12	4.17	54.2	98.64	5343.00
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lamps		0.0089	1467	13	6	8.33	108.3	44.2	4788.33
Porcelain	Toilet bowl-Morvarid model	76.5*41.5*72.5/6litre	Furniture		1.87	0.0187	2403	45	20	2.50	112.5	0.2939 m3/m2	1373.98
	Basin	67*42	Furniture		0.5	0.0050	2403	12	15	3.33	40.0	0.2939 m3/m2	489.34
Doors	Total frame door		Doors		16.54m	0.05	700	42	20	2.50	105.0	8.788	922.74
	Total Door - Panel/ MDF face		Doors	10	11.44 m2	0.11	700	77	20	2.50	192.5	8.788	1691.69
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm		0.05	2500	125	15	3.33	416.7	16.537	6890.42
Filler	Filler		Floor		5.12	1.55	1700	2635	70	0.71	1882.1	2.76	5194.71
Window	Total Galvanized steel		Window	2	8.25	0.016	7850	125.6	30	1.67	209.3	98.64	20648.64
	Stairs	Removing stairs	Floor	2m		0.0306	1700	52	15	3.33	173.3	2.76	478.40
<b>Total EW</b>													<b>245,779</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity; EWC=Embodied water coefficient; EW= Embodied water.

### 6.F.2) EW of scenario 2

Table 6.F.2. EW of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	EWC (l/kg)	EW (l)
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	3.937	5059.31
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	0.84	177.10
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	30	1.67	6293.3	2.768	17419.95
	Total Cement mortar 350 kg/m3		Wall and Floor		122.66	3.04	2100	6384	40	1.25	7980.0	3.329	26565.42
Brick	Total Hollow brick block 190*180*8 mm	Total Hollow brick block 190*180*8 mm	Walls	80	33.3	2.66	1300	3458	70	0.71	2470.0	1.89	4668.30
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	30	1.67	595.0	14.453	8599.54

	Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	1900	266	40	1.25	332.5	14.453	4805.62
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	39.77	0.32	1160	371.2	20	2.50	928.0	8.366	7763.65
Gypsum Mortar	Total Gypsum Mortar				103.2	0.95	1300	1237	10	5.00	6185.0	0.46	2845.10
Clay plaster	Total Clay plaster	Clay plaster, thickness 15mm	Walls		50.56	0.76	1600	1216	75	0.67	810.7	0.76	616.11
Double Coat paint	Total walls painting		Walls	23.85 liter	118.83		1200	28.4	7	7.14	202.9	4.58	929.09
	Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	4.58	203.05
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	11	3208.33
Wood(MDF)	Total Door -frame		Doors	7	16.54m	0.05	700	36	25	2.00	72.0	8.788	632.74
	Total Door - Hollow-core panel/ MDF face		Doors	10	11.44	0.11	700	77	25	2.00	154.0	8.788	1353.35
	Closet		Furniture	16	16.12	0.26	780	201.18	50	1.00	201.2	8.788	1767.95
	WC's furniture		Furniture	16	2.93	0.05	780	36.57	25	2.00	73.1	8.788	642.69
	Shoe boxes		Furniture	16	14.31	0.23	780	178.59	50	1.00	178.6	8.788	1569.44
	Cabinets		Furniture	16	41.76	0.67	780	521.16	25	2.00	1042.3	8.788	9159.99
	MDF 50mm countertops		Furniture	50	86.56	4.33	780	3375.84	25	2.00	6751.7	8.788	59333.76
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	26.35m	0.021	780	29.3	25	2.00	58.6	8.788	514.98
steel	All cabinets and closet accessories		Furniture	48 units		0.004	8000	32	15	3.33	106.7	98.64	10521.60
	Doors' accessories (handle & hinge)		Furniture	3+9 units		0.0011	8000	8.5	15	3.33	28.3	98.64	2794.80
Mirror	Shoes box's mirror		Furniture	8	2.05	0.0200	2900	58	35	1.43	82.9	24.75	2050.71
	Closets' mirror		Furniture	8	3.84	0.0300	2900	87	35	1.43	124.3	24.75	3076.07
	WC's mirror		Furniture	6	0.35	0.0031	2900	9	20	2.50	22.5	24.75	556.88
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					68	12	4.17	283.3	6665.8 l/unit	27796.39
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19 m		0.0086	7880	67.5	25	2.00	135.0	98.64	13316.40
	Kitchen.WC.Bathroom		Furniture			0.0016	8000	13	25	2.00	26.0	98.64	2564.64
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	27ss+16lamps		0.0130	1467	19	10	5.00	95.0	44.2	4199.00
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture		1.87	0.0187	2403	45	35	1.43	64.3	0.2939 m3/m2	784.46
	Basin	67*42	Furniture		0.54	0.0054	2403	13	35	1.43	18.6	0.2939 m3/m3	227.08
Window	Total Galvanized steel		Window	2	7.2	0.016	7850	106.8	30	1.67	178.0	98.64	17557.92
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm	7.2	0.05	2500	125	30	1.67	208.3	16.537	3445.21
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	2.768	3394.75
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	30	5.8	30	1.67	9.7	32.384	313.05
<b>Total EW</b>													<b>250,434</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity; EWC=Embodied water coefficient; EW= Embodied water.

### 6.F.3) EW of scenario 3

Table 6.F.3. EW of scenario 3

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m²)	Volume (m³)	Density (Kg/m³)	weight (Kg)	EL (Year)	NR	TQ (kg)	EWC (l/kg)	EW (l)
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	3.937	5059.31
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	0.84	177.10
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	40	1.25	4720.0	2.768	13064.96
	Total Cement mortar 350 kg/m3		Wall and Floor		87.85	1.61	2100	3381	50	1.00	3381.0	3.329	11255.35
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	40	1.25	446.3	14.453	6449.65
	Total Ceramic tile 500*500*10 mm		Floor	10	53.63	0.54	1900	1026	50	1.00	1026.0	14.453	14828.78
Gypsum Mortar	Total Gypsum Mortar				105.49	0.57	1300	741	10	5.00	3705.0	0.46	1704.30
Steel	Total Knauf steel stud			1.2	30.61	0.036	7800	280.8	50	1.00	280.8	98.64	27698.11
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	23.78 m²	0.03	7800	234	50	1.00	234.0	98.64	23081.76
	Self-Tapping Screw TB 3.5 x 35 mm					200 pcs/pack	7800	0.85	50	1.00	0.9	98.64	83.84

Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m			1 role - 90m			550	0.45	50	1.00	0.5	51.999	23.40
Plasterboard	Total wall's plasterboard		Walls	12	49.63	0.6	760	425.6	50	1.00	425.6	0.84	357.50
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	760	212.8	50	1.00	212.8	0.84	178.75
Double Coat paint	Total walls painting		Walls	23.88 liter	119.38	0	1200	28.6	7	7.14	204.3	4.58	935.63
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78	0	1200	12.9	15	3.33	43.0	4.58	196.94
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	11	3208.33
Glass	Total glass				7.02	0.05	2500	125	25	2.00	250.0	16.537	4134.25
UPVC	Total UPVC window	UPVC window	Window		7.2	0.065	1467	95.35	25	2.00	190.7	51.999	9916.21
Wood	Total Door -frame		Doors	7	16.54m	0.05	700	36	30	1.67	60.0	8.788	527.28
	Total Door - Hollow-core panel/ HDF face		Doors	10	11.44 m2	0.11	700	77	30	1.67	128.3	8.788	1127.79
	Closet		Furniture	16	17.51	0.28	780	218.52	50	1.00	218.5	8.788	1920.40
	WC furniture		Furniture	16	2.86	0.05	780	35.69	25	2.00	71.4	8.788	627.34
	Shoe boxes		Furniture	16	6.56	0.10	780	81.87	50	1.00	81.9	8.788	719.46
	Cabinets		Furniture	16	36.46	0.58	780	455.02	25	2.00	910.0	8.788	7997.45
	Total High gloss door(shoe boxes, cabinets,...)		Furniture	16	13.54	0.22	780	171.60	50	1.00	171.6	8.788	1508.02
	Corian solid surface countertops		Furniture	12	3.57	0.043	1780	76.54	20	2.50	191.4	8.788	1681.58
Skirting-board Baseboard	Height 60 mm x thickness 13 mm		Decorative	13	27.5m	0.021	780	14.7	25	2.00	29.4	8.788	258.37
Steel	All cabinets and closet accessories		Furniture	58 units			8000	26.4	15	3.33	88.0	98.64	8680.32
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	15	3.33	28.3	98.64	2794.80
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.4	24.75	1025.36
	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.0	24.75	618.75
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	40	1.25	48.9	214.3	10487.31
Package	Iranradiator-ECO24FF	79*40*34cm/Thermal capacity 20636 kcal/h	Mechanical Eq					29	40	1.25	36.3	2839.7 l/unit	3549.63
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	19.3	50	1.00	19.3	51.999	1003.58
Split and compressor	General split-GENERAL GNR-24WN	24000Btu/hr	Mechanical Eq					44	20	2.50	110.0	3991.9 l/unit	9979.75
Copper	Copper pipe		Mechanical Eq	5m				4	20	2.50	10.0	77.794	777.94
Glass wool	3cm thickness and density 24kg/m3		Walls	30	6.1	0.183	24	4.4	30	1.67	7.3	32.384	237.48
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				8000	13	30	1.67	21.7	98.64	2137.20
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21lamps				19	10	5.00	95.0	44.2	4199.00
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture		1.87	0.0187	2403	45	35	1.43	64.3	0.2939 m3/m2	784.29
	Basin	67*42	Furniture		0.54	0.0054	2403	13	35	1.43	18.6	0.2939 m3/m3	226.57
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	2.768	3394.75
<b>Total EW</b>													<b>188,619</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity; EWC=Embodied water coefficient; EW= Embodied water.

Table 6.F.4. Embodied Water (EW) of scenarios 1 to 3

	Scenario 1	Scenario 2	Scenario 3
<b>Embodied Water (EW) - I</b>	245,779	250,434	188,619
<b>I8. Embodied Water (EW) - I/m2</b>	4,551	4,638	3,493

## Appendix 6.G. Construction Waste (CW-I<sub>0</sub>) of scenarios 1 to 3

### 6.G.1) CW of scenario 1

Table 6.G.1. CW of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	ACWR (%)	CW (kg)	CW (kg/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	27.54	2.75	1220	3355	75	0.67	2236.7	10.00%	223.67	
Cement mortar	Cement mortar 150kg/m <sup>3</sup> (sloping)	Total Cement mortar 150 kg/m <sup>3</sup>	Floor		53.64	2.36	1600	3776	25	2.00	7552.0	6.00%	453.12	
	Total Cement mortar 350 kg/m <sup>3</sup>	Total Cement mortar 350 kg/m <sup>3</sup>	Wall and Floor		122.14	1.91	2100	4011	20	2.50	10027.5	6.00%	601.65	
Ceramic tile	Total Ceramic tile 20*20*6 mm		Walls	6	39.71	0.24	1700	408	20	2.50	1020.0	10.50%	107.10	
	Total Ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	25	2.00	2052.0	10.50%	215.46	
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	60	0.83	2924.2	10.00%	292.42	
Gypsum Mortar	Total Gypsum Mortar	Basic Ceiling	Ceiling	10	54.51	0.54	1300	702	15	3.33	2340.0	6.00%	140.40	
Wallpaper	Wallpaper- 0.53*10m	Total wallpaper	Walls		118.83	0.1737	950	165	15	3.33	550.0	1.00%	5.50	
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	0.20%	0.09	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	5.00%	14.58	
Wood (MDF)	Cabinet (Bottom)		Furniture	16	8.87	0.14	780	110.70	14	3.57	395.3	9.00%	35.58	
	WC closet		Furniture	16	2.78	0.04	780	34.69	10	5.00	173.5	9.00%	15.61	
	Cabinet (Top)		Furniture	16	11.22	0.18	780	140.03	14	3.57	500.1	9.00%	45.01	
	Closet		Furniture	16	7.56	0.12	780	94.35	35	1.43	134.8	9.00%	12.13	
	MDF 50mm countertops		Furniture	50	3.23	0.22	780	171.60	14	3.57	612.9	9.00%	55.16	
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71m	0.021	780	29.3	25	2.00	58.6	9.00%	5.27	
Mirror	WC's mirror		Furniture	6	0.35	0.0031	2900	9	20	2.50	22.5	1.00%	0.23	
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19m		0.0086	7880	67.5	25	2.00	135.0	7.16%	9.67	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lamps		0.0089	1467	13	6	8.33	108.3	4.00%	4.33	
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm		0.05	2500	125	15	3.33	416.7	1.00%	4.17	
Filler	Filler		Floor		5.12	1.55	1700	2635	70	0.71	1882.1	6.00%	112.93	
	Stairs	Removing stairs	Floor		2m	0.0306	1700	52	15	3.33	173.3	6.00%	10.40	
<b>Total CW</b>													<b>2,364</b>	<b>44</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity of material during the study period of 50 years; ARCW= Average construction waste rate; CW= Construction waste.

### 6.G.2) CW of scenario 2

Table 6.G.2. EW of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	ACWR (%)	CW (kg)	CW (kg/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	10.00%	128.51	
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	10.00%	21.08	
Cement Mortar	Cement mortar 150kg/m <sup>3</sup> (sloping)	Total Cement mortar 150 kg/m <sup>3</sup>	Floor		53.64	2.36	1600	3776	30	1.67	6293.3	6.00%	377.60	
	Total Cement mortar 350 kg/m <sup>3</sup>		Wall and Floor		122.66	3.04	2100	6384	40	1.25	7980.0	6.00%	478.80	
Brick	Total Hollow brick block 190*180*8 mm	Total Hollow brick block 190*180*8 mm	Walls	80	33.3	2.66	1300	3458	70	0.71	2470.0	12.00%	296.40	
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	30	1.67	595.0	10.50%	62.48	
	Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	1900	266	40	1.25	332.5	10.50%	34.91	
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	39.77	0.32	1160	371.2	20	2.50	928.0	6.00%	55.68	
Gypsum Mortar	Total Gypsum Mortar				103.2	0.95	1300	1237	10	5.00	6185.0	6.00%	371.10	
Clay plaster	Total Clay plaster	Clay plaster, thickness 15mm	Walls		50.56	0.76	1600	1216	75	0.67	810.7	6.00%	48.64	
Double Coat paint	Total walls painting		Walls	23.85 liter	118.83		1200	28.4	7	7.14	202.9	0.20%	0.41	
	Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	0.20%	0.09	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	5.00%	14.58	
Wood (MDF)	Closet		Furniture	16	16.12	0.26	780	201.18	50	1.00	201.2	9.00%	18.11	

	WC's furniture		Furniture	16	2.93	0.05	780	36.57	25	2.00	73.1	9.00%	6.58	
	Shoe boxes		Furniture	16	14.31	0.23	780	178.59	50	1.00	178.6	9.00%	16.07	
	Cabinets		Furniture	16	41.76	0.67	780	521.16	25	2.00	1042.3	9.00%	93.81	
	MDF 50mm countertops		Furniture	50	75.12	3.76	780	2929.68	25	2.00	5859.4	9.00%	527.34	
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	26.35m	0.021	780	29.3	25	2.00	58.6	9.00%	5.27	
Mirror	Shoes box's mirror		Furniture	8	2.05	0.0200	2900	58	35	1.43	82.9	1.00%	0.83	
	Closets' mirror		Furniture	8	3.84	0.0300	2900	87	35	1.43	124.3	1.00%	1.24	
	WC's mirror		Furniture	6	0.35	0.0031	2900	9	20	2.50	22.5	1.00%	0.23	
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19 m		0.0086	7880	67.5	25	2.00	135.0	7.16%	9.67	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	27ss+16lamps		0.0130	1467	19	10	5.00	95.0	4.00%	3.80	
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm	7.2	0.05	2500	125	30	1.67	208.3	1.00%	2.08	
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	6.00%	73.59	
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	30	5.8	30	1.67	9.7	5.00%	0.48	
<b>Total CW</b>													<b>2,649</b>	<b>49</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity of material during the study period of 50 years; ARCW= Average construction waste rate; CW= Construction waste.

### 6.G.3) CW of scenario 3

Table 6.G.3. EW of scenario 3;

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	ACWR (%)	CW (kg)	CW (kg/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	10.00%	128.51	
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	10.00%	21.08	
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	40	1.25	4720.0	6.00%	283.20	
	Total Cement mortar 350 kg/m3		Wall and Floor		87.85	1.61	2100	3381	50	1.00	3381.0	6.00%	202.86	
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	40	1.25	446.3	10.50%	46.86	
	Total Ceramic tile 500*500*10 mm		Floor	10	53.63	0.54	1900	1026	50	1.00	1026.0	10.50%	107.73	
Gypsum Mortar	Total Gypsum Mortar				105.49	0.57	1300	741	10	5.00	3705.0	6.00%	222.30	
Steel	Total Knauf steel stud			1.2	30.61	0.036	7800	280.8	50	1.00	280.8	2.50%	7.02	
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	23.78 m <sup>2</sup>	0.03	7800	234	50	1.00	234.0	2.50%	5.85	
Plasterboard	Total wall's plasterboard		Walls	12	49.63	0.6	760	425.6	50	1.00	425.6	6.40%	27.24	
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	760	212.8	50	1.00	212.8	6.40%	13.62	
Double Coat paint	Total walls painting		Walls	23.88 liter	119.38	0	1200	28.6	7	7.14	204.3	0.20%	0.41	
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78	0	1200	12.9	15	3.33	43.0	0.20%	0.09	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	5.00%	14.58	
Glass	Total glass				7.02	0.05	2500	125	25	2.00	250.0	1.00%	2.50	
Wood	Closet		Furniture	16	17.51	0.28	780	218.52	50	1.00	218.5	9.00%	19.67	
	WC furniture		Furniture	16	2.86	0.05	780	35.69	25	2.00	71.4	9.00%	6.42	
	Shoe boxes		Furniture	16	6.56	0.10	780	81.87	50	1.00	81.9	9.00%	7.37	
	Cabinets		Furniture	16	36.46	0.58	780	455.02	25	2.00	910.0	9.00%	81.90	
	Total High gloss door(shoe boxes, cabinets,...)		Furniture	16	13.54	0.22	780	171.60	50	1.00	171.6	9.00%	15.44	
	Corian solid surface countertops		Furniture	12	3.57	0.043	1780	76.54	20	2.50	191.4	9.00%	17.22	
Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	27.5m	0.021	780	14.7	25	2.00	29.4	9.00%	2.65		
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.4	1.00%	0.41	
	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.0	1.00%	0.25	
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	19.3	50	1.00	19.3	7.16%	1.38	
	Copper pipe		Mechanical Eq	5m				4	20	2.50	10.0	7.16%	0.72	
Glass wool	3cm thickness and density 24kg/m3		Walls	30	6.1	0.183	24	4.4	30	1.67	7.3	5.00%	0.37	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21lamps				19	10	5.00	95.0	4.00%	3.80	
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	6.00%	73.59	
<b>Total CW</b>													<b>1,315</b>	<b>24</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity of material during the study period of 50 years; ARCW= Average construction waste rate.



## Appendix 6.H. Demolition Waste (DW-I<sub>12</sub>) of scenarios 1 to 3

### 6.H.1) DW of scenario 1

Table 6.H.1. DW of scenario 1

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	Mp (Kg)	EL (Year)	NR	DW (kg)	DW (kg/m <sup>3</sup> )
Cement block	Total cement block 400*200*100		Walls	100	27.54	2.75	1220	3355	75	0.67	2236.7	
Cement mortar	Cement mortar 150kg/m <sup>3</sup> (sloping)	Total Cement mortar 150 kg/m <sup>3</sup>	Floor		53.64	2.36	1600	3776	25	2.00	7552.0	
	Total Cement mortar 350 kg/m <sup>3</sup>	Total Cement mortar 350 kg/m <sup>3</sup>	Wall and Floor		122.14	1.91	2100	4011	20	2.50	10027.5	
Ceramic tile	Total Ceramic tile 20*20*6 mm		Walls	6	39.71	0.24	1700	408	20	2.50	1020.0	
	Total Ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	25	2.00	2052.0	
Gypsum block	Total Gypsum block		wall		36.63	3.19	1100	3509	60	0.83	2924.2	
Gypsum Mortar	Total Gypsum Mortar	Basic Ceiling	Ceiling	10	54.51	0.54	1300	702	15	3.33	2340.0	
Wallpaper	Wallpaper- 0.53*10m	Total wallpaper	Walls		118.83		950	165	15	3.33	550.0	
Double Coat paint	Total ceiling painting	Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	
Wood (MDF)	Cabinet (Bottom)		Furniture	16	8.87	0.14	780	110.70	14	3.57	395.3	
	WC closet		Furniture	16	2.78	0.04	780	34.69	10	5.00	173.5	
	Cabinet (Top)		Furniture	16	11.22	0.18	780	140.03	14	3.57	500.1	
	Closet		Furniture	16	7.56	0.12	780	94.35	35	1.43	134.8	
	MDF 50mm countertops		Furniture	50	3.23	0.22	780	171.60	14	3.57	612.9	
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	52.71m	0.021	780	29.3	25	2.00	58.6	
steel	Doors' accessories (handle & hinge)		Furniture	4+12 units			8000	7	10	5.00	35.0	
	All cabinets and closet accessories		Furniture	48 units			8000	28	10	5.00	140.0	
Mirror	WC's mirror		Furniture	6	0.35	0.003	2900	9	20	2.50	22.5	
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					68	12	4.17	283.3	
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19m			7880	67.5	25	2.00	135.0	
	Kitchen.WC.Bathroom		Furniture				8000	13	12	4.17	54.2	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	23ss+10lamps				13	6	8.33	108.3	
Porcelain	Toilet bowl-Morvarid model	76.5*41.5*72.5/6litre	Furniture					45	20	2.50	112.5	
	Basin	67*42	Furniture					12	15	3.33	40.0	
Doors	Total frame door		Doors		16.54m	0.05	700	42	20	2.50	105.0	
	Total Door - Panel/ MDF face		Doors	10	11.44 m <sup>2</sup>	0.11	700	77	20	2.50	192.5	
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm		0.05	2500	125	15	3.33	416.7	
Filler	Filler		Floor		5.12	1.55	1700	2635	70	0.71	1882.1	
Window	Total Galvanized steel		Window	2	8.25	0.016	7850	125.6	30	1.67	209.3	
	Stairs	Removing stairs	Floor		2m		1700	52	15	3.33	173.3	
<b>Total DW</b>											<b>34,823</b>	<b>645</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; Mp= the mass of each product that has been used for the construction or rehabilitation; DW= Demolition waste.

## 6.H.2) DW of scenario 2

Table 6.H.2. DW of scenario 2

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	Mp (Kg)	EL (Year)	NR	DW (kg)	DW (kg/m <sup>2</sup> )
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	30	1.67	6293.3	
	Total Cement mortar 350 kg/m3		Wall and Floor		122.66	3.04	2100	6384	40	1.25	7980.0	
Brick	Total Hollow brick block 190*180*8 mm	Total Hollow brick block 190*180*8 mm	Walls	80	33.3	2.66	1300	3458	70	0.71	2470.0	
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	30	1.67	595.0	
	Total Ceramic tile 500*500*10 mm		Floor	10	13.86	0.14	1900	266	40	1.25	332.5	
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	39.77	0.32	1160	371.2	20	2.50	928.0	
Gypsum Mortar	Total Gypsum Mortar				103.2	0.95	1300	1237	10	5.00	6185.0	
Clay plaster	Total Clay plaster	Clay plaster, thickness 15mm	Walls		50.56	0.76	1600	1216	75	0.67	810.7	
Double Coat paint	Total walls painting		Walls	23.85 liter	118.83		1200	28.4	7	7.14	202.9	
	Total ceiling painting	False ceiling and Ceiling	Ceilings	11.23 liter	54.51		1200	13.3	15	3.33	44.3	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	
Wood(MDF)	Total Door -frame		Doors	7	16.54m	0.05	700	36	25	2.00	72.0	
	Total Door - Hollow-core panel/ MDF face		Doors	10	11.44 m2	0.11	700	77	25	2.00	154.0	
	Closet		Furniture	16	16.12	0.26	780	201.18	50	1.00	201.2	
	WC's furniture		Furniture	16	2.93	0.05	780	36.57	25	2.00	73.1	
	Shoes boxes		Furniture	16	14.31	0.23	780	178.59	50	1.00	178.6	
	Cabinets		Furniture	16	41.76	0.67	780	521.16	25	2.00	1042.3	
	MDF 50mm counter tops		Furniture	50	6.76	0.34	780	263.64	25	2.00	527.3	
	Skirting-board Baseboard	Height 60 mm x thickness 13 mm	Decorative	13	26.35m	0.021	780	29.3	25	2.00	58.6	
steel	All cabinets and closet accessories		Furniture	48 units			8000	32	15	3.33	106.7	
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	15	3.33	28.3	
Mirror	Shoes box's mirror		Furniture	8	2.05	0.02	2900	58	35	1.43	82.9	
	Closets' mirror		Furniture	8	3.84	0.03	2900	87	35	1.43	124.3	
	WC's mirror		Furniture	6	0.35	0.003	2900	9	20	2.50	22.5	
Fan coil	Saravel-TE02 200 CFM- 7800 BTU/hr	102*60*21 cm	Mechanical Eq					68	12	4.17	283.3	
Pipes and tabs	Installations and pipes	Galvanized pipes	Mechanical Eq	43.19 m			7880	67.5	25	2.00	135.0	
	Kitchen.WC.Bathroom		Furniture				8000	13	25	2.00	26.0	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	27ss+16lamps				19	10	5.00	95.0	
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45	35	1.43	64.3	
	Basin	67*42	Furniture					13	35	1.43	18.6	
Window	Total Galvanized steel		Window	2	7.2	0.016	7850	106.8	30	1.67	178.0	
Glass	Clear glass 3mm	Double Glazed	Window	2*3mm	7.2	0.05	2500	125	30	1.67	208.3	
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	
Mineral wool	3cm thickness and density 30kg/m3		Walls	30	6.1	0.183	30	5.8	30	1.67	9.7	
<b>Total DW</b>											<b>32,546</b>	<b>603</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; Mp= the mass of each product that has been used for the construction or rehabilitation; DW= Demolition waste.

### 6.H.3) DW of scenario 3

Table 6.H.3. DW of scenario 3

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m²)	Volume (m³)	Density (Kg/m³)	Mp (Kg)	EL (Year)	NR	DW (kg)	DW (kg/m²)
Cement block	Total cement block 400*200*100		Walls	100	15.78	1.58	1220	1927.6	75	0.67	1285.1	
Gypsum block	Total Gypsum block		wall	100	2.33	0.23	1100	253	60	0.83	210.8	
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		53.64	2.36	1600	3776	40	1.25	4720.0	
	Total Cement mortar 350 kg/m3		Wall and Floor		87.85	1.61	2100	3381	50	1.00	3381.0	
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	34.22	0.21	1700	357	40	1.25	446.3	
	Total Ceramic tile 500*500*10 mm		Floor	10	53.63	0.54	1900	1026	50	1.00	1026.0	
Gypsum Mortar	Total Gypsum Mortar				105.49	0.57	1300	741	10	5.00	3705.0	
Steel	Total Knauf steel stud			1.2	30.61	0.036	7800	280.8	50	1.00	280.8	
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	23.78 m²	0.03	7800	234	50	1.00	234.0	
	Self Tapping Screw TB 3.5 x 35 mm				200 pcs/pack		7800	0.85	50	1.00	0.9	
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m			1 role - 90m			550	0.45	50	1.00	0.5	
Plasterboard	Total wall's plasterboard		Walls	12	49.63	0.6	760	425.6	50	1.00	425.6	
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	23.78	0.28	760	212.8	50	1.00	212.8	
Double Coat paint	Total walls painting		Walls	23.88 liter	119.38	0	1200	28.6	7	7.14	204.3	
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	53.78	0	1200	12.9	15	3.33	43.0	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	30	1.67	291.7	
Glass	Total glass				7.02	0.05	2500	125	25	2.00	250.0	
UPVC	Total UPVC window	UPVC window	Window		7.2	0.065	1467	95.35	25	2.00	190.7	
Wood	Total Door -frame		Doors	7	16.54m	0.05	700	36	30	1.67	60.0	
	Total Door - Hollow-core panel/ HDF face		Doors	10	11.44 m2	0.11	700	77	30	1.67	128.3	
	Closet		Furniture	16	17.51	0.28	780	218.52	50	1.00	218.5	
	WC furniture		Furniture	16	2.86	0.05	780	35.69	25	2.00	71.4	
	Shoes boxes		Furniture	16	6.56	0.10	780	81.87	50	1.00	81.9	
	Cabinets		Furniture	16	36.46	0.58	780	455.02	25	2.00	910.0	
	Total High gloss door (shoe boxes, cabinets,...)		Furniture	16	13.54	0.22	780	171.60	50	1.00	171.6	
	Corian solid surface counter tops		Furniture	12	3.57	0.043	1780	76.54	20	2.50	191.4	
Skirting-board Baseboard	Height 60 mm x thickness 13 mm		Decorative	13	27.5m	0.021	780	14.7	25	2.00	29.4	
Steel	All cabinets and closet accessories		Furniture	58 units			8000	26.4	15	3.33	88.0	
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	8.5	15	3.33	28.3	
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.4	
	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.0	
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	40	1.25	48.9	
Package	Iranradiator-ECO24FF	79*40*34cm/Thermal capacity 20636 kcal/h	Mechanical Eq					29	40	1.25	36.3	
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	19.3	50	1.00	19.3	
Split and compressor	General split-GENERAL GNR-24WN	24000Btu/hr	Mechanical Eq					44	20	2.50	110.0	
Copper	Copper pipe		Mechanical Eq	5m				4	20	2.50	10.0	
Glass wool	3cm thickness and density 24kg/m3		Walls	30	6.1	0.183	24	4.4	30	1.67	7.3	
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				8000	13	30	1.67	21.7	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	33ss+21lamps				19	10	5.00	95.0	
Porcelain	Toilet bowl-Golsar model	76.5*41.5*72.5/8litre	Furniture					45	35	1.43	64.3	
	Basin and toilet furniture	67*42	Furniture					13	35	1.43	18.6	
Filler	Filler		Floor		2.13	1.01	1700	1717	70	0.71	1226.4	
<b>Total DW</b>											<b>20,611</b>	<b>382</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; Mp= the mass of each product that has been used for the construction or rehabilitation; DW= Demolition waste.

## Appendix 6.I. Expert-based questionnaire for evaluation of aesthetic and beauty of interior spaces (I<sub>19</sub>)

The present document contains an expert-based questionnaire to evaluate the aesthetic and beauty of interior spaces of the selected sample of study (Aleph-1 apartment unit) in Ekbatan, Tehran, Iran. To do so, three different rehabilitation scenarios of Aleph-1 have been presented in the following section more in detail.

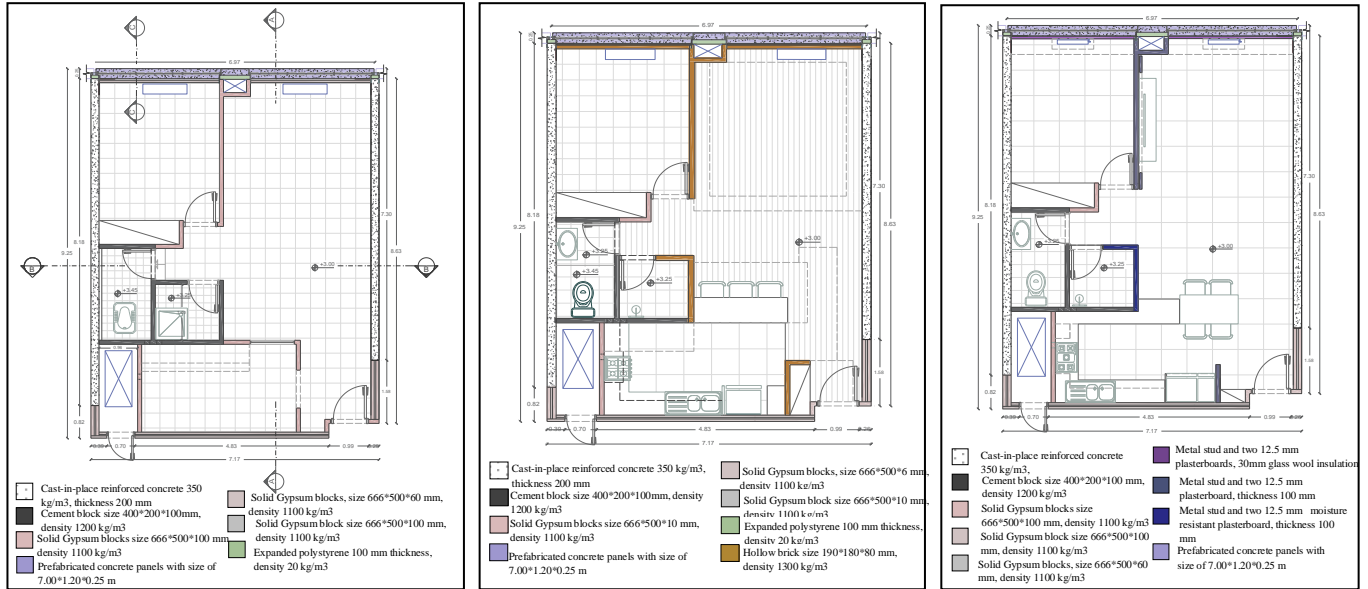


Figure 6.I.1. The architectural layouts and applied materials of Scenarios 1-3; Left: Scenario 1, middle: Scenario 2, and, right: Scenario 3

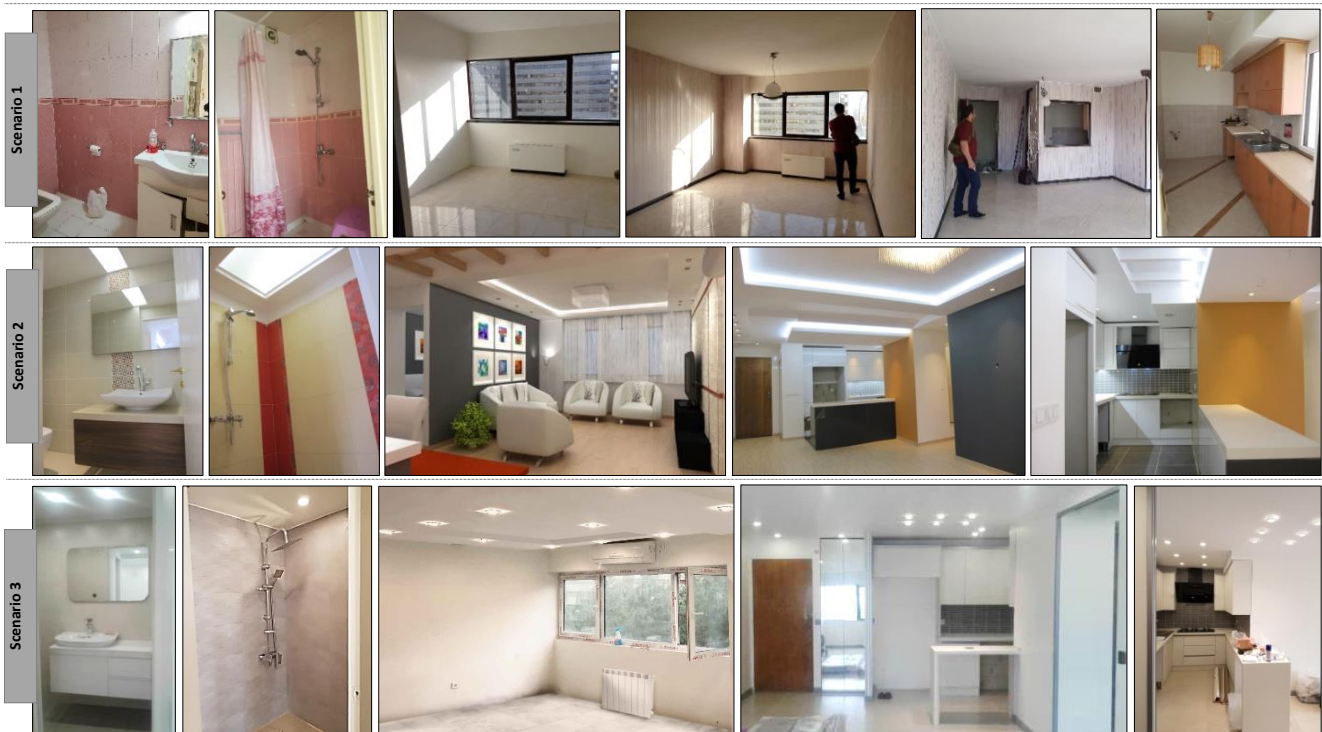


Figure 6.I.2. The pictures of Scenarios 1-3; Top: Scenario 1, middle: Scenario 2, and, bottom: Scenario 3

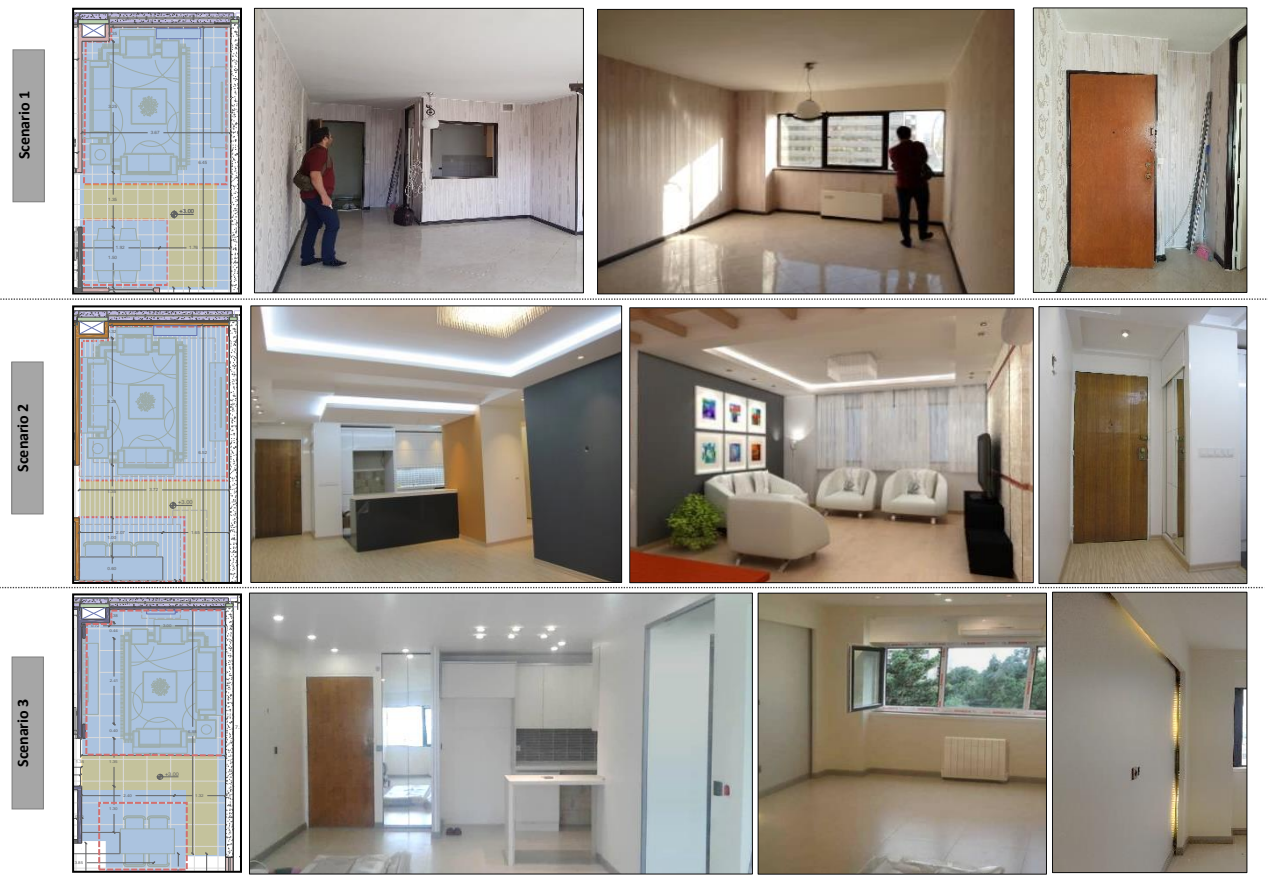


Figure 6.I.3. Living and dining space of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3



Figure 6.I.4. Kitchen and entrance space of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3



Figure 6.1.5. Bedroom of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3

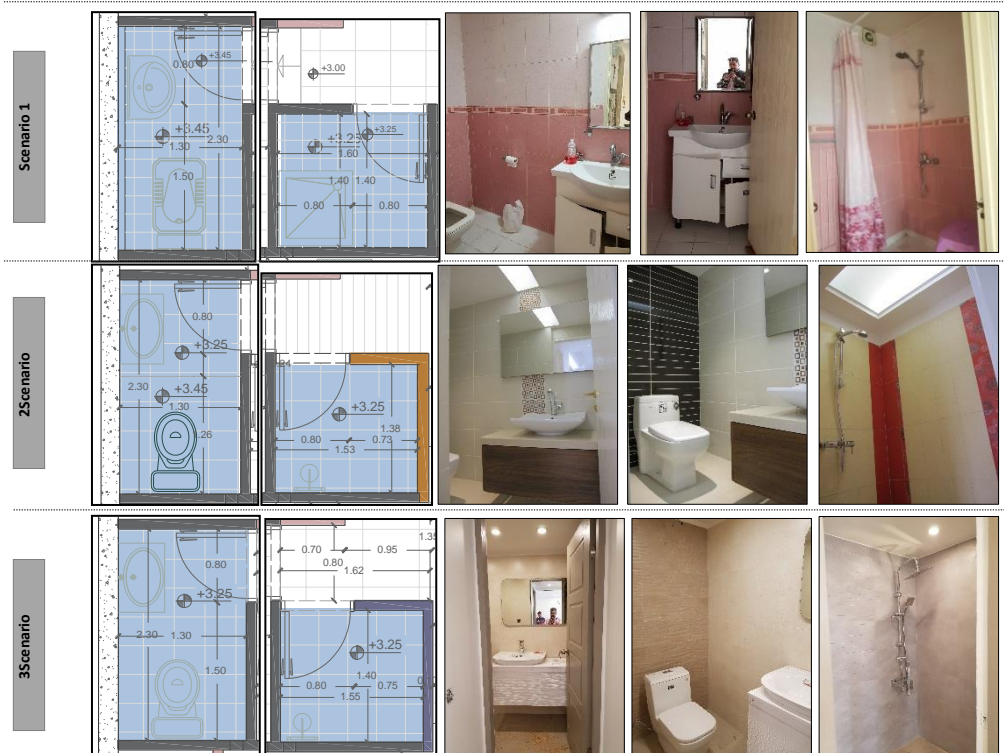


Figure 6.1.6. Bathroom and WC of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3

**Question 1:** What is your opinion regarding **form**, **shape**, and **geometrical composition** – e.g., symmetry, repetition, equilibrium, disposition – of each scenario? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate. Please score the average score of Bathroom and WC spaces as a total value.

	Scenario 1	Scenario 2	Scenario 3
Living and dining room			
Kitchen			
Bedroom			
Bathroom and WC			

**Question 2:** What is your opinion regarding **details quality** – the **quality of the applied interior materials and elements** – of each scenario? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate. Please score the average score of Bathroom and WC spaces as a total value.

		Scenario 1	Scenario 2	Scenario 3
Living and dining room				
Kitchen				
Bedroom				
Bathroom and WC				

**Question 3:** What is your opinion regarding **harmony** – the **harmonious relationship from one part to another or the whole as an appropriate unity visually such as harmony in color, material and etc.** – of each scenario? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate. Please score the average score of Bathroom and WC spaces as a total value.

	Scenario 1	Scenario 2	Scenario 3
Living and dining room			
Kitchen			
Bedroom			
Bathroom and WC			

**Question 4:** What is your opinion regarding **creativity and innovation** of design of each scenario? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate. Please score the average score of Bathroom and WC spaces as a total value.

	Scenario 1	Scenario 2	Scenario 3
Living and dining room			
Kitchen			
Bedroom			
Bathroom and WC			



## **APPENDIX OF CHAPTER 7**

**Application of the proposed MIVES-Delphi model on an improved rehabilitation scenario: scenario 4**



## Appendix of chapter 7

### Appendix 7.A. Initial rehabilitation costs (I<sub>1</sub>) of scenario 4

Table 7.A.1. Initial demolition cost of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IMPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)	DWC (euro)	IDC (euro)
Gypsum Block	Gypsum Block 666*500*60	Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	1.09	0.07								
		Basic Wall: Gypsum block 666*500*60 Duct	Walls	60	0.24	0.01								
		ceiling: Gypsum Duct	Ceiling	60	1.95	0.12								
		Basic Wall: Gypsum block 666*500*60 Facade	Walls	60	2.99	0.18								
		Basic Wall: Gypsum block 666*500*60 Facade	Walls	60	2.99	0.18								
	Total Gypsum block 666*500*60		Walls	60	9.26	0.56	1100	616	10402	199500/m <sup>3</sup>	111720			
	Gypsum Block 666*500*100	Basic Wall: Gypsum block 666*500*100	Walls	100	1.73	0.17								
		Basic Wall: Gypsum block 666*500*100	Walls	100	0.86	0.09								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	4.08	0.41								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	3.73	0.37								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	1.84	0.18								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	1.54	0.15								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	9.29	0.93								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	1.84	0.18								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	1.54	0.15								
		Basic Wall: Gypsum block 666*500*100 Interior	Walls	100	0.92	0.09								
	Total Gypsum block 666*500*100		Walls	100	27.37	2.63	1100	2893	10402	199500/m <sup>3</sup>	524685			
	Cement Block	Cement Block 400*200*100	Basic Wall 1: Cement Block 400*200*100	Walls	100	4.58	0.46							
			Basic Wall 2: Cement Block 400*200*100	Walls	100	2.58	0.26							
Basic Wall 3 Cement Block 400*200*100			Walls	100	3.64	0.36								
Basic Wall 4: Cement Block 400*200*100			Walls	100	3.9	0.39								
Basic Wall 5: Cement Block 400*200*100			Walls	100	3.64	0.36								
Basic Wall 6: Cement Block 400*200*100			Walls	100	4.68	0.47								
Basic Wall 7: Cement Block 400*200*100			Walls	100	4.52	0.45								
Total cement block 400*200*100			Walls	100	27.54	2.75	1220	3355	10402	199500/m <sup>3</sup>	548625			
Ceramic tile	Ceramic tile 200*200*6 mm	kitchen Wall no.1	Walls	6	3.92	0.02								
		kitchen Wall no.2	Walls	6	2.45	0.01								
		kitchen Wall no.3	Walls	6	3.92	0.02								
		kitchen Wall no.4	Walls	6	1.57	0.01								
		Wall WC no.1	Walls	6	5.33	0.03								
		Wall WC no.2	Walls	6	3.05	0.02								
		Wall WC no.3	Walls	6	4.04	0.02								
		Wall WC no.4	Walls	6	2.96	0.02								
		Bathroom Wall no.1	Walls	6	3.92	0.02								
		Bathroom Wall no.2	Walls	6	3.23	0.02								
	Bathroom Wall no.3	Walls	6	2.04	0.01									
	Bathroom Wall no.4	Walls	6	3.28	0.02									
	Total Ceramic tile 200*200*6 mm		Walls	6	39.71	0.24	1700	408	10505-8	6330/m <sup>2</sup>	251364.3			
	Ceramic tile 350*350*10 mm	WC Floor	Floor	10	2.99	0.03								
		Bathroom Floor	Floor	10	2.13	0.02								
kitchen Floor		Floor	10	8.74	0.09									
Bedroom Floor		Floor	10	10.31	0.1									
Total ceramic tile 350*350*10 mm		Floor	10	53.63	0.54	1900	1026	10505-8	6330/m <sup>2</sup>	339477.9				
Glass	Glass	Single Glazed 6mm	Window	1* 3mm	1.07									
	Glass	Double Glazed	Window	2*3mm	1.15									
	Glass	Double Glazed	Window	2*3mm	1.39									
	Glass	Double Glazed	Window	2*3mm	1.15									

	Glass	Double Glazed	Window	2*3mm	1.15															
	Glass	Double Glazed	Window	2*3mm	1.39															
	Glass	Double Glazed	Window	2*3mm	1.15															
	Total				8.45	0.05	2500	125			28400/m <sup>2</sup>	242536								
Galvanized steel	Galvanized steel	Galvanized steel Window frame 1 -3 mm	Window	3	2.24															
	Galvanized steel	Galvanized steel Window frame 2 -3 mm	Window	3	2.24															
	Galvanized steel	Galvanized steel Window frame 3 -3 mm	Window	1	0.8															
	Total Galvanized steel		Window	7	5.28	0.016	7850	125.6	010701-2		42500/unit	297500								
Wood (MDF)	Door - Frame	M_Single-Flush: Bathroom Door	Doors		2.09	0.02														
	Door - Frame	M_Single-Flush: WC Door	Doors		2.09	0.02														
	Door - Frame	M_Single-Flush: Bedroom Door	Doors		2.31	0.02														
	Total frame door				6.49	0.06	700	42			4150/m	68641								
	Door - Panel/ MDF face	M_Single-Flush: Bathroom Door	Doors	10	3.66	0.04														
	Door - Panel/ MDF face	M_Single-Flush: WC Door	Doors	10	3.66	0.04														
	Door - Panel/ MDF face	M_Single-Flush: Bedroom Door	Doors	10	4.09	0.04														
	Total Door - Panel/ MDF face		Doors	10	11.41	0.11	700	77	010604-6		31000/unit	93000								
	Cabinet (Bottom)		Furniture	16	8.87															
	Cabinet (Top)		Furniture	16	11.22															
	Closet		Furniture	16	7.56															
Total cabinets and closets		Furniture	16	27.65	0.48	780	374.4	10605		9430/m2	260739.5									
Steel	Cabinet's hinges		Furniture							2.6										
	Doors' hinges		Doors							1.9										
	Doors' handle		Doors							3.1										
	Kitchen, WC, and bathroom's taps		Furniture							13										
	Cabinets' accessories (handle & hinge)		Furniture							6.4										
	Screw		Furniture							8										
				Furniture			0.002	7850	35		3570/unit	82110								
Bituminous	Bituminous waterproofing 4mm	kitchen Wall no.1	Walls	4	1.57															
	Bituminous waterproofing 4mm	kitchen Wall no.2	Walls	4	0.98															
	Bituminous waterproofing 4mm	Wall WC no.1	Walls	4	2.66															
	Bituminous waterproofing 4mm	Wall WC no.2	Walls	4	1.52															
	Bituminous waterproofing 4mm	Wall WC no.3	Walls	4	2.02															
	Bituminous waterproofing 4mm	Wall WC no.4	Walls	4	1.48															
	Bituminous waterproofing 4mm	Bathroom Wall no.1	Walls	4	3.13															
	Bituminous waterproofing 4mm	Bathroom Wall no.2	Walls	4	2.58															
	Bituminous waterproofing 4mm	Bathroom Wall no.3	Walls	4	1.63															
	Bituminous waterproofing 4mm	Bathroom Wall no.4	Walls	4	2.62															
	Bituminous waterproofing 4mm	WC Floor	Floor	4	2.99															
	Bituminous waterproofing 4mm	Bathroom Floor	Floor	4	2.13															
	Bituminous waterproofing 4mm	kitchen Floor	Floor	4	8.74															
	Total Bituminous waterproofing 4mm		Walls and Floor	4	34.05	0.14	1250	175	10514		2050/m2	69802.5								
Gypsum Mortar	Gypsum Mortar	Basic Wall 1: Gypsum Mortar	Walls	6	8.17	0.05														
		Basic Wall 2: Gypsum Mortar	Walls	6	7.46	0.04														
		Basic Wall 3: Gypsum Mortar	Walls	6	3.68	0.02														
		Basic Wall 4: Gypsum Mortar	Walls	6	3.08	0.02														
		Ceiling 1: Gypsum Mortar	Ceiling	6	18.58	0.11														
		Basic Wall 5: Gypsum Mortar	Walls	6	1.84	0.01														
		Basic Wall 6: Gypsum Mortar	Walls	6	10.92	0.07														
		Basic Wall 7: Gypsum Mortar	Walls	6	3.9	0.02														
Basic Wall 8: Gypsum Mortar	Walls	6	2.73	0.02																

		Basic Wall 9: Gypsum Mortar	Walls	6	3.62	0.02																
		Basic Wall 10: Gypsum Mortar	Walls	6	5.09	0.03																
		Basic Wall 11: Gypsum Mortar	Walls	6	3.76	0.02																
		Basic Wall 12: Gypsum Mortar	Walls	6	6.23	0.04																
		<b>Total Gypsum Mortar</b>		<b>6</b>	<b>79.06</b>	<b>0.47</b>	<b>1300</b>	<b>611</b>	<b>0</b>	<b>0</b>	<b>0</b>											
Cement mortar	Cement mortar 350kg/m3	kitchen Wall no.1	Walls	10	3.92	0.04																
		kitchen Wall no.2	Walls	10	2.45	0.02																
		kitchen Wall no.3	Walls	10	16.36	0.16																
		kitchen Wall no.4	Walls	10	5.45	0.15																
		Wall WC no.1	Walls	10	5.33	0.15																
		Wall WC no.2	Walls	10	3.05	0.03																
		Wall WC no.3	Walls	10	4.04	0.04																
		Wall WC no.4	Walls	10	2.96	0.03																
		Bathroom Wall no.1	Walls	10	3.92	0.04																
		Bathroom Wall no.2	Walls	10	3.23	0.03																
		Bathroom Wall no.3	Walls	10	2.04	0.02																
		Bathroom Wall no.4	Walls	10	3.28	0.03																
		Bedroom Wall no.1	Walls	10	3.92	0.04																
		Bedroom Wall no.2	Walls	10	8.56	0.08																
		WC Floor	Floor	20	2.99	0.04																
		Bathroom Floor	Floor	20	2.13	0.04																
		kitchen Floor	Floor	20	8.74	0.17																
		Bedroom Floor	Floor	20	10.31	0.21																
		Livingroom Floor	Floor	20	29.46	0.59																
			<b>Total Cement mortar 350 kg/m3</b>	<b>Wall and Floor</b>		<b>122.14</b>	<b>1.91</b>	<b>2100</b>	<b>4011</b>	<b>10509</b>	<b>14150/m2</b>	<b>1728281</b>										
		Cement mortar 150kg/m3 (sloping)	WC Floor	Floor	40	2.99	0.12															
			Bathroom Floor	Floor	40	2.13	0.04															
			kitchen Floor	Floor	40	8.74	0.35															
			Bedroom Floor	Floor	40	10.31	0.41															
			Livingroom Floor	Floor	50	29.46	1.47															
		<b>Total Cement mortar 150 kg/m3</b>		<b>Floor</b>		<b>53.64</b>	<b>2.36</b>	<b>1600</b>	<b>3776</b>	<b>10509</b>	<b>14150/m2</b>	<b>759006</b>										
	Filler	Filler	WC Floor	Floor	390	2.99	1.17															
Bathroom Floor			Floor	180	2.13	0.38																
<b>Total</b>			<b>Floor</b>		<b>5.12</b>	<b>1.55</b>	<b>1700</b>	<b>2635</b>	<b>10509</b>	<b>14150/m2</b>	<b>72448</b>											
Porcelain	Toilet bowl and basin		Furniture																			
Galvanized steel	Galvanized steel pipes 3/8 to 1 inches		Mechanical Eq		31.12 m		7800	42	10803	2520/m	78422.4											
Plastics (PVC)	Switches & Sockets & lamps		Electrical Eq	29				8.8	010809-10	3660/unit	106140											
Mirror	Mirror		Furniture	8	0.35		2900	8.1		3900/unit	3900											
Stairs	Removing stairs		Floor	2m			1700	52	10501	11900/m	23800											
Fan coil	Fan coil		Mechanical Eq					68		54500/unit	109000											
	<b>Total initial demolition cost</b>								<b>20545</b>			<b>5793298.6</b>	<b>386.22</b>	<b>93.89</b>	<b>480.11</b>							

Legend: DWC = Disposal waste cost, IDC = Initial demolition cost

Table 7.A.2. The construction cost of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Price code in IMPL	Cost per unit (Toman)	Total price (Toman)	Total price (euro)	
Cement mortar	Cement mortar 150kg/m3 (sloping)	WC and Bathroom Floor	Floor	40	5.12	0.20							
		kitchen Floor	Floor	40	9.34	0.37							
		Bedroom and Livingroom Floor	Floor	40	41.26	1.47							
		<b>Total Cement mortar 150 kg/m3</b>	<b>Floor</b>		<b>55.72</b>	<b>2.04</b>	<b>1600</b>	<b>3271.68</b>	<b>080202-210105</b>	<b>482750/m3</b>	<b>987127.2</b>		
	Cement mortar 350kg/m3	kitchen Wall no.1	Walls	10	1.9	0.02							
		kitchen Wall no.2	Walls	10	1.9	0.02							
		Bathroom and WC Walls	Walls	10	18.07	0.18							
WC and Bathroom Floor		Floor	10	5.12	0.05								
	<b>Total Cement mortar 350 kg/m3</b>	<b>Wall and Floor</b>		<b>26.99</b>	<b>0.27</b>	<b>2100</b>	<b>567</b>	<b>080202-210105</b>	<b>482750/m3</b>	<b>130342.5</b>			
Ceramic	Ceramic tile 400*600*6 mm	kitchen Wall no.1	Walls	6	1.9	0.01							
		kitchen Wall no.2	Walls	6	1.6	0.01							
		Bathroom and WC Walls	Walls	6	18.07	0.11							
		<b>Total Ceramic tile 400*600*6 mm</b>	<b>Walls</b>	<b>6</b>	<b>21.57</b>	<b>0.12842</b>	<b>1700</b>	<b>218.314</b>	<b>200125</b>	<b>122500/m2</b>	<b>2642325</b>		
	Ceramic tile 500*500*10 mm	WC and Bathroom Floor	Floor	10	5.12	0.05							
		<b>Total Ceramic tile 500*500*10 mm</b>	<b>Floor</b>	<b>10</b>	<b>5.12</b>	<b>0.05</b>	<b>1900</b>	<b>95</b>	<b>200325-411805</b>	<b>131750/m2</b>	<b>674560</b>		
Gypsum Mortar	Gypsum Mortar	Basic Ceiling	Ceiling	1	55.72	0.056							
	<b>Total Gypsum Mortar</b>				<b>55.72</b>	<b>0.056</b>	<b>1300</b>	<b>72.8</b>	<b>180207</b>	<b>17750/m2</b>	<b>989030</b>		



Pipes	Installations and pipes	Neo pipes- PVC pipes	Mechanical Eq	49.64m			1467	18.75		25000/m	1241000	
Split	LG ALL NEW GENCOOL(DUALInverter) 24000BTU/hr		Mechanical Eq					42.9		15200000	15200000	
Copper	Copper pipe		Mechanical Eq	5m				4		69000/m	345000	
Expanded Polystyrene	5cm thickness and density 40kg/m3		Walls	50	6.1	0.305	40	12.2	140215	12800/m2	78080	
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				7850	13			1575000	
Parquet			Floor	8	44.26	0.35	1160	410.73	191501	185000/m2	4802210	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+211 amps			1467	19	010813-14	18660/unit	745000	
Porcelain	Wall hung toilet bowl Fiure L7004+installation	55*37*35 cm/6litre	Furniture				2403	32		3850000/unit	3850000	
	Shower base- Shini	140*90*14 cm	Furniture				2403	65		2150000/unit	2150000	
	Basin	76*52	Furniture				2403	14		860000/unit	860000	
Home appliances	Sink/SIGNUS-N100	48*48*27	Furniture					7.5		850000/unit	850000	
	Stove	Alton G401W Glass Gas Hob With 4 Burners	Furniture					14		1650000/unit	1650000	
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture					17		1465000/unit	1465000	
Solid surface	Corian solid surface countertops		Furniture	12	1.96	0.02352	1780	41.87		1350000/m2	2646000	
curtain fabrics	100% Cotton- High density 375 kg/m3	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632	375	28.62		39500/m2	1004880	
Total construction cost								9291			101656907.6	6,777.13

Concerning all mentioned initial rehabilitation cost that has been explained in detail in [Tables 7.A.1](#) and [7.A.2](#), and section 6.1, the value of indicator 1 for scenario 4 has been presented in [Table 7.A.3](#).

Table 7.A.3 Initial rehabilitation Cost (I<sub>1</sub>) of scenario

Initial rehabilitation cost	Scenario 4 (€)	Scenario 4 (€/m <sup>2</sup> )
a) Apartment evacuation cost ( <a href="#">Equation 6.1</a> )	54.24	
b) Initial demolition costs ( <a href="#">Table 7.A.1</a> )	(382.22+93.89) = 480.11	
c) Designing cost ( <a href="#">Table 6.3</a> )	413.64	
d) Construction cost ( <a href="#">Tables 7.A.2</a> )	6777.13	
e) Apartment repatriation cost	54.24	
<b>Total initial rehabilitation cost</b>	<b>7779.36</b>	<b>144.06</b>

## Appendix 7.B. Maintenance cost (I<sub>2</sub>) of scenario 4

Table 7.B. Maintenance cost (I<sub>2</sub>) of scenario 4

Material Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Demolition cost per unit	Demolition cost	Construction cost per unit	Construction price(Toman)	Maintenance cost for each time	Life expectancy	Numbers of rehabilitation during 50 years	Total maintenance cost for 50 years	Total price (euro)	Total price (€/m <sup>2</sup> )
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		55.72	2.04	14150/m2	788438	482750/m3	984810	1773248	40	0.25	443312		
	Total Cement mortar 350 kg/m3		Wall and Floor		26.99	0.27	14150/m2	381908.5	482750/m3	130342.5	512251	50	0.00	0		
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	21.57	0.12	6030/m2	130067.1	122500/m2	2642325	2772392.1	40	0.25	693098		
	Total Ceramic tile 500*500*10 mm		Floor	10	5.12	0.54	6030/m2	30873.6	131750/m2	627200	658073.6	50	0.00	0		
Gypsum Mortar	Total Gypsum Mortar		Ceiling		55.72	0.056	0	0	17750/m2	989030	989030	10	4.00	3956120		
Steel	Two-wheeled trolleys, steel galvanized	Dimension 90*70*147 mm-hanger bolt M16	Structure	4 units		12 kg	2900/kg	34800	107000/unit	428000	462800	50	0.00	0		
	Track stop, the adjustable retaining force	with plastic rubber 90*76*126	Structure	4 units		11.20	2900/kg	32480	105000/unit	420000	452480	50	0.00	0		
	Wall mounting bracket	Standard L- profile/ equal angles sections size 30mm	Structure	4 units		4.80	2900/kg	13920	21500/unit	86000	99920	50	0.00	0		
	Door bottom seal strip	Soundproof, dustproof, insect-proof, weatherproof	Structure	1 unit	4.20 m	35.28	2900/kg	102312	74300/m	312060	414372	50	0.00	0		
	Standard rectangular structural hollow sections - HSS	Dimension 25*25*2.5 mm	Structure		36.8 m	106.35 kg	2900/kg	308415	6350/kg	675335.2	983750.2	50	0.00	0		
	Predrilled running track, steel galvanized	U-shape steel 12*10 cm-Thickness 4mm	Structure	2 units	5.78 m	69.94 kg	2900/kg	202826	6750/kg	472081.5	674907.5	50	0.00	0		
	Curtain running track and accessories	25*25*2.5 mm	Structure	2 units	8.16 m	10.77 kg	2900/kg	31233	6350/kg	68397.12	99630.12	50	0.00	0		
	WC running track and accessories	U-shape steel 4*4 cm-Thickness 1.8mm	Structure	1 unit	1.64 m	3.94 kg	2900/kg	11426	6350/kg	24993.6	36419.6	50	0.00	0		
	Installation fee for movable elements		Structure					115000		550000	665000	50	0.00	0		
Fiberglass	Self Tapping Screw TB 3.5 x 35 mm		Structure	200 pcs/pack		0.85 kg	2900/kg	2465	43500	43500	45965	50	0.00	0		
	Fiberglass Mesh - Drywall Tape (48mm)- 90m		Walls	1 role - 90m			0	0		38700	38700	50	0.00	0		
Plasterboard	Total wall's plasterboard		Walls	12	27.52	0.18	5090/m2	140076.8	112500/m2	3096000	3236076.8	50	0.00	0		
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	55.72	0.67	5090/m2	283614.8	98500/m2	3816820	4100434.8	50	0.00	0		
Double Coat paint	Total walls painting		Walls	23.88 liter	69.83	0	0		25300/m2	1766699	1766699	15	2.33	4122298		
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.76 liter	55.72	0	0		25300/m2	1409716	1409716	15	2.33	3289337		
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	26.69	0.14	2050/m2	54714.5	61950/m2	1653445.5	1708160	30	0.67	1138773		
Wood	Door - Sliding Panel/ MDF face		Doors	16	1.68	0.04	31000/unit	52080	94500/m2	158760	210840	30	0.67	140560		
	Closets and furniture		Furniture	16	151.2 l	2.42	9430/m2	1412301.4	141500/m2	21396215	22808516.4	50	0.00	0		
	WC furniture		Furniture	16	2.81	0.04	9430/m2	26245.4	141500/m2	397615	423860.4	25	1.00	423860		
	Shoe boxes		Furniture	16	8.96	0.14	9430/m2	83686.4	141500/m2	1267840	1351526.4	50	0.00	0		
	Cabinets		Furniture	16	22.64	0.36	9430/m2	211457.6	141500/m2	3203560	3415017.6	25	1.00	3415018		
Stainless Steel	All cabinets and closet accessories		Furniture	94 units			3570/unit	352500	20500/unit	1927000	2279500	25	1.00	2279500		
	Doors' accessories (handle & hinge)		Furniture	3+9 units			3570/unit	45000	105000	315000	360000	15	2.33	840000		
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	3900/m2	4680	375000	375000	379680	35	0.43	162720		
	WC's mirror		Furniture	6	0.35	0.003	3900/m2	1365	178000	178000	179365	20	1.50	269048		

Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			54500/unit	109000	68000/panel	1972000	2081000	40	0.25	520250										
Package	Condensing Package Iranradiato-ECO24C condensing	72*40*32cm/Thermal capacity 22098 kcal/h	Mechanical Eq				125000/unit	125000	5250000	5250000	5375000	40	0.25	1343750										
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			2520/m	101762	25000/m	1241000	1342762	50	0.00	0										
Split and compressor	LG ALL NEW GENCOOL(DUALinverter) 24000BTU/hr	24000Btu/hr	Mechanical Eq				125000/unit	125000	15200000	15200000	15325000	25	1.00	15325000										
Copper	Copper pipe		Mechanical Eq	5m			2050/m	10250	69000/m	345000	355250	25	1.00	355250										
Expanded Polystyrene	5cm thickness and density 40 kg/m3		Walls	50	6.1	0.305	2050/m2	12505	12800/m2	78080	90585	30	0.67	60390										
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				3570/unit	10710		1575000	1585710	30	0.67	1057140										
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+211 amps			3660/unit	142740	18660/unit	742000	884740	10	4.00	3538960										
Porcelain	Wall hung toilet bowl L7004+installation	55*37*35 cm/6litre	Furniture				11050/unit	11050	3850000/unit	3850000	3861050	35	0.43	1654736										
	Shower base- Shini	140*90*14 cm	Furniture				11050/unit	11050	2150000/unit	2150000	2150000	35	0.43	921429										
	Basin	76*52	Furniture				11050/unit	11050	860000/unit	860000	871050	35	0.43	373307										
Home appliances	Sink/SIGNUS-N100	48*48*27	Furniture				0	0	850000/unit	850000	850000	20	1.50	1275000										
	Stove	Alton G401W Glass Gas Hob With 4 Burners	Furniture				0	0	1650000/unit	1650000	1650000	15	2.33	3850000										
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture				0	0	1465000/unit	1465000	1465000	15	2.33	3418333										
Window	Thermal break aluminum Window frame 1.7 mm	with low-E glasses	Window	7	7.2		51500/unit	309000	741500/m2	5338800	5647800	70	0.00	0										
Corian solid surface	Corian solid surface counter tops		Furniture	12	1.96	0.023	18750/m2	36750	1350000/m2	2646000	2682750	20	1.50	4024125										
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	44.26	0.35	5950/m2	263347	185000/m2	8188100	8451447	25	1.00	8451447										
curtain fabrics	100% Cotton- High density 375 kg/m3	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632			39500/m2	1004880	1004880	10	4.00	4019520										
<b>Total maintenance cost</b>																							<b>4,757.49</b>	<b>88.10</b>

## Appendix 7.C. Demolition cost (I<sub>3</sub>) of scenario 4

Table 7.C. Demolition cost (I<sub>3</sub>) of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Demolition cost per unit (Toman)	Demolition cost (Toman)	Waste disposal cost (Toman)	Total demolition cost (Toman)	Total demolition cost (euro)	Total demolition cost (euro/m2)
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		55.72	2.04	1600	3271.68	14150/m2	788438				
	Total Cement mortar 350 kg/m3		Wall and Floor		26.99	0.27	2100	567	14150/m2	381908.5				
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	21.57	0.12	1700	218.31	6030/m2	130067.1				
	Total Ceramic tile 500*500*10 mm		Floor	10	5.12	0.54	1900	95	6030/m2	30873.6				
Gypsum Mortar	Total Gypsum Mortar		Ceiling		55.72	0.056	1300	72.8	0	0				
Steel	Total Knauf steel stud		Walls	1.2	109.4	0.018	7800	140.2	0	0				
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	55.72m <sup>2</sup>	0.03	7800	438	0	0				
	Two-wheeled trolleys, steel galvanized	Dimension 90*70*147 mm-hanger bolt M16	Structure	4 units		12 kg	7800	12	2900/kg	34800				
	Track stop, the adjustable retaining force	with plastic rubber 90*76*126	Structure	4 units		11.20	7800	11.2	2900/kg	32480				
	Wall mounting bracket	Standard L- profile/ equal angles sections size 30mm	Structure	4 units		4.80	7800	4.8	2900/kg	13920				
	Door bottom seal strip	Soundproof, dustproof, insect-proof, weatherproof	Structure	1 unit	4.20m	35.28	7800	35.28	2900/kg	102312				
	Standard rectangular structural hollow sections - HSS	Dimension 25*25*2.5 mm	Structure		36.8m	106.35 kg	7800	106.35	2900/kg	308415				
	Predrilled running track, steel galvanized	U-shape steel 12*10 cm-Thickness 4mm	Structure	2 units	5.78m	69.94 kg	7800	69.94	2900/kg	202826				
	Curtain running track and accessories	25*25*2.5 mm	Structure	2 units	8.16	10.77 kg	7800	10.77	2900/kg	31233				
	WC running track and accessories	U-shape steel 4*4 cm-Thickness 1.8mm	Structure	1 unit	1.64m	3.94 kg	7800	3.94	2900/kg	11426				
	Self-tapping Screw TB 3.5 x 35 mm		Structure	200 pcs/pack		0.85 kg	7800	0.85	2900/kg	2465				
Movable elements		Structure							115000					
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m		Walls	1 role - 90m			550	0.45	0	0				
Plasterboard	Total wall's plasterboard		Walls	12	27.52	0.18	760	136.8	5090/m2	140076.8				
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	55.72	0.67	760	509.2	5090/m2	283614.8				
Double Coat paint	Total walls painting		Walls	13.96 liter	69.83	0	1200	16.752	0	0				
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.99liter	55.72	0	1200	13.188	0	0				
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	26.69	0.14	1250	133.45	2050/m2	54714.5				
Wood	Door - Sliding Panel/ MDF face		Doors	16	1.68	0.04	700	28.00	31000/unit	52080				
	Closets and furniture		Furniture	16	151.21	2.42	780	1887.10	9430/m2	1412301.4				
	WC furniture		Furniture	16	2.81	0.04	780	35.07	9430/m2	26245.4				
	Shoe boxes		Furniture	16	8.96	0.14	780	111.82	9430/m2	83686.4				
	Cabinets		Furniture	16	22.64	0.36	780	282.55	9430/m2	211457.6				
Steel	All cabinets and closet accessories		Furniture	94 units			8000	42.3	3570/unit	352500				
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	2.7	3570/unit	45000				
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	3900/m2	4680				
	WC's mirror		Furniture	6	0.35	0.003	2900	10	3900/m2	1365				
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	54500/unit	109000				
Package	Condensing Package Iranradiato-ECO24C condensing	72*40*32cm/Thermal capacity 22098 kcal/h	Mechanical Eq					29	125000/unit	125000				



Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	18.75	2520/m	101762					
Split and compressor	LG ALL NEW GENCOOL(DUAL inverter) 24000BTU/hr	24000Btu/hr	Mechanical Eq					42.9	125000/unit	125000					
Copper	Copper pipe		Mechanical Eq	5m				4	2050/m	10250					
Expanded Polystyrene	5cm thickness and density 40 kg/m3		Walls	50	6.1	0.305	40	12.2	2050/m2	12505					
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				7850	13	3570/unit	10710					
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+21lamps			1467	19	3660/unit	142740					
Porcelain	Wall hung toilet bowl L7004+installation	55*37*35 cm/6litre	Furniture				2403	32	11050/unit	11050					
	Shower base- Shini	140*90*14 cm	Furniture				2403	65	11050/unit	11050					
	Basin	76*52	Furniture				2403	14	11050/unit	11050					
Home appliances	Sink/SIGNUS-N100	48*48*27	Furniture					7.5	0	0					
	Stove	Alton G401W Glass Gas Hob With 4 Burners	Furniture					14	0	0					
	Hood	Dorsa Roya Diagonal Hood Size 90cm-680m3/h	Furniture					17	0	0					
Window	Thermal break aluminum Window frame 1.7 mm	with low-E glasses	Window	7	7.2			185.9	51500/unit	309000					
Corian solid surface	Corian solid surface countertops		Furniture	12	1.96	0.023	1780	41.87	18750/m2	36750					
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	44.26	0.35	1160	410.73	5950/m2	263347					
curtain fabrics	100% Cotton- High density 375 kg/m3	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632	375	28.62	0	0					
<b>Total maintenance cost</b>															
										9291.12	6133100.1	633,190	6,766,290	€ 451.09	€ 8.35

## Appendix 7.D. Property added-value (I4) for scenario 4

Table 7.D.1. The value of indicator 4 – property added-value – for scenario 4

	Agency1 (Didar)	Agency 2 (Ariya)	Agency 3 (Khatereh)	Agency 4 (Ayandeh)	Agency 5 (Shahriar)	Agency 6 (Golha)	Agency 7 (Novin)	Agency 8 (Hamid)	Agency 9 (Almas)	Average price (€)	The property added-value (I4) (€)
<b>Initial state</b>	91,667	93,333	92,000	94,667	91,333	91,667	90,667	93,333	91,667	92,259	
<b>Scenario 4</b>	115,000	106,667	113,333	103,333	110,000	109,333	114,667	118,333	116,667	111,926	<b>19,667</b>

## Appendix 7.E. Rehabilitation process time (I<sub>5</sub>) of scenario 4

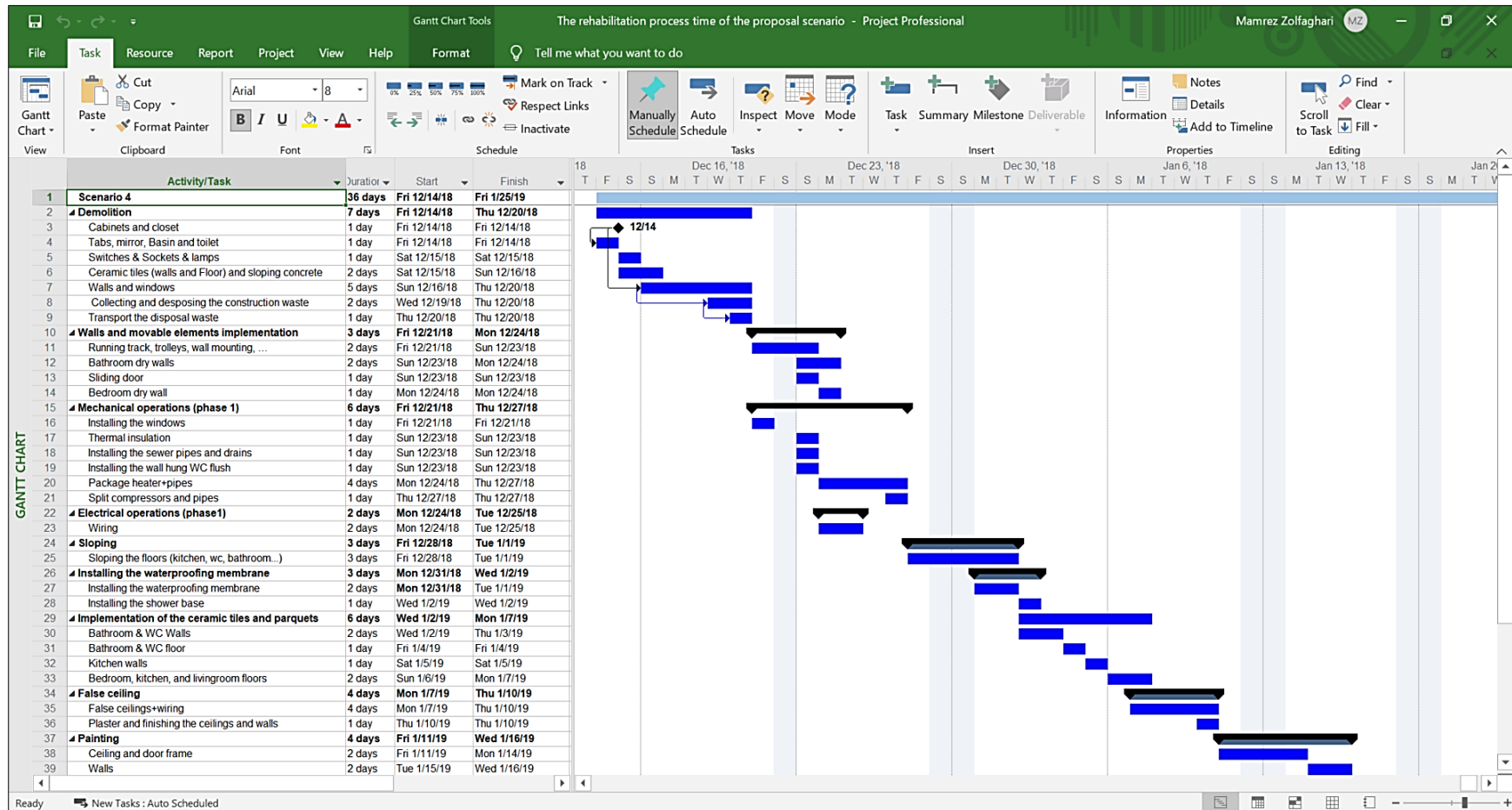


Figure 7.E.1 Rehabilitation process time of scenario 4, developed by Microsoft Project Professional

## Appendix 7.F. Embodied Energy (EE-I<sub>6</sub>) and Embodied Carbon (EC-I<sub>7</sub>) of scenario 4

Table 7.F.1. Embodied Energy (EE) and Embodied Carbon (EC) of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	Life expectancy	Numbers of rehabilitation during 50 years	Total applied material during 50 years	EE coefficient (MJ/kg)	EC coefficient (kgCO <sub>2</sub> /kg)	Total EE (MJ)	Total EC (kgCO <sub>2</sub> )
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		55.72	2.04	1600	3271.68	40	1.25	4089.60	1.33	0.22	5439.17	899.71
	Total Cement mortar 350 kg/m3		Wall and Floor		26.99	0.27	2100	567	50	1.00	567.00	0.86	0.14	487.62	79.38
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	21.57	0.12	1700	218.31	40	1.25	272.89	11	0.71	3001.76	193.75
	Total Ceramic tile 500*500*10 mm		Floor	10	5.12	0.54	1900	95	50	1.00	95.00	12	0.78	1140.00	74.10
Gypsum Mortar	Total Gypsum Mortar		Ceiling		55.72	0.056	1300	72.8	10	5.00	364.00	1.8	0.13	655.20	47.32
	Total Knauf steel stud		Walls	1.2		0.018	7800	140.2	50	1.00	140.20	28.5	2.09	3995.70	293.02
Steel	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	55.72m <sup>2</sup>	0.03	7800	438	50	1.00	438.00	28.5	2.09	12483.00	915.42
	Two-wheeled trolleys, steel galvanized	Dimension 90*70*147 mm-hanger bolt M16	Structure	4 units		12 kg	7800	12	50	1.00	12.00	28.5	2.09	342.00	25.08
	Track stop, the adjustable retaining force	with plastic rubber 90*76*126	Structure	4 units		11.20	7800	11.2	50	1.00	11.20	28.5	2.09	319.20	23.41
	Wall mounting bracket	Standard L- profile/ equal angles sections size 30mm	Structure	4 units		4.80	7800	4.8	50	1.00	4.80	28.5	2.09	136.80	10.03
	Door bottom seal strip	Soundproof, dustproof, insect-proof, weatherproof	Structure	1 unit	4.20m	35.28	7800	35.28	50	1.00	35.28	28.5	2.09	1005.48	73.74
	Standard rectangular structural hollow sections - HSS	Dimension 25*25*2.5 mm	Structure		36.8m	106.35 kg	7800	106.35	50	1.00	106.35	28.5	2.09	3030.98	222.27
	Predrilled running track, steel galvanized	U-shape steel 12*10 cm-Thickness 4mm	Structure	2 units	5.78m	69.94 kg	7800	69.94	50	1.00	69.94	28.5	2.09	1993.29	146.17
	Curtain running track and accessories	25*25*2.5 mm	Structure	2 units	8.16	10.77 kg	7800	10.77	50	1.00	10.77	28.5	2.09	306.95	22.51
	WC running track and accessories	U-shape steel 4*4 cm-Thickness 1.8mm	Structure	1 unit	1.64m	3.94 kg	7800	3.94	50	1.00	3.94	28.5	2.09	112.29	8.23
	Self-tapping Screw TB 3.5 x 35 mm		Structure	200 pcs/pack		0.85 kg	7800	0.85	50	1.00	0.85	28.5	2.09	24.23	1.78
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m		Walls	1 role - 90m		0.45	550	0.45	50	1.00	0.45	28	1.54	12.60	0.69
Plasterboard	Total wall's plasterboard		Walls	12	27.52	0.18	760	136.8	50	1.00	136.80	6.75	0.39	923.40	53.35
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	55.72	0.67	760	509.2	50	1.00	509.20	6.75	0.39	3437.10	198.59
Double Coat paint	Total walls painting		Walls	13.96 liter	69.83	0	1200	16.752	15	3.33	55.84	70	2.91	3908.80	162.49
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.99liter	55.72	0	1200	13.188	15	3.33	43.96	70	2.91	3077.20	127.92
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	26.69	0.14	1250	133.45	30	1.67	222.42	51	0.55	11343.25	122.33
Wood	Door - Sliding Panel/ MDF face		Doors	16	1.68	0.04	700	28.00	30	1.67	46.67	11	-0.93	513.33	-43.40
	Closets and furniture		Furniture	16	151.21	2.42	780	1887.10	50	1.00	1887.10	11	-0.93	20758.11	-1755.00
	WC furniture		Furniture	16	2.81	0.04	780	35.07	25	2.00	70.14	11	-0.93	771.51	-65.23
	Shoe boxes		Furniture	16	8.96	0.14	780	111.82	50	1.00	111.82	11	-0.93	1230.03	-103.99
	Cabinets		Furniture	16	22.64	0.36	780	282.55	25	2.00	565.09	11	-0.93	6216.04	-525.54
Stainless Steel	All cabinets and closet accessories		Furniture	94 units			8000	42.3	25	2.00	84.60	56.7	6.15	4796.82	520.29
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	2.7	15	3.33	9.00	56.7	6.15	510.30	55.35
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.43	23.5	1.35	973.57	55.93
	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.00	23.5	1.35	587.50	33.75
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	40	1.25	48.94	157.1	8.78	7688.08	429.67

Package	Condensing Package Iranradiato-ECO24C condensing	72*40*32cm/Thermal capacity 22098 kcal/h	Mechanical Eq					29	40	1.25	36.25	832.7	79.9	1040.88	99.88
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	18.75	50	1.00	18.75	67.5	3.23	1265.63	60.56
Split and compressor	LG ALL NEW GENCOOL(DUAL inverter) 24000BTU/hr	24000Btu/hr	Mechanical Eq					42.9	25	2.00	85.80	1702.8	139.30	3405.60	278.60
Copper	Copper pipe		Mechanical Eq	5m				4	25	2.00	8.00	57	3.81	456.00	30.48
Expanded Polystyrene	5cm thickness and density 40 kg/m3		Walls	50	6.1	0.305	40	12.2	30	1.67	20.33	88.6	3.29	1801.53	66.90
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				7850	13	30	1.67	21.67	56.7	6.15	1228.50	133.25
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+21lamps			1467	19	10	5.00	95.00	77.2	3.23	7334.00	306.85
Porcelain	Wall hung toilet bowl L7004+installation	55*37*35 cm/6litre	Furniture				2403	32	35	1.43	45.71	29	1.61	1325.71	73.60
	Shower base- Shini	140*90*14 cm	Furniture				2403	65	35	1.43	92.86	29	1.61	2692.86	149.50
	Basin	76*52	Furniture				2403	14	35	1.43	20.00	29	1.61	580.00	32.20
Glass	low-E glasses		Window			2500	133.5	70	0.71	95.36	15	0.91	1430.36	86.78	
Aluminum	Thermal break aluminum Window frame 1.7 mm		Window	7	7.2		2700	52.4	70	0.71	37.43	157.10	8.78	5880.03	328.62
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	44.26	0.35	1160	410.73	25	2.00	821.46	12	-0.84	9857.52	-690.03
curtain fabrics	100% Cotton- High density 375 kg/m3	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632	375	28.62	10	5.00	143.10	52.74	3.80	7547.09	543.78
<b>Total EE and EC</b>								9210.75			11621.99			147,067	3,804

Table 7.F.2. Embodied Energy (EE) and Embodied Carbon (EC) of scenario 4

	Embodied Energy (EE)-MJ	I <sub>6</sub> . Embodied Energy (EE)-MJ/m <sup>2</sup>	Embodied Carbon (EC)-kgCO <sub>2</sub>	I <sub>7</sub> . Embodied Carbon (EC)-kgCO <sub>2</sub> /m <sup>2</sup>
<b>Scenario 4</b>	147,067	<b>2723</b>	3,804	<b>70</b>

## Appendix 7.G. Embodied Water (EW-I<sub>8</sub>) of scenario 4

Table 7.G.1. Embodied Water (EW) of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	EWC (l/kg)	EW (l)
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		55.72	2.04	1600	3271.68	40	1.25	4089.60	2.768	11320.01
	Total Cement mortar 350 kg/m3		Wall and Floor		26.99	0.27	2100	567	50	1.00	567.00	3.329	1887.54
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	21.57	0.12	1700	218.31	40	1.25	272.89	14.453	3944.04
	Total Ceramic tile 500*500*10 mm		Floor	10	5.12	0.54	1900	95	50	1.00	95.00	14.453	1373.04
Gypsum Mortar	Total Gypsum Mortar		Ceiling		55.72	0.056	1300	72.8	10	5.00	364.00	0.46	167.44
Steel	Total Knauf steel stud		Walls	1.2		0.018	7800	140.2	50	1.00	140.20	98.64	13829.33
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	55.72m <sup>2</sup>	0.03	7800	438	50	1.00	438.00	98.64	43204.32
	Two-wheeled trolleys, steel galvanized	Dimension 90*70*147 mm-hanger bolt M16	Structure	4 units		12 kg	7800	12	50	1.00	12.00	98.64	1183.68
	Track stop, the adjustable retaining force	with plastic rubber 90*76*126	Structure	4 units		11.20	7800	11.2	50	1.00	11.20	98.64	1104.77
	Wall mounting bracket	Standard L- profile/ equal angles sections size 30mm	Structure	4 units		4.80	7800	4.8	50	1.00	4.80	98.64	473.47
	Door bottom seal strip	Soundproof, dustproof, insect-proof, weatherproof	Structure	1 unit	4.20m	35.28	7800	35.28	50	1.00	35.28	98.64	3480.02
	Standard rectangular structural hollow sections - HSS	Dimension 25*25*2.5 mm	Structure		36.8m	106.35 kg	7800	106.35	50	1.00	106.35	98.64	10490.36
	Predrilled running track, steel galvanized	U-shape steel 12*10 cm-Thickness 4mm	Structure	2 units	5.78m	69.94 kg	7800	69.94	50	1.00	69.94	98.64	6898.88
	Curtain running track and accessories	25*25*2.5 mm	Structure	2 units	8.16	10.77 kg	7800	10.77	50	1.00	10.77	98.64	1062.35
	WC running track and accessories	U-shape steel 4*4 cm-Thickness 1.8mm	Structure	1 unit	1.64m	3.94 kg	7800	3.94	50	1.00	3.94	98.64	388.64
	Self-Tapping Screw TB 3.5 x 35 mm		Structure	200 pcs/pack		0.85 kg	7800	0.85	50	1.00	0.85	98.64	83.84
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)-90m		Walls	1 role - 90m		0.45	550	0.45	50	1.00	0.45	51.999	23.40
Plasterboard	Total wall's plasterboard		Walls	12	27.52	0.18	760	136.8	50	1.00	136.80	0.84	114.91
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	55.72	0.67	760	509.2	50	1.00	509.20	0.84	427.73
Double Coat paint	Total walls painting		Walls	13.96 liter	69.83	0	1200	16.752	15	3.33	55.84	4.58	255.75
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.99liter	55.72	0	1200	13.188	15	3.33	43.96	4.58	201.34
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	26.69	0.14	1250	133.45	30	1.67	222.42	11	2446.58
Wood	Door - Sliding Panel/ MDF face		Doors	16	1.68	0.04	700	28.00	30	1.67	46.67	8.788	410.11
	Closets and furniture		Furniture	16	151.21	2.42	780	1887.10	50	1.00	1887.10	8.788	16583.84
	WC furniture		Furniture	16	2.81	0.04	780	35.07	25	2.00	70.14	8.788	616.37
	Shoes boxes		Furniture	16	8.96	0.14	780	111.82	50	1.00	111.82	8.788	982.68
	Cabinets		Furniture	16	22.64	0.36	780	282.55	25	2.00	565.09	8.788	4966.05
Stainless Steel	All cabinets and closet accessories		Furniture	94 units			8000	42.3	25	2.00	84.60	98.64	8344.94
	Doors' accessories (handle & hinge)		Furniture	3+9 units			8000	2.7	15	3.33	9.00	98.64	887.76
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.43	24.75	1025.36

	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.00	24.75	618.75
Radiator	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	40	1.25	48.94	88	4306.50
Package	Condensing Package Iranradiato-ECO24C condensing	72*40*32cm/Thermal capacity 22098 kcal/h	Mechanical Eq					29	40	1.25	36.25	2839.7 l/unit	3549.63
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	18.75	50	1.00	18.75	51.999	974.98
Split and compressor	LG ALL NEW GENCOOL(DUAL inverter)	24000Btu/hr	Mechanical Eq					42.9	25	2.00	85.80	3991.9 l/unit	7983.80
Copper	Copper pipe		Mechanical Eq	5m				4	25	2.00	8.00	77.794	622.35
Expanded Polystyrene	5cm thickness and density 40 kg/m3		Walls	50	6.1	0.305	40	12.2	30	1.67	20.33	192.72	3918.64
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				7850	13	30	1.67	21.67	98.64	2137.20
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+21lamps			1467	19	10	5.00	95.00	44.2	4199.00
Porcelain	Wall hung toilet bowl L7004+installation	55*37*35 cm/6litre	Furniture		1.3316687	0.0133	2403	32	35	1.43	45.71	0.2939 m3/m2	557.71
	Shower base- Shini	140*90*14 cm	Furniture		2.7049521	0.0270	2403	65	35	1.43	92.86	0.2939 m3/m2	1132.86
	Basin	76*52	Furniture		0.5826051	0.0058	2403	14	35	1.43	20.00	0.2939 m3/m2	244.00
Glass	low-E glasses		Window				2500	133.5	70	0.71	95.36	16.537	1576.92
Aluminum	Thermal break aluminum Window frame 1.7 mm		Window	7	7.2		2700	52.4	70	0.71	37.43	88.00	3293.71
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	44.26	0.35	1160	410.73	25	2.00	821.46	8.366	6872.33
curtain fabrics	100% Cotton- High density 375 kg/m3	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632	375	28.62	10	5.00	143.10	9.11	1303.64
<b>Total EW</b>											<b>11621.99</b>		<b>181,471</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity; EWC=Embodied water coefficient; EW= Embodied water.

Table 7.G.2. Embodied Water (EW) of scenario 4

	Embodied Water (l)	<b>18. Embodied Water (l/m2)</b>
<b>Scenario 4</b>	181471	<b>3361</b>

## Appendix 7.H. Construction Waste (CW-I<sub>9</sub>)

Table 7.H. Construction waste of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	weight (Kg)	EL (Year)	NR	TQ (kg)	ACWR (%)	CW (kg)	I <sub>8</sub> .CW (kg/m <sup>2</sup> )
Cement Mortar	Cement mortar 150kg/m <sup>3</sup> (sloping)	Total Cement mortar 150 kg/m <sup>3</sup>	Floor		55.72	2.04	1600	3271.68	40	1.25	4089.60	6.00%	245.38	
	Total Cement mortar 350 kg/m <sup>3</sup>		Wall and Floor		26.99	0.27	2100	567	50	1.00	567.00	6.00%	34.02	
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	21.57	0.12	1700	218.31	40	1.25	272.89	10.50%	28.65	
	Total Ceramic tile 500*500*10 mm		Floor	10	5.12	0.54	1900	95	50	1.00	95.00	10.50%	9.98	
Gypsum Mortar	Total Gypsum Mortar		Ceiling		55.72	0.056	1300	72.8	10	5.00	364.00	6.00%	21.84	
Steel	Total Knauf steel stud		Walls	1.2		0.018	7800	140.2	50	1.00	140.20	2.50%	3.51	
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	55.72m <sup>2</sup>	0.03	7800	438	50	1.00	438.00	2.50%	10.95	
	Door bottom seal strip	Soundproof, dustproof, insect-proof, weatherproof	Structure	1 unit	4.20m	35.28	7800	35.28	50	1.00	35.28	2.50%	0.88	
	Standard rectangular structural hollow sections - HSS	Dimension 25*25*2.5 mm	Structure		36.8m	106.35 kg	7800	106.35	50	1.00	106.35	2.50%	2.66	
	Predrilled running track, steel galvanized	U-shape steel 12*10 cm-Thickness 4mm	Structure	2 units	5.78m	69.94 kg	7800	69.94	50	1.00	69.94	2.50%	1.75	
	Curtain running track and accessories	25*25*2.5 mm	Structure	2 units	8.16	10.77 kg	7800	10.77	50	1.00	10.77	2.50%	0.27	
	WC running track and accessories	U-shape steel 4*4 cm-Thickness 1.8mm	Structure	1 unit	1.64m	3.94 kg	7800	3.94	50	1.00	3.94	2.50%	0.10	
Plasterboard	Total wall's plasterboard		Walls	12	27.52	0.18	760	136.8	50	1.00	136.80	6.40%	8.76	
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	55.72	0.67	760	509.2	50	1.00	509.20	6.40%	32.59	
Double Coat paint	Total walls painting		Walls	13.96 liter	69.83	0	1200	16.752	15	3.33	55.84	0.20%	0.11	
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.99liter	55.72	0	1200	13.188	15	3.33	43.96	0.20%	0.09	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	26.69	0.14	1250	133.45	30	1.67	222.42	5.00%	11.12	
Wood	Door - Sliding Panel/ MDF face		Doors	16	1.68	0.04	700	28.00	30	1.67	46.67	9.00%	4.20	
	Closets and furniture		Furniture	16	151.21	2.42	780	1887.10	50	1.00	1887.10	9.00%	169.84	
	WC furniture		Furniture	16	2.81	0.04	780	35.07	25	2.00	70.14	9.00%	6.31	
	Shoe boxes		Furniture	16	8.96	0.14	780	111.82	50	1.00	111.82	9.00%	10.06	
	Cabinets		Furniture	16	22.64	0.36	780	282.55	25	2.00	565.09	9.00%	50.86	
Mirror	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.43	1.00%	0.41	
	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.00	1.00%	0.25	
Pipes	Installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	18.75	50	1.00	18.75	7.16%	1.34	
Expanded Polystyrene	5cm thickness and density 40 kg/m <sup>3</sup>		Walls	50	6.1	0.305	40	12.2	30	1.67	20.33	5.00%	1.02	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+2llamps			1467	19	10	5.00	95.00	4.00%	3.80	
Glass	low-E glasses		Window				2500	133.5	70	0.71	95.36	1.00%	0.95	
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	44.26	0.35	1160	410.73	25	2.00	821.46	6.00%	49.29	
Curtain fabrics	100% Cotton- High density 375 kg/m <sup>3</sup>	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632	375	28.62	10	5.00	143.10	8.00%	11.45	
<b>Total EW</b>													<b>722</b>	<b>13</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; TQ= Total quantity of material during the study period of 50 years; ARCW= Average construction waste rate; CW= Construction waste.

## Appendix 7.I. Operational Energy (OE-I<sub>10</sub>) and Operational Carbon (OC-I<sub>11</sub>) of scenario 4

Table 7.I. Operational energy (I<sub>10</sub>) and operational carbon (I<sub>11</sub>) of scenario 4

	OE for Heating - Natural gas (kWh/year)	OE for Cooling -Electricity (kWh/year)	Total OE (kWh/year)	I <sub>10</sub> . Total OE (kWh/ kWh/m <sup>2</sup> /year)	CO <sub>2</sub> emissions for heating- Natural gas (kgCO <sub>2</sub> /year)	CO <sub>2</sub> emissions for cooling- Electricity (kgCO <sub>2</sub> /year)	Total OC (kgco <sub>2</sub> /year)	I <sub>11</sub> .Total OC (kgco <sub>2</sub> /m <sup>2</sup> ,year)
Scenario 4	51.4	1125.49	1176.89	21.79	11.36	634.78	646.14	11.97

## Appendix 7.J. Demolition Waste (DW-I<sub>12</sub>) of scenario 4

Table 7.J. DW of scenario 4

Material: Name	Material: Description	Family and Type	Category	Thickness (mm)	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )	Density (Kg/m <sup>3</sup> )	Mp (Kg)	EL (Year)	NR	DW (kg)	I12.DW (kg/m <sup>2</sup> )
Cement Mortar	Cement mortar 150kg/m3 (sloping)	Total Cement mortar 150 kg/m3	Floor		55.72	2.04	1600	3271.68	40	1.25	4089.60	
	Total Cement mortar 350 kg/m3		Wall and Floor		26.99	0.27	2100	567	50	1.00	567.00	
Ceramic tile	Total Ceramic tile 400*600*6 mm		Walls	6	21.57	0.12	1700	218.31	40	1.25	272.89	
	Total Ceramic tile 500*500*10 mm		Floor	10	5.12	0.54	1900	95	50	1.00	95.00	
Gypsum Mortar	Total Gypsum Mortar		Ceiling		55.72	0.056	1300	72.8	10	5.00	364.00	
Steel	Total Knauf steel stud		Walls	1.2		0.018	7800	140.2	50	1.00	140.20	
	Knauf Furring Channel on Suspended Frames	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	1.2	55.72m <sup>2</sup>	0.03	7800	438	50	1.00	438.00	
	Two-wheeled trolleys, steel galvanized	Dimension 90*70*147 mm-hanger bolt M16	Structure	4 units		12 kg	7800	12	50	1.00	12.00	
	Track stop, the adjustable retaining force	with plastic rubber 90*76*126	Structure	4 units		11.20	7800	11.2	50	1.00	11.20	
	Wall mounting bracket	Standard L- profile/ equal angles sections size 30mm	Structure	4 units		4.80	7800	4.8	50	1.00	4.80	
	Door bottom seal strip	Soundproof, dustproof, insect-proof, weatherproof	Structure	1 unit	4.20m	35.28	7800	35.28	50	1.00	35.28	
	Standard rectangular structural hollow sections - HSS	Dimension 25*25*2.5 mm	Structure		36.8m	106.35 kg	7800	106.35	50	1.00	106.35	
	Predrilled running track, steel galvanized	U-shape steel 12*10 cm-Thickness 4mm	Structure	2 units	5.78m	69.94 kg	7800	69.94	50	1.00	69.94	
	Curtain running track and accessories	25*25*2.5 mm	Structure	2 units	8.16	10.77 kg	7800	10.77	50	1.00	10.77	
	WC running track and accessories	U-shape steel 4*4 cm-Thickness 1.8mm	Structure	1 unit	1.64m	3.94 kg	7800	3.94	50	1.00	3.94	
	Self-Tapping Screw TB 3.5 x 35 mm		Structure	200 pcs/pack		0.85 kg	7800	0.85	50	1.00	0.85	
Fiberglass	Fiberglass Mesh - Drywall Tape (48mm)- 90m		Walls	1 role - 90m		0.45	550	0.45	50	1.00	0.45	
Plasterboard	Total wall's plasterboard		Walls	12	27.52	0.18	760	136.8	50	1.00	136.80	
	Total ceiling's plasterboard	Compound Ceiling: Knauf-KCF40A.L1C4	Ceilings	12	55.72	0.67	760	509.2	50	1.00	509.20	
Double Coat paint	Total walls painting		Walls	13.96 liter	69.83	0	1200	16.752	15	3.33	55.84	
	Total ceiling painting	False ceiling and Ceiling	Ceilings	10.99liter	55.72	0	1200	13.188	15	3.33	43.96	
Bituminous	Total Bituminous waterproofing 4mm		Walls and Floor	4	26.69	0.14	1250	133.45	30	1.67	222.42	
Wood	Door - Sliding Panel/ MDF face		Doors	16	1.68	0.04	700	28.00	30	1.67	46.67	
	Closets and furniture		Furniture	16	151.21	2.42	780	1887.10	50	1.00	1887.10	
	WC furniture		Furniture	16	2.81	0.04	780	35.07	25	2.00	70.14	
	Shoe boxes		Furniture	16	8.96	0.14	780	111.82	50	1.00	111.82	
	Cabinets		Furniture	16	22.64	0.36	780	282.55	25	2.00	565.09	
	Stainless Steel	All cabinets and closet accessories		Furniture	94 units		8000	42.3	25	2.00	84.60	
Mirror	Doors' accessories (handle & hinge)		Furniture	3+9 units		8000	2.7	15	3.33	9.00		
	Shoes box's mirror		Furniture	8	1.2	0.01	2900	29	35	1.43	41.43	
Radiator	WC's mirror		Furniture	6	0.35	0.003	2900	10	20	2.50	25.00	
	Iranradiator-termo 500	6*9*58cm/Thermal capacity 126kcal/h per panel	Mechanical Eq	3units/29 panels			2730	39.15	40	1.25	48.94	
Package	Condensing Package Iranradiato-ECO24C condensing	72*40*32cm/Thermal capacity 22098 kcal/h	Mechanical Eq					29	40	1.25	36.25	
Pipes	installations and pipes	Neo pipes	Mechanical Eq	51.64m			1467	18.75	50	1.00	18.75	



Split and compressor	LG ALL NEW GENCOOL(DUAL inverter)	24000Btu/hr	Mechanical Eq					42.9	25	2.00	85.80	
Copper	Copper pipe		Mechanical Eq	5m				4	25	2.00	8.00	
Expanded Polystyrene	5cm thickness and density 40 kg/m3		Walls	50	6.1	0.305	40	12.2	30	1.67	20.33	
Pipes and tabs	Kitchen.WC.Bathroom		Furniture				7850	13	30	1.67	21.67	
Plastics (PVC)	Switches & Sockets & lamps& wire		Electrical Eq	28ss+21lamps			1467	19	10	5.00	95.00	
Porcelain	Wall hung toilet bowl L7004+installation	55*37*35 cm/6litre	Furniture		1.331668747	0.0133	2403	32	35	1.43	45.71	
	Shower base- Shini	140*90*14 cm	Furniture		2.704952143	0.0270	2403	65	35	1.43	92.86	
	Basin	76*52	Furniture		0.582605077	0.0058	2403	14	35	1.43	20.00	
Glass	low-E glasses		Window				2500	133.5	70	0.71	95.36	
Aluminum	Thermal break aluminum Window frame 1.7 mm		Window	7	7.2		2700	52.4	70	0.71	37.43	
Parquet	Direct Pressure Laminate (DPL)-8mm thickness		Floor	8	44.26	0.35	1160	410.73	25	2.00	821.46	
curtain fabrics	100% Cotton- High density 375 kg/m3	2.40*10.60 m- Thickness 3 mm	Furniture	3	25.44	0.07632	375	28.62	10	5.00	143.10	
<b>Total DW</b>											<b>11621.99</b>	<b>215</b>

Legend: EL= Expected lifetime; NR= Numbers of rehabilitation or recurrent; Mp= the mass of each product that has been

## Appendix 7.K. Expert-based questionnaires for evaluation of I<sub>13</sub>, I<sub>14</sub>, and I<sub>19</sub>

The present document contains **three expert-based questionnaires** to evaluate **the functionality of the physical spaces (I<sub>13</sub>), adequate spaces and storages (I<sub>14</sub>), and aesthetic and beauty of interior spaces (I<sub>19</sub>)** of scenario 4 for the selected sample of study (Aleph-1 apartment unit) in Ekbatan, Tehran, Iran.

To do so, first, the **general and specific characteristics of scenario 4** have been presented – see section 7.K.1.

In the second section – section 7.K.2 –, **the general and specific characteristics of the three defined scenarios** (scenarios 1 to 3) – among real implemented rehabilitation projects in Aleph-1 apartment – besides **their obtained values of the social indicators from user-based questionnaires** have been presented to facilitate the judgment between the first three scenarios and the fourth one.

In the third section – section 7.K.3 –, three questionnaires for the evaluation of I<sub>13</sub>, I<sub>14</sub>, and I<sub>19</sub> with their defined effective parameters and corresponding questions have been presented.

### 7.K.1. General and specific characteristics of scenario 4

In this part, **the general and specific characteristics of scenario 4** – regarding indicators 13,14, and 19 – such as architectural layouts, applied materials, 3D models of each space, the useful area, and storage spaces have been presented more in detail. Also, it is worthy to mention that the real pictures of LifeEdited-1 besides its 3D models have been presented to facilitate the perception of its spaces and better judgment.

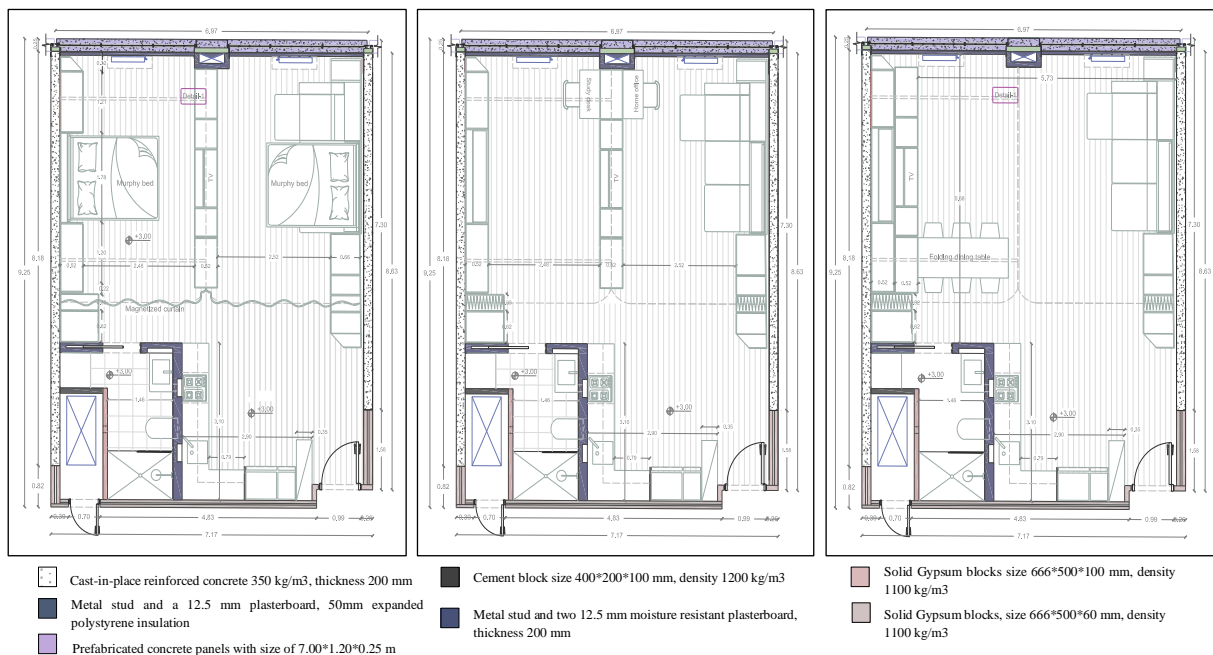


Figure 7.K.1. Architectural plans – The different states of scenario 4

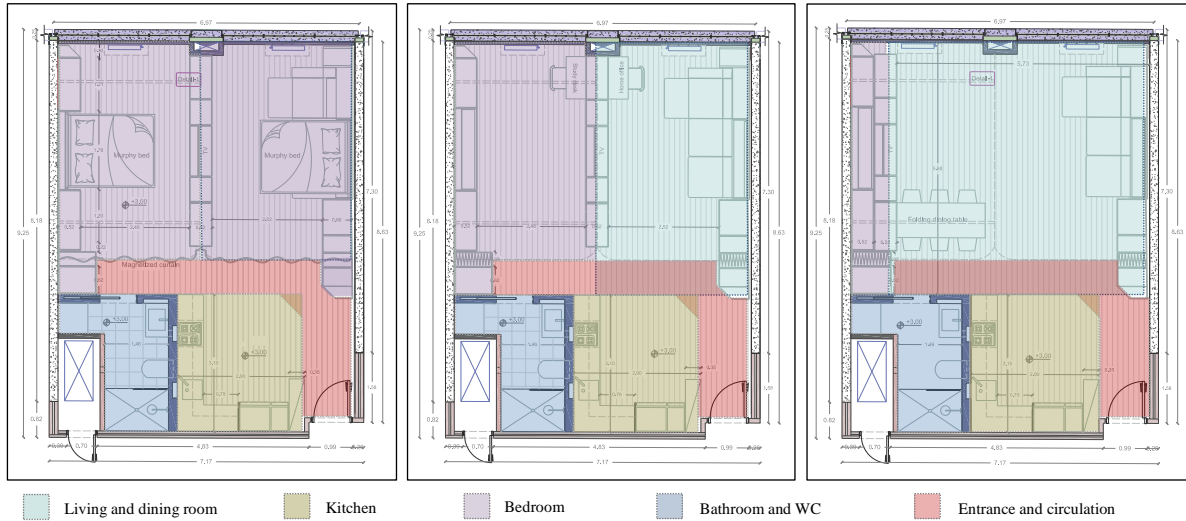


Figure 7.K.2. Architectural layouts – The different states of scenario 4



Figure 7.K.3. The different versions of LifeEdited-1; left: the initial and implemented version, middle and right: the improved versions



Figure 7.K.4. The different states of living and dining spaces of scenario 4



Figure 7.K.5. Kitchen of scenario 4

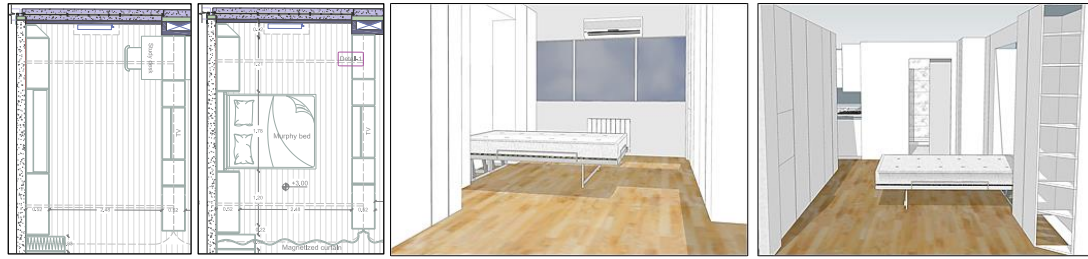


Figure 7.K.6. Bedroom of scenario 4



Figure 7.K.7. Bathroom and WC of scenario 4

As indicated in table 7.K.1, by applying LifeEdited-1 to Aleph-1, **the useful area and storage spaces** have been increased from 54.13 m<sup>2</sup> and 4.74 m<sup>3</sup> up to 91.25 m<sup>2</sup> and 22.47 m<sup>3</sup> respectively.

Table 7.K.1. Architectural layouts and storage spaces

		Kitchen	Living space	Bedroom	Bathroom and WC	Entrance and circulation	Total
Useful area (m <sup>2</sup> )	The initial state	8.47	18.10	11.45	5.13	10.98	54.13
	Scenario 4	8.89	Up to 35.18	Up to 35.18	4.98	7.02	Up to 91.25
Storage spaces (m <sup>3</sup> )	The initial state	1.74	0	3	0	0	4.74
	Scenario 4	3.61	9.47	7.78	0.56	1.05	22.47

Table 7.K.2. Applied construction materials and components for scenario 4

Space	Material/Furniture	Descriptions
<b>Living room and Bedroom</b>		
	Magnetized curtain	Curtain fabrics,100% Cotton, high density 375 kg/m <sup>3</sup>
	Parquet	Direct Pressure Laminate (DPL), 10mm thickness
	Closets	White MDF, 16 mm thickness
	Window	Thermal break aluminum, window frame, 1.7 mm thickness
	Double Glazed Glass	Low-E
	Paint	Double Coat water-based paint
	Murphy bed	1.80*2.00 m
	Radiator	Iranradiator-termo 500 - 6*9*58cm,thermal capacity 126kcal/h per panel
	Condensing Package	Iranradiator-ECO24C condensing, 0.72*0.40*0.32 m, thermal capacity 22098 kcal/h
	Split	LG All New Gencool (inverter), 24000BTU/hr
<b>Kitchen</b>		
	Cabinets	White MDF, 16 mm thickness
	Countertops	Corian solid surface
	Sink	SIGNUS-N100
	Stove	Alton G401W Glass Gas Hob With 4 Burners
	Hood	Dorsa Roya Diagonal Hood, size 90cm,680m <sup>3</sup> /h
<b>Bathroom and WC</b>		
	Bathroom walls	Basic Wall: Knauf-KSW10.2L2C7
	Ceramic tile 400*600*6 mm	
	Shower base- Shini	140*90*14 cm
	Wall hung toilet bowl Fiure L7004+installation	55*37*35 cm/6litre
	Basin-Zomorrod 0741	76*52

## 7.K.2. General and specific characteristics of the first three defined scenarios: scenarios 1 to 3

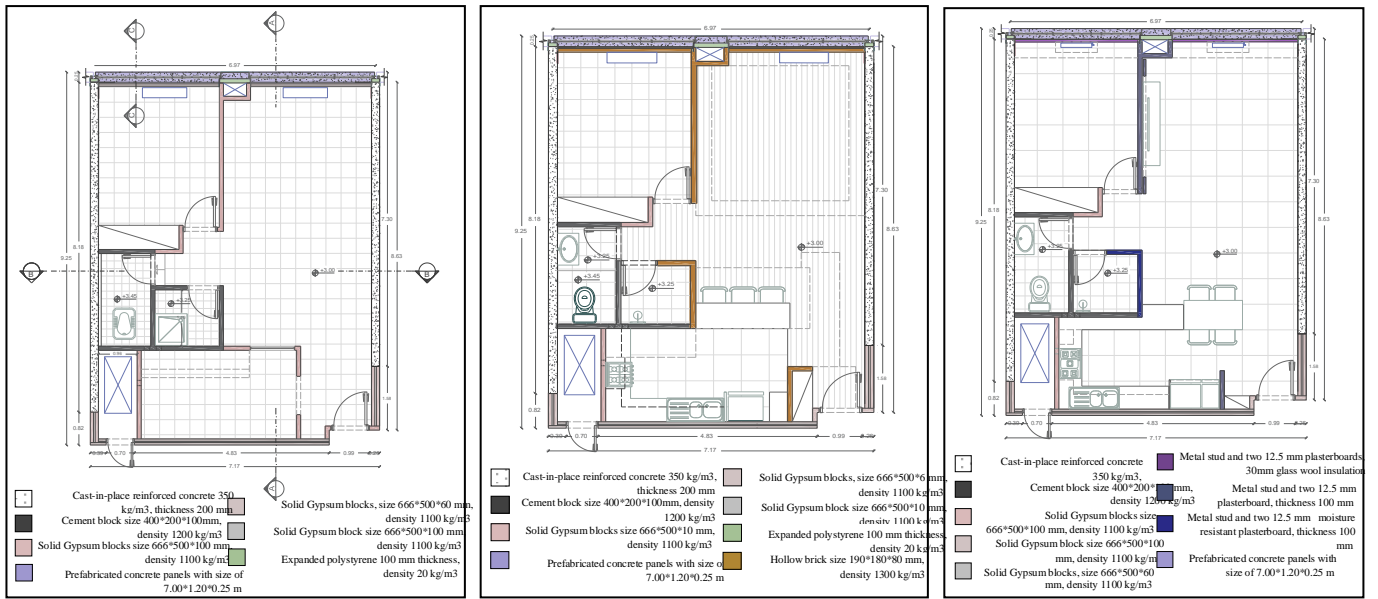


Figure 7.K.8. The architectural layouts and applied materials of Scenarios 1-3; Left: Scenario1, middle: Scenario 2, and, right: Scenario 3

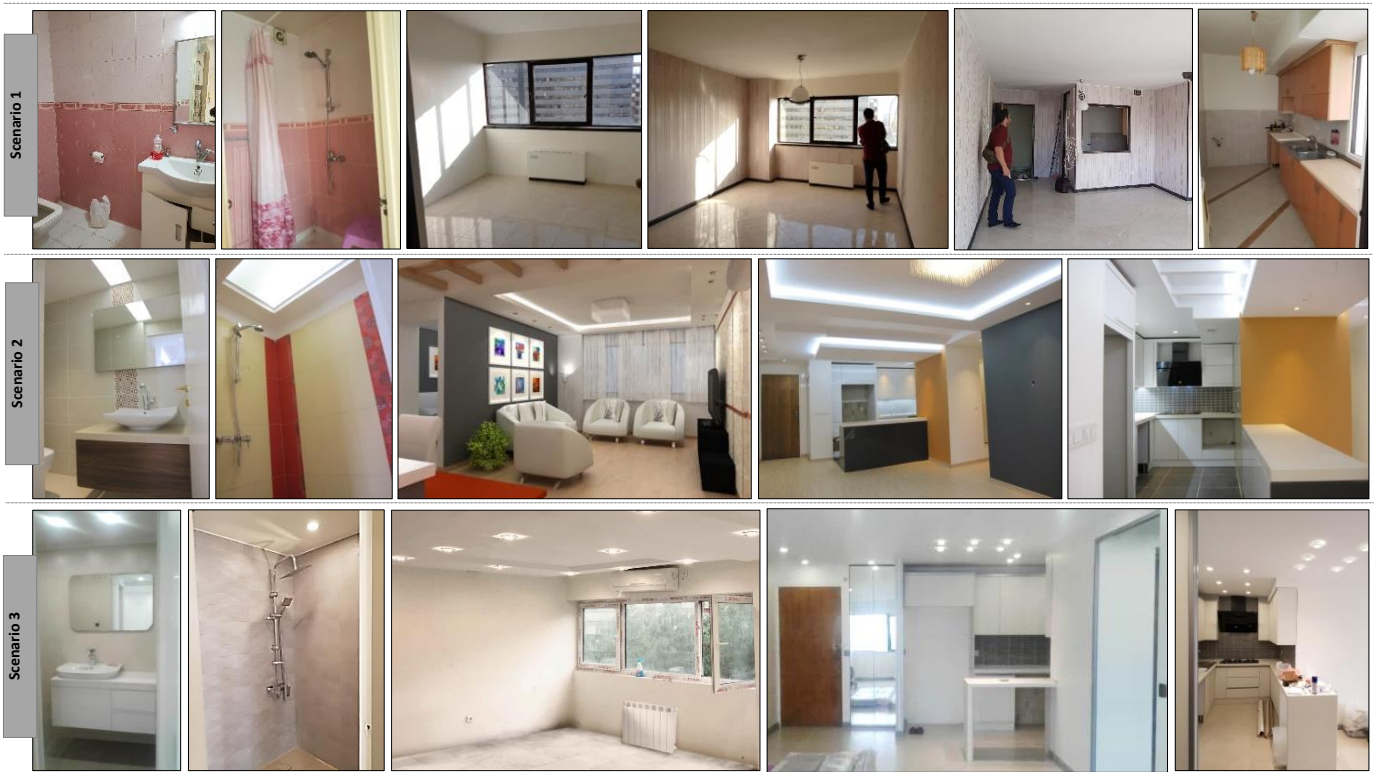


Figure 7.K.9. The pictures of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3

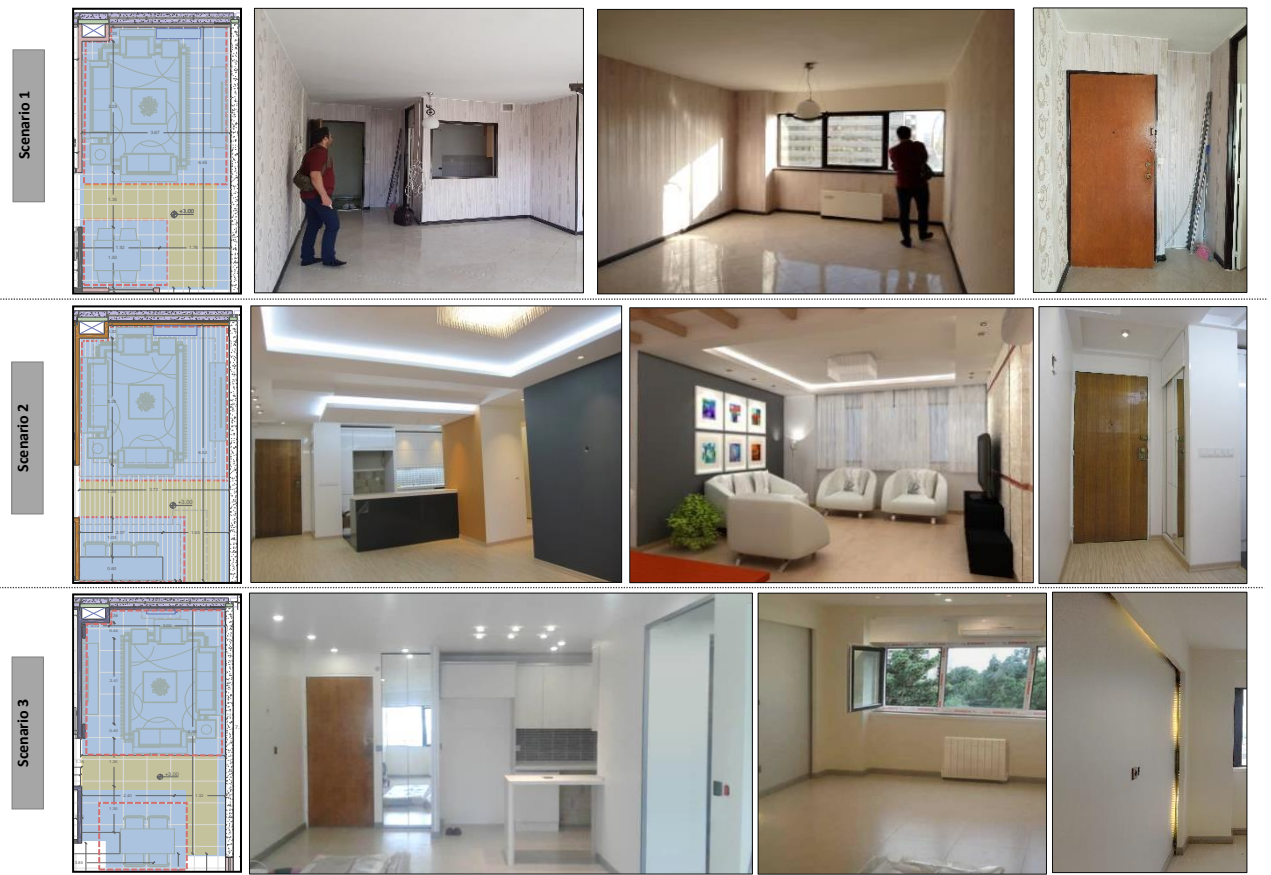


Figure 7.K.10. Living and dining space of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3



Figure 7.K.11. Kitchen and entrance space of Scenarios 1-3; Top: Scenario1, middle: Scenario 2, and, bottom: Scenario 3



Figure 7.K.12. Bedroom of Scenarios 1-3; Top: Scenario 1, middle: Scenario 2, and, bottom: Scenario 3

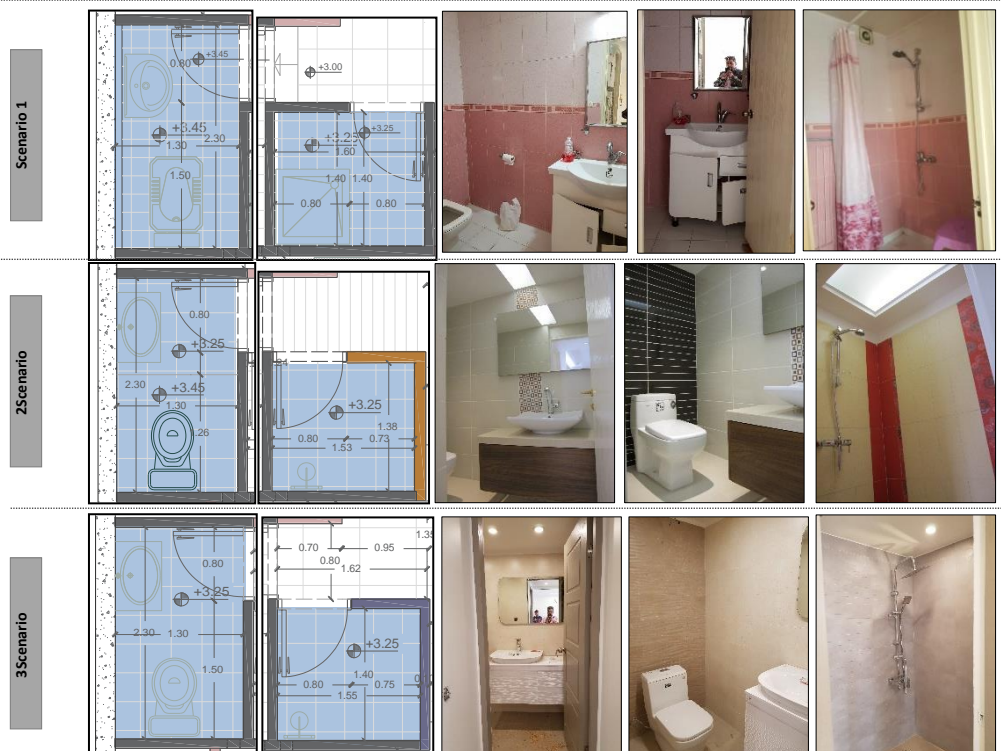


Figure 7.K.13. Bathroom and WC of Scenarios 1-3; Top: Scenario 1, middle: Scenario 2, and, bottom: Scenario 3

### 7.K.3. Questionnaires for the evaluation of $I_{13}$ , $I_{14}$ , and $I_{19}$

Subsections 7.K.3.a to c present the corresponding questionnaires for evaluation of  $I_{13}$ ,  $I_{14}$ , and  $I_{19}$  respectively.

### 7.K.3.a. Questionnaire 1: The functionality of the physical spaces (I<sub>13</sub>)

**Question 1:** What is your opinion regarding **flexibility and multifunctionality** of spaces – capacity of satisfying multiple occupants' needs – of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	2.78	3.23	3.45	
Kitchen	1.95	3.38	3.55	
Bedroom	2.84	3.07	3.09	
Bathroom and WC	2.43	3.45	3.38	

**Question 2:** What is your opinion regarding **adequacy of necessary facilities and amenities** of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	2.84	3.38	3.45	
Kitchen	1.84	3.85	3.82	
Bedroom	2.63	3.07	3.27	
Bathroom and WC	1.95	3.45	3.45	

**Question 3:** What is your opinion regarding **unity and integrity** of space of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	2.63	3.76	3.81	
Kitchen	1.53	3.77	3.82	
Bedroom	3.10	3.23	3.27	
Bathroom and WC	2.84	3.23	2.78	

**Question 4:** What is your opinion regarding **responding to specific needs of elderly or the disabled people** of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.42	3.38	3.36	
Kitchen	2.32	3.15	3.36	
Bedroom	3.47	3.30	3.45	
Bathroom and WC	2.32	2.63	2.78	

### 7.K.3.b. Questionnaire 2: Adequate spaces and storages (I<sub>14</sub>)

**Question 1:** What is your opinion regarding the **size** of spaces of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.47	3.54	3.73	
Kitchen	3.05	3.54	3.55	



Bedroom	3.42	3.46	3.55	
Bathroom and WC	3.23	3.27	3.27	

**Question 2:** What is your opinion regarding **storage** spaces of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	2.10	3.00	3.27	
Kitchen	1.84	3.38	4.00	
Bedroom	2.32	3.23	3.55	
Bathroom and WC	1.71	2.84	2.69	

### 7.K.3.c. Questionnaire 3: The aesthetic and beauty of interior spaces (I<sub>19</sub>)

**Question 1:** What is your opinion regarding **form, shape, and geometrical composition** – symmetry, repetition, equilibrium, disposition – of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	2.00	4.00	3.89	
Kitchen	1.56	4.11	3.89	
Bedroom	2.44	3.56	3.67	
Bathroom and WC	2.22	3.22	3.56	

**Question 2:** What is your opinion regarding **details quality** – the **quality of the applied interior materials and elements** – of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	1.44	3.78	4.00	
Kitchen	1.22	3.56	3.67	
Bedroom	1.44	3.11	3.78	
Bathroom and WC	1.56	2.89	3.44	

**Question 3:** What is your opinion regarding **harmony** – the **harmonious relationship from one part** to another or the whole as an appropriate unity visually such as harmony in color, material and etc. – of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	1.78	3.44	3.67	
Kitchen	1.33	3.44	3.67	
Bedroom	2.00	3.33	3.56	
Bathroom and WC	1.89	2.56	3.78	

**Question 4:** What is your opinion regarding **creativity and innovation** of design of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	1.11	3.78	3.44	
Kitchen	1.11	3.56	3.56	
Bedroom	1.33	3.11	3.11	
Bathroom and WC	1.33	2.67	3.33	

## Appendix 7.L. Expert-based questionnaires for evaluation of $I_{15}$ and $I_{16}$

The present document contains **two expert-based questionnaires** to evaluate **the thermal comfort ( $I_{15}$ )** and **indoor air quality (IAQ) ( $I_{16}$ )** of scenario 4 for the selected sample of study (Aleph-1 apartment unit) in Ekbatan, Tehran, Iran.

To do so, first, the **general and specific characteristics of scenario 4** have been presented – see section 7.L.1.

In the second section – section 7.L.2 –, **the general and specific characteristics of the three defined scenarios** (scenarios 1 to 3) – among real implemented rehabilitation projects in Aleph-1 apartment – besides **their obtained values of the indicators 15 and 16 from the user-based questionnaires** have been presented to facilitate the judgment between the first three scenarios and the fourth one.

In the third section – section 7.L.3 –, two questionnaires for the evaluation of  $I_{15}$  and  $I_{16}$  with their defined effective parameters and corresponding questions have been presented.

### 7.L.1. General and specific characteristics of scenario 4

In this part, **the general and specific characteristics of scenario 4** – regarding indicators 15 and 16 – such as architectural layouts, 3D models of each space, and the mechanical characteristics – the HVAC systems, applied insulation materials, envelopes, and windows – have been presented more in detail. Also, it is worthy to mention that the real pictures of LifeEdited-1 besides its 3D models have been presented to facilitate the perception of spaces and better expert’s judgment.

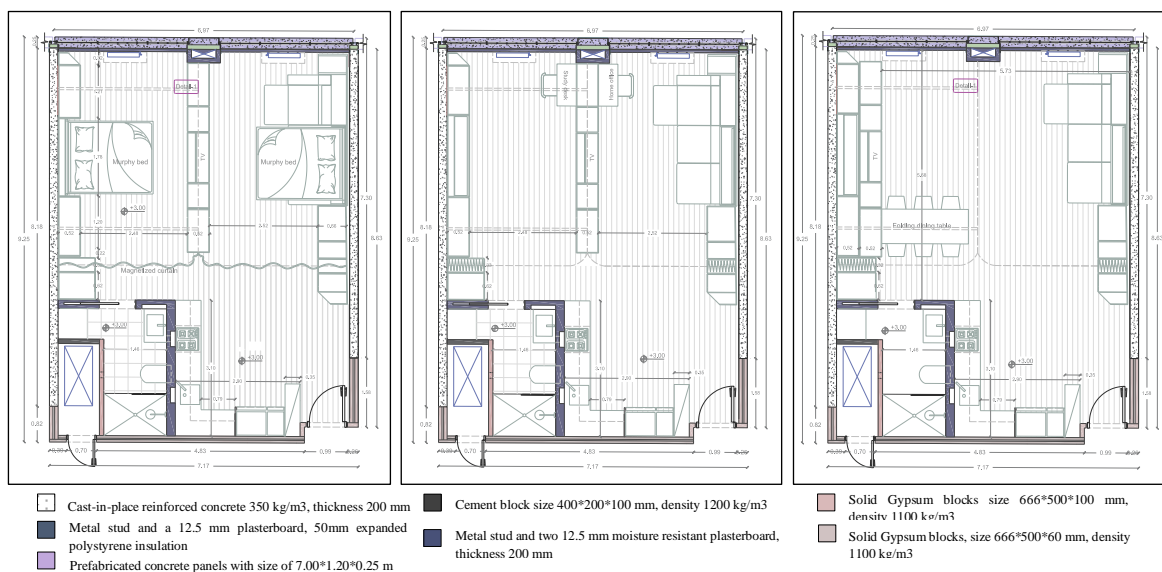


Figure 7.L.1. Architectural plans – The different states of scenario 4

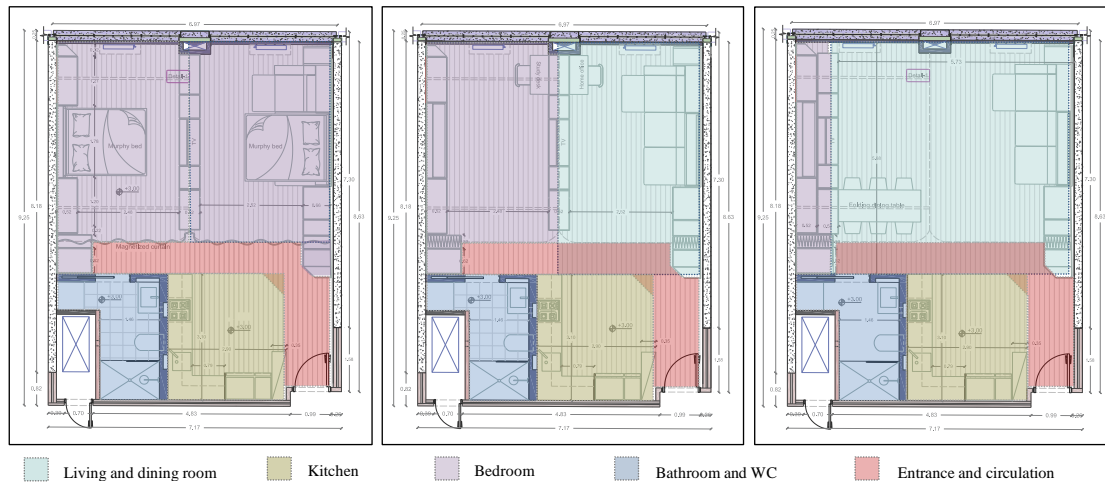


Figure 7.L.2. Architectural layouts – The different states of scenario 4



Figure 7.L.3. The different versions of LifeEdited-1; left: the initial and implemented version, middle and right: the improved versions



Figure 7.L.4. The different states of living and dining spaces of scenario 4



Figure 7.L.5. Kitchen of scenario 4

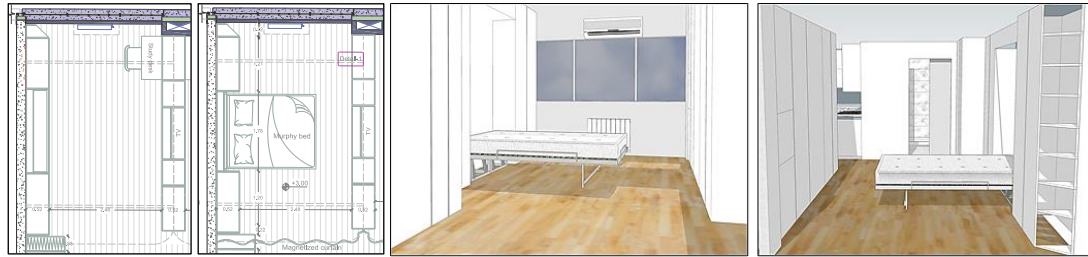


Figure 7.L.6. Bedroom of scenario 4



Figure 7.L.7. Bathroom and WC of scenario 4

Table 7.L.1. Mechanical characteristics of scenario 4

		Scenario 4
Applied materials	Wall	Drywall (stud, plasterboard, and plastic paint)
	Ceiling	False ceiling (false ceiling stud, plasterboard, and plastic paint)
	Floor	Parquet Direct Pressure Laminate (DPL), size: 190*1200 mm, thickness: 10mm, Ceramic tile 50*50 cm for bathroom
HVAC	Cooling	Split = Inverter Split, LG All New Gencool (inverter) 24000BTU/hr
	Heating	package = Condensing Package, Iranradiator - ECO24C condensing, 72*40*32cm, thermal capacity 22098 kcal/h, Radiator = Thermo 500 - 6*9*58cm, thermal capacity 126kcal/h per panel
Insulation	Thermal insulation	Walls insulation (5cm expanded polystyrene (EPS), thermal conductivity: 0.042 W/mK, Wall U-Value = 0.704 W/m <sup>2</sup> K)
	Acoustic insulation	Vinyl layer-4mm
	Moisture insulation	Bituminous, 4mm thickness
Window frame		Thermal Break, aluminum frame
Window glass		Double Glazed Low-E Glass 6mm/13mm air
Mechanical ventilation	Kitchen	Hood = Dorsa Roya Diagonal Hood Size 90cm, 680m <sup>3</sup> /h
	Bathroom and WC	Exhaust fan = FanIran, silent-100-CZ, 180 m <sup>3</sup> /h

## 7.L.2. General and specific characteristics of the first three defined scenarios: scenarios 1 to 3

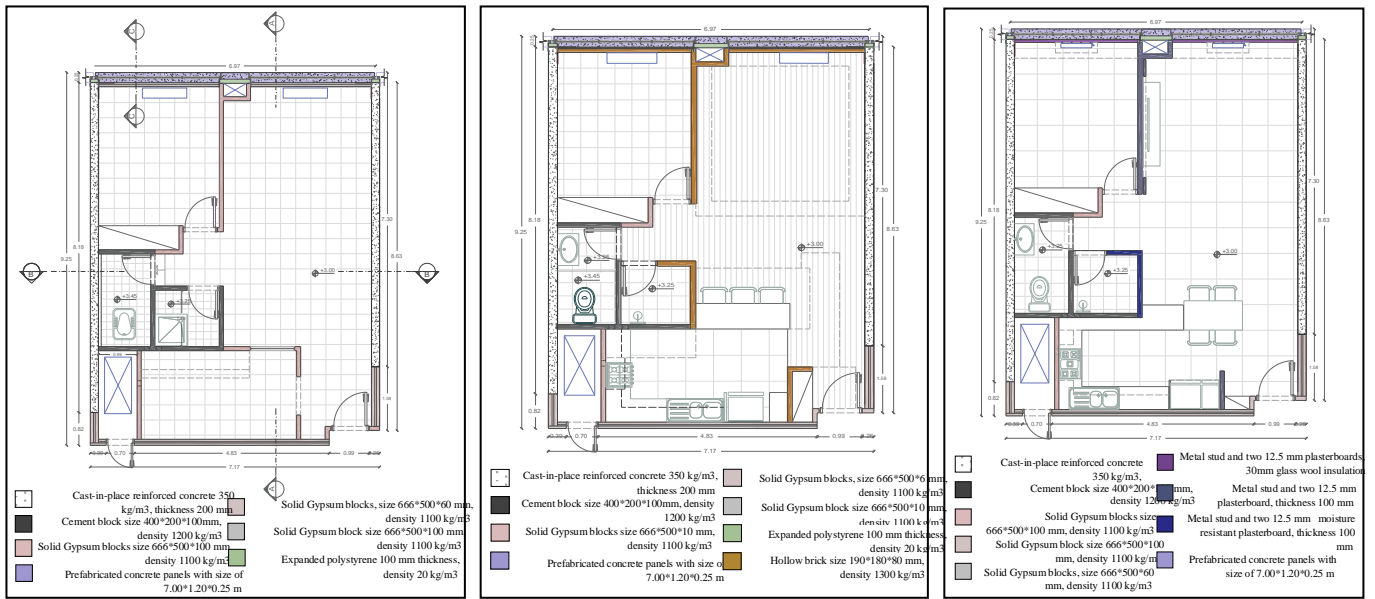


Figure 7.L.8. The architectural layouts and applied materials of Scenarios 1-3; Left: Scenario 1, middle: Scenario 2, and, right: Scenario 3

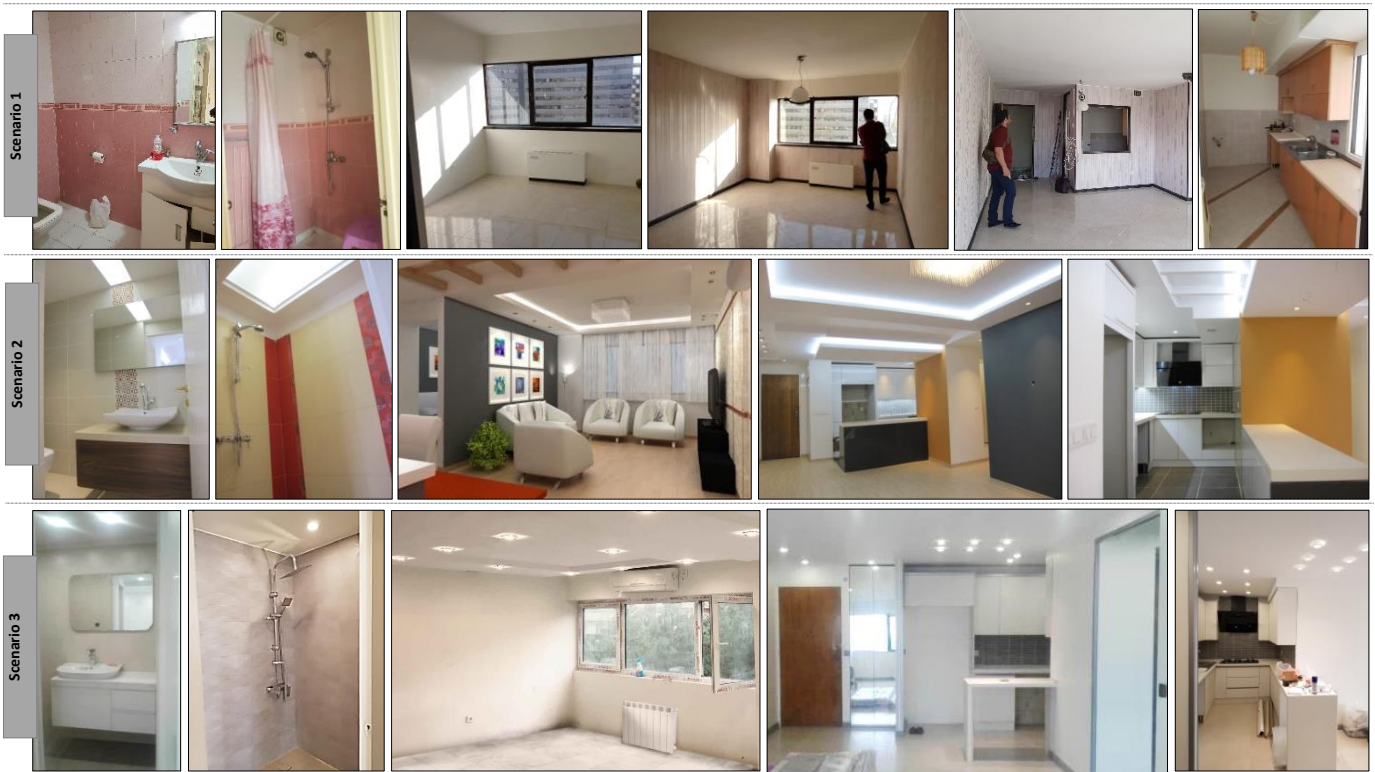


Figure 7.L.9. The pictures of Scenarios 1-3; Top: Scenario 1, middle: Scenario 2, and, bottom: Scenario 4

Table 7.L.2. Mechanical characteristics of scenarios 1 to 3

		Scenario 1	Scenario 2	Scenario 3
Applied materials	Facade	Prefabricated concrete panels with a size of 7.00*1.20*0.25 m, 6 cm of air gap, solid gypsum blocks with a size of 666*500*60 mm, water-based paint.	Prefabricated concrete panels with a size of 7.00*1.20*0.25 m, 6 cm of the air gap, 3 cm of the mineral wool, hollow brick wall with a size of 190*180*80 mm thickness of 12.5 mm, 15 mm clay plaster, 10 mm plaster; and water-based paint.	Prefabricated concrete panels with a size of 7.00*1.20*0.25 m, 6 cm of the air gap, 3 cm of the glass wool, and metal stud and one-layer plasterboard with a thickness of 12.5 mm, and water-based paint.
HVAC	Cooling	Fan coil unit (cooling = comp. Chiller, hot water (5°C))	Fan coil unit (cooling = comp. Chiller, hot water (5°C))	General split (General GNR-24WN)

	Heating	Fan coil unit (heating = boiler, hot water (80°C))	Fan coil unit (heating = boiler, hot water (80°C))	Radiator (Thermal capacity 126kcal/h per panel) & general package (Thermal capacity 20636 kcal/h)
<b>Insulation</b>	Thermal insulation	Without insulation	3cm of mineral wool batt, u-value = 0.42 W/m <sup>2</sup> K	3 cm of glass wool, u-value = 0.38 W/m <sup>2</sup> K
	Acoustic insulation	Without insulation	Without insulation	Without insulation
	Moisture insulation	Bituminous, thickness 4mm	Bituminous, thickness 4mm	Bituminous, thickness 4mm
<b>Window</b>	Window frame	Galvanized steel frame	Galvanized steel frame	UPVC frame
	Window glass	Double glazing, 6mm clear glass, and 13mm air	Double glazing, 6mm clear glass, and 13mm air	Double glazing – clear glass 6mm and 13mm argon gas
<b>Mechanical ventilation</b>	Kitchen	Hood = Bimax B1002U, size 90cm-480m <sup>3</sup> /h	Hood = Dorsa Mahdis Hood Size 90cm-540 m <sup>3</sup> /h	Hood = Dorsa Roya Diagonal Hood Size 90cm-680m <sup>3</sup> /h
	Bathroom and WC	Exhaust fan = Simple flux mechanical ventilation system, Sabalan, 95 m <sup>3</sup> /h	Exhaust fan = Simple flux mechanical ventilation system, Damandeh, VBX-20S2S, 150 m <sup>3</sup> /h	Exhaust fan = Simple flux mechanical ventilation system, Ilka, VIK-40L4S, 150 m <sup>3</sup> /h
<b>Natural ventilation</b>	Living room and bedroom	Two vertical pivot windows with a size of 1.10 *1.20 m	Four tilt and turn windows with a size of 1.10 *1.20 m	Four tilt and turn windows with a size of 1.10 *1.20 m

### 7.L.3. Questionnaires for the evaluation of I<sub>15</sub> and I<sub>16</sub>

Subsections 7.L.3.a and b present the corresponding questionnaires for evaluation of I<sub>15</sub> and I<sub>16</sub> respectively.

#### 7.L.3.a. Questionnaire 1: The thermal comfort (I<sub>15</sub>)

**Question 1:** What is your opinion regarding the **cooling** satisfaction of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.21	3.15	3.73	
Kitchen	1.63	2.77	3.64	
Bedroom	3.32	3.31	4.00	
Bathroom and WC	2.13	2.74	2.53	

**Question 2:** What is your opinion regarding the **heating** satisfaction of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.32	3.38	4.00	
Kitchen	3.11	3.08	3.91	
Bedroom	3.47	3.54	4.27	
Bathroom and WC	2.53	2.87	2.93	

#### 7.L.3.b. Questionnaire 2: The Indoor air quality (IAQ) (I<sub>16</sub>)

**Question 1:** What is your opinion regarding the **mechanical ventilation satisfaction** of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	-	-	-	-
Kitchen	1.89	3.31	3.45	
Bedroom	-	-	-	-
Bathroom and WC	-	-	-	-

**Question 2:** What is your opinion regarding the **natural ventilation and fresh air** satisfaction of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.58	3.62	3.73	
Kitchen	1.42	3.15	3.18	
Bedroom	3.74	3.85	3.82	
Bathroom and WC	1.93	2.13	2.00	



## Appendix 7.M. Expert-based questionnaires for evaluation of I<sub>17</sub> and I<sub>18</sub>

The present document contains **two expert-based questionnaires** to evaluate **the lighting comfort (I<sub>17</sub>) and acoustic comfort (I<sub>18</sub>)** of scenario 4 for the selected sample of study (Aleph-1 apartment unit) in Ekbatan, Tehran, Iran.

To do so, first, the **general and specific characteristics of scenario 4** have been presented – section 7.M.1.

In the second section – section 7.M.2 –, **the general and specific characteristics of the three defined scenarios** – between real implemented rehabilitation projects in Aleph-1 apartment – besides **their obtained values of the social indicators from user-based questionnaires** have been presented to facilitate the judgment between the first three scenarios and the fourth one.

In the third part – section 7.M.3 –, two questionnaires for the evaluation of I<sub>17</sub> and I<sub>18</sub> with their defined effective parameters and corresponding questions have been presented.

### 7.M.1. General and specific characteristics of scenario 4

In this part, **the general and specific characteristics of scenario 4** – regarding the indicators 17 and 18 – such as architectural layouts, 3D models of each space, and the lighting and acoustic characteristics – have been presented more in detail. Also, it is worthy to mention that the real pictures of LifeEdited-1 besides its 3D models have been presented to facilitate the perception of spaces and better judgment.

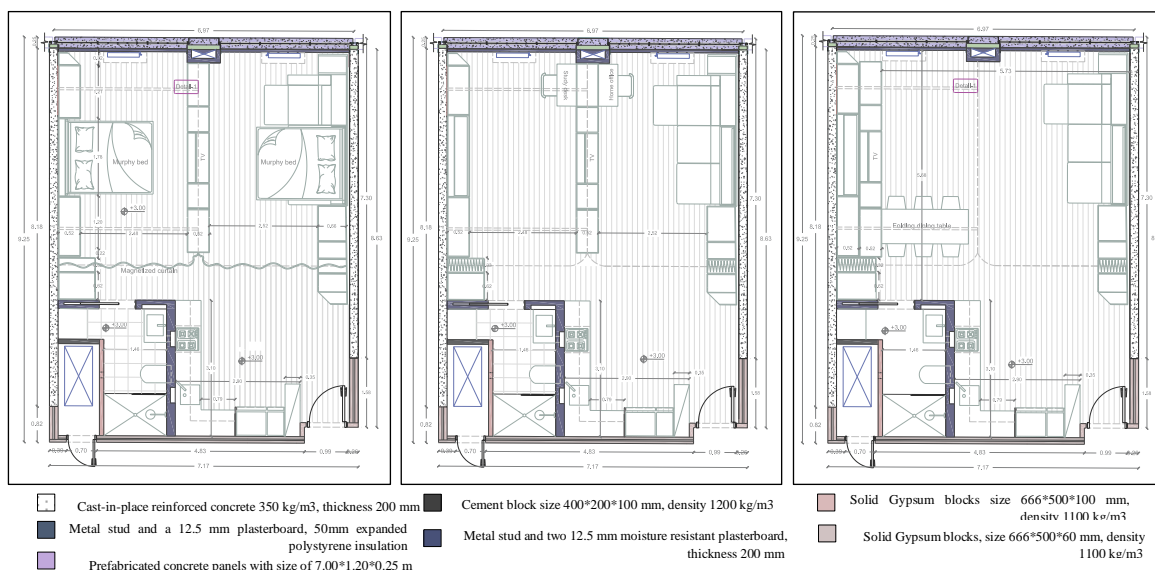


Figure 7.M.1. Architectural plans – The different states of scenario 4



Figure 7.M.2. The different versions of LifeEdited-1; left: the initial and implemented version, middle and right: the improved versions



Figure 7.M.3. The different states of living and dining spaces of scenario 4



Figure 7.M.4. Kitchen of scenario 4

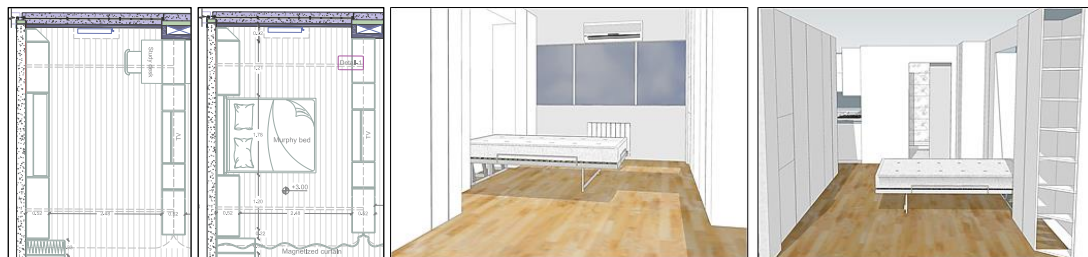


Figure 7.M.5. Bedroom of scenario 4

Table 7.M.1 Lighting and acoustic characteristics of scenario 4

Scenario 4		
<b>Applied material</b>	Wall	Drywall (stud, plasterboard, and plastic paint)
	Ceiling	False ceiling (false ceiling stud, plasterboard, and plastic paint)
	Floor	Parquet Direct Pressure Laminate (DPL)-Size: 190*1200 mm, thickness: 10mm, Ceramic tile 50*50 cm for bathroom
<b>Insulation</b>	Thermal insulation	Walls insulation (5cm expanded polystyrene (EPS)/Thermal Conductivity: 0.042 W/mK, Wall U-Value = 0.704 W/m <sup>2</sup> K)
	Acoustic insulation	Vinyl layer-4mm
	Moisture insulation	Bituminous-thickness 4mm
<b>Window</b>	Window frame	Thermal Break Aluminum frame
	Window glass	Double Glazed Low-E Glass 6mm/13mm air
<b>Natural lighting</b>	Living room and bedroom	Two windows – 1.20*3.00 m – provide direct natural lighting

## 7.M.2. General and specific characteristics of the first three defined scenarios: scenarios 1 to 3

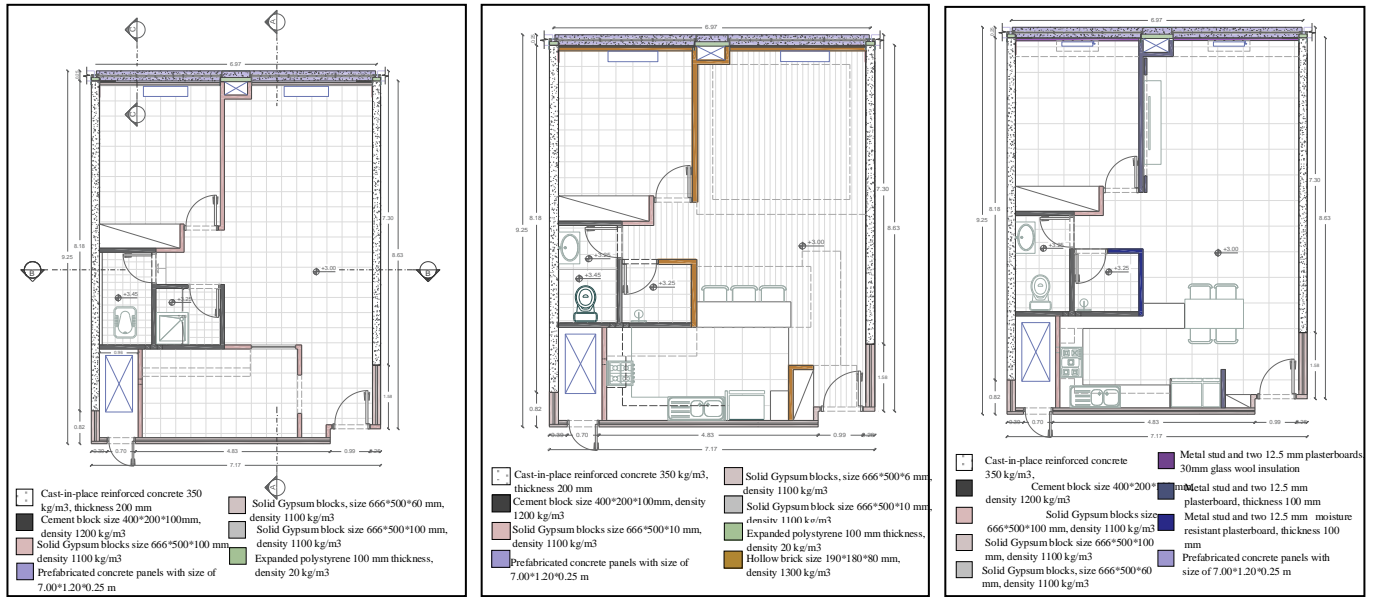


Figure 7.M.6. The architectural layouts and applied materials of Scenarios 1-3; Left: Scenario 1, middle: Scenario 2, and, right: Scenario 3

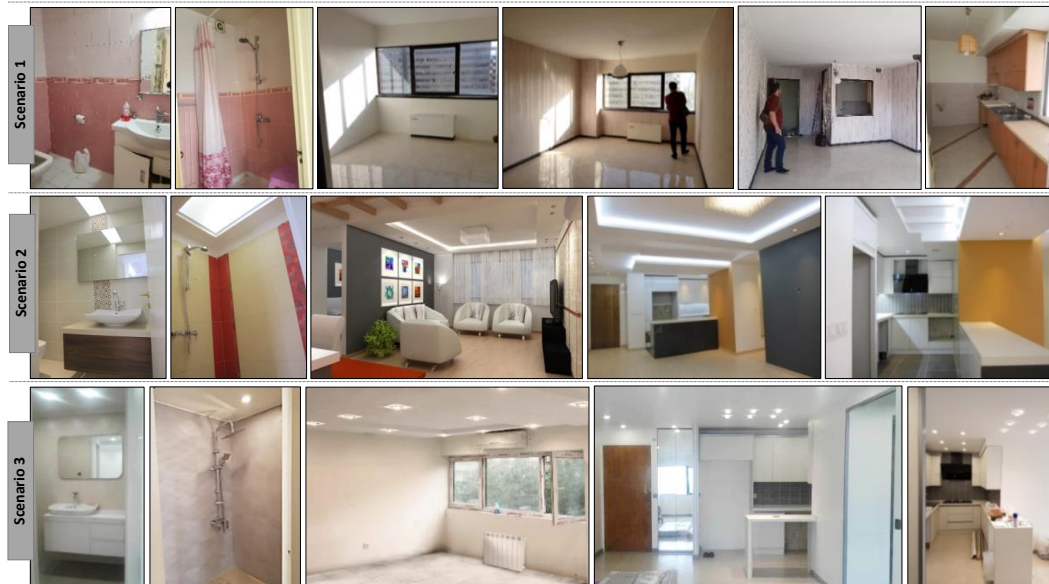


Figure 7.M.7. The pictures of Scenarios 1-3; Top: Scenario 1, middle: Scenario 2, and, bottom: Scenario 3

Table 7.M.2. Lighting and acoustic characteristics of scenarios 1 to 3

		Scenario 1	Scenario 2	Scenario 3
<b>Applied materials</b>	Facade	Prefabricated concrete panels with a size of 7.00*1.20*0.25 m, 6 cm of the air gap, and solid gypsum blocks with a size of 666*500*60 mm	Prefabricated concrete panels with a size of 7.00*1.20*0.25 m, 6 cm of the air gap, 3 cm of the mineral wool, and hollow brick wall with a size of 190*180*80 mm	Prefabricated concrete panels with a size of 7.00*1.20*0.25 m, 6 cm of the air gap, 3 cm of the glass wool, and metal stud and one-layer plasterboard with a thickness of 12.5 mm
	Interior walls/partitions	Solid Gypsum blocks, density 1100 kg/m <sup>3</sup>	Hollow brick size 190*180*80 mm, density 1300 kg/m <sup>3</sup>	Metal stud and two 12.5 mm plasterboard, thickness 100 mm
	Ceiling	No false ceiling	False ceiling	False ceiling
	Floor	Ceramic tiles 50*50	Parquet, Direct Pressure Laminate (DPL)-10mm thickness	Ceramic tiles 60*60
	<b>Insulation</b>	Acoustic insulation	Without insulation	Without insulation
<b>Window</b>	Window frame	Galvanized steel frame	Galvanized steel frame	UPVC frame
	Window glass	Double glazing - clear glass 6mm and 13mm air	Double glazing - clear glass 6mm and 13mm air	Double glazing - clear glass 6mm and 13mm argon gas
<b>Natural lighting</b>	Living room and bedroom	Two windows – 1.20*3.00 m – provide direct natural lighting	Two windows – 1.20*3.00 m – provide direct natural lighting	Two windows – 1.20*3.00 m – provide direct natural lighting

### 7.M.3. Questionnaires for the evaluation of I<sub>17</sub> and I<sub>18</sub>

Subsections 7.M.3.a and b present the corresponding questionnaires for evaluation of I<sub>17</sub> and I<sub>18</sub> respectively.

#### 7.M.3.a. Questionnaire 1: The lighting comfort (I<sub>17</sub>)

**Question 1:** What is your opinion regarding the **natural lighting** satisfaction of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.89	4.00	3.91	
Kitchen	1.63	3.31	3.45	
Bedroom	3.95	3.92	4.00	

#### 7.M.3.b. Questionnaire 2: The acoustic comfort (I<sub>18</sub>)

**Question 1:** What is your opinion regarding the **outdoor noise** satisfaction of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.89	3.92	4.00	
Kitchen	3.63	3.77	3.73	
Bedroom	3.79	3.85	3.91	

**Question 2:** What is your opinion regarding the **indoor noise** satisfaction of scenario 4? Please score based on the Likert-scale scoring 1 to 5 where 1 is highly inappropriate and 5 is highly appropriate – by considering the obtained values of scenarios 1 to 3 from user-based questionnaires.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Living and dining room	3.95	3.92	3.82	
Kitchen	3.89	3.85	3.82	
Bedroom	4.05	4.08	4.09	



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# Bibliography of Appendices

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