

AN EVIDENCE-BASED EXAMINATION OF THE CLAIMS OF THE MODERNISM PROGRAM: THE CASE OF SWEDEN

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Abstract. Sweden, like other countries, quickly adopted the ideas of the modernism program for architecture developed in the early 20th Century, most notably in a massive building campaign known as the “Million Program.” Yet, perhaps surprisingly, there has been little direct examination of the claims made for this approach in the light of available evidence of the outcomes. We examine three key claims as they apply to the Swedish context, and assess the evidence. We do not find supporting evidence for the claims, and significant evidence for their falsification. We conclude that the ideas of the modernism program were not scientific, as claimed, but more likely the product of an irrational belief system. We draw implications for policy and practice today.

Keywords: *Modernism, Health problems, Social problems, Economic costs, Le Corbusier.*

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1. Introduction

Sweden’s history of urbanization in the Twentieth Century offers as a significant laboratory to evaluate the claims of the modernism program for architecture, particularly those formulated on health, social and economic grounds. Yet there is surprisingly little evidence-based examination of these claims. Instead, what we find is an apparent set of unquestioned beliefs about the inevitability and correctness of this form of development that persists for many practitioners and policymakers even today. Here we offer a brief examination of this history, and evidence-based review of the soundness of its claims, with a focus on medical evidence.

After the Second World War, Sweden went through a period of rapid socio-economic development. The increase in economic and industrial capacity created opportunities to address the critical housing shortage which had plagued the country for so long. Lasting for ten years from 1965, the *Million Program* was a construction program that aimed to provide housing for one million people.

The original ideas for the architectural and urban planning of the Million Program may be traced to meetings between the Swedish architects Uno Åhrén and Sven Markelius, and Le Corbusier in Paris in 1925. Åhrén and Markelius were impressed by Le Corbusier’s visions for modern architecture, and this would subsequently be of immense importance to urban development in Sweden. The founder of Bauhaus, Walter Gropius, also made significant contributions.

Together with three other architects and an art historian, Åhrén and Markelius formed a group of six – here referred to as the *Modernism Sextet* – which disseminated these

ideas among colleagues of theirs. With the *Stockholm exhibition* of 1930 and the book *acceptera* (in English *accept*, and written with a small *a* to underline the modern approach) (Asplund *et al.*, 1931)) that was published the following year, the group reached a broad audience.

Consequently, architectural training was radicalized according to the new ideas: straight lines, right angles, no ornaments, and flat roofs. Building laws were also reformed during the 1930s and 40s according to the new principles. This *modernism program of architecture* was in Sweden often referred to as *functionalism*. It would, they argued, meet the needs of the *new modern man*. They did not realize that the fractal geometry characteristic of the premodern era was going to be replaced by a non-fractal geometry with immense, negative consequences for architecture.

By 1965, when the construction of the Million Program started, the modernism program was a well-established vision for urban planning in Sweden. The modernism program architect Lennart Holm became the head of Sweden's largest ever investment in housing construction. According to Holm, the new architecture could create conditions “*for a new and free man who can shake off the buoys that class, society, convention, and religion imposed on her... Do you recognize **acceptera**, the manifesto of functionalism? Its images mock the historical masquerade, style, and motif architecture, but show respect for logical form, regardless of age.*”

Holm implemented novel ways for the planning and development of the construction industry according to the principles of mass production. Together with the big construction companies, Holm developed an industry for the rational mass and serial production of housing with flat roofs, windows in long lines without scopes, doors without portals, and walls completely free of ornaments. Holm wrote: *The key to this whole process, whose evil or good are hardly worthy to discuss when it seems to proceed almost by its own power; and the means are normalization, typification, standardization, tempo work, serial production, mass production and automation* (Holm, 1955).

2. Critical analysis of the modernism program in Sweden

The special thing about architecture is that it is an art form that has direct contact with society. It is intrinsic to our homes, our streets, our squares, and our institutional buildings. It concerns us all. It is therefore important that we can talk about it and shape it so that it benefits us all.

It was the ambition that modern architecture in Sweden would be part of the democratic development and construction of welfare. The modernism program of architecture aroused great interest in the *avant-garde*, but the architects neglected to initiate the dialogue with the city's users that is required in a democratic society in times of changes. With its abstract language, difficulties understanding the new kind of architecture arose.

The body of architects claimed that the justification for the new architecture was objective and scientific. Therefore, they deemed it unnecessary testing it out beforehand. Thus, they did not bother to formulate any hypotheses to be tested concerning the claimed advantages of the new architecture.

Critical rationalism, as described by the philosopher and theorist of science *Karl Popper*, is useful to a retrospective scientific investigation into whether the modern

program succeeded in fulfilling the promises of making improvements to well-being, society, morality, and economy. His *hypothetical-deductive method* is appropriate for such an investigation.

3. Karl Popper, Critical Rationalism and the Open Society

Karl Popper (1902–1994) was one of the most influential philosophers of science during the 20th century. His openminded theories are in line with a tradition of critical thinkers from Thales and Socrates of antiquity, Galilei Galileo of the Renaissance, Charles Darwin of the 19th century, and Albert Einstein of the 20th century. Sir Peter Medawar, Nobel laureate in medicine in 1960, considered Popper to be the most important theorist of science of any time. Popper's thoughts and theories can give us tools to judge the relevance of the architectural ideas of modernism as realized by the *Million Program*.

Popper was a realist. The question is not if reality exists or not, but with what precision we perceive it and if we interpret it correctly. Popper devised the hypothetical-deductive method in 1934 for the acquisition of knowledge (Popper, 1935). It is acquired, he argued, by analyzing the problems, formulating hypotheses, and then eliminating the less true options. In ordinary real-life situations, as well as in science, we guess what might be the best solution to a question.

The hypothetical-deductive method is a theory of science as well as a practical tool to guide ordinary, everyday decision making. Such decisions can include mundane tasks such as selecting which food to eat, how to design and construct a house, or in what theory to believe. The guess — the hypothesis — is then tested: Did the food taste good? Does it make me healthier? Does it matter to the world if I choose transportation that is good for the environment or not? Have building materials X sufficient strength and durability for the building project Y? Does Building Z have high aesthetic values or not?

This is how Popper formulated his hypothetical-deductive method:

$$P1 \Rightarrow TT \Rightarrow EE \Rightarrow P2$$

where P1 = problem; TT = tentative theory; EE = elimination of error; P2 = renewed problem.

Tentative theory is another term for hypothesis. Elimination of error occurs through theoretical and practical tests of the hypothesis. These tests are conducted in a fault-finding pursuit. They are attempts at refuting and falsifying the hypothesis and if these attempts fail, the hypothesis is probably valid.

The hypothetical-deductive method can be used to the construction of a house, or the architectural plans for a neighborhood. According to Popper, it is more important to avoid harm than to find the perfect solution (Popper, 1945). One should not strive to create the perfect city. But if you strive to create cities for well-being, beauty, meeting places, social interaction, health, and creating the conditions for children's play and needs, the greater the chance of achieving a good result.

Step by step our knowledge increases, but it can never be complete. Critical rationalism is undogmatic, non-deterministic, and is different from a scientific method based on induction. The latter is based on the idea that one can with accuracy calculate the laws of nature and thereby predict the future.

Inductive thinking is a scientific myth, according to Popper. The idea of the perfect plan that can be implemented without repeated critical review and testing, has again and again proved unsustainable. Induction is the method used by modernism. Proponents of modernism made a theoretical plan for urban areas that they, without testing, realized.

Social change and development including city planning are complicated processes and are best conducted through what Popper calls *piecemeal social engineering* (Popper, 1945). A machine can be constructed on the drawing board and the final product can be completed according to that plan. However, that simplicity is inappropriate when building a city district with its inherent complexity.

A basic assumption of the modern program for architecture is that housing can advantageously be mass-produced. Le Corbusier was already thinking about this in 1914 when he created a model of a simple concrete structure: the so-called *Mason Dom-Ino system*. The word plays on the words Dom, Latin for a house, and Ino, an abbreviation of the word innovation. The Mason Dom-Ino system was a prototype for mass production of houses which has been highly influential. Le Corbusier propagated: *La grand industrie doit s'occuper du bâtiment et établir en série les éléments de la maison* (Le Corbusier, 1923, p. XX).

But is it a good idea to mass-produce houses? No, according to Kurt Psilander, who showed in a study that mass production was much more expensive (Psilander, 2008). The mathematician, architect, and author Christopher Alexander has strong arguments against mass production of houses. The fifteen properties, which he describes as fundamental for a living architecture, cannot be produced that way (Alexander, 2002). They demand detailed planning and an architect responsible for each step of the planning and building process.

Alexander's fifteen properties are:

1. Levels of Scale (similar figures at a range of scales)
2. Strong Centers (prominent geometrical zones in between others)
3. Boundaries (geometrical zones that bound others, e.g. centers)
4. Alternating Repetition (patterns that repeat with some alternating variation)
5. Positive Space (a geometric region that does not have excessively acute sub-regions)
6. Good Shape (a geometric region that is coherent and interrelated)
7. Local Symmetries (groups of regions that are internally symmetrical but may not be externally symmetrical)
8. Deep Interlock and Ambiguity (patterns that inter-relate in complex ways)
9. Contrast (adjacent figures that are starkly different from one another)
10. Gradients (figures whose characteristics gradually transition)
11. Roughness (figures with many small-scale asymmetrical characteristics)
12. Echoes (figures that repeat some aspect from other figures)
13. The Void (areas where few or no figures are present)
14. Simplicity and Inner Calm. (A living whole has certain slowness, majesty, and quietness, i.e., a state of inner calm. This quality derives from inner simplicity, where everything that is unnecessary is removed. It does not refer to simplicity in the superficial sense but to the true simplicity of the heart.)
15. Not-Separateness. (In a living whole, any centers deeply connect and melt into their surroundings. They are merged inseparably, but they still have their character and personality. As a result of this deep coherence, things feel completely at peace.)

4. Le Corbusier's and the Modernism Sextet's view of objectivity

Le Corbusier claimed, without any proofs, that his architecture was factual and objective, and rested on scientific principles. What were these principles, precisely? He claimed that:

- The right angle and square, triangle, circle, and the cylinder are objective basic forms.
- Objectivity requires that the exterior of a house is a direct consequence of the inside of the house. This was earlier stated by the American architect Louis Sullivan who stated that form follows function.
- Decoration destroys the shape because it is irrelevant, and not objective (purism).
- The modernist house is better at promoting health than traditionally built houses (the health aspect).
- Modernism promotes morality, as opposed to traditional architecture (the moral aspect).
- Modernism is well suited for the mass production of houses, which is economically advantageous (machine culture, l'Esprit Nouveau).
- *La cité géométrique*, the geometric city, with its straight lines and right angles, with sparsely placed houses and large, straight thoroughfares, is well adapted to modern man.

Le Corbusier and the Modernism Sextet did not propose any methods for how to show that their architecture is better for health, harmony, morality, and economics. However, with further scrutiny of how he and other modernists fulfilled the promises of high aesthetics and good function, which would create the conditions for healthy, happy, and moral people in well-functioning cities at low costs, one may justifiably be skeptical.

They did not formulate any hypotheses and did not conduct any scientific tests or analyses. To test the validity of their alleged objectivity, three hypotheses based on central statements about the benefits of the modernism architecture are formulated as follows:

Hypothesis 1 — Houses built according to the principles of the modernism program promote health better than traditionally built houses.

Hypothesis 2 — Houses built according to the principles of the modernism program promote more harmonious relations among people.

Hypothesis 3 — Houses built according to the principles of the modernism program lead to lower costs.

We consider each of these hypotheses individually below.

Hypothesis 1 — Houses built according to the principles of the modernism program promote health better than traditionally built houses.

Le Corbusier and the Modernism Sextet made health one of their principal concerns. *We are unhappy to live in unworthy houses, because they ruin our health and our moral*, wrote Le Corbusier in his influential book *Vers une architecture* (Towards One Architecture) (Le Corbusier, 1923 p. 6). In its English translation, the totalitarian title was changed to *Towards a New Architecture*.

But was reconstruction, that is, the demolition and construction of new neighborhoods and entire cities, the right solution for better health? If so, how would the city be planned for a society with healthier and more harmonious people? Figure 1.

A goal of the new urban planning was to create equal housing environments for everyone, with good access to sunlight and air. However, their claims that their plans would better meet these requirements than the block and garden city, were not backed up with scientific data.

The modern program city plan, with *towers in park*, resembles the sanatorium for tuberculosis, a similarity that was not explicit, but which was certainly a reference. Tuberculosis still ravaged the 1920s and 30s. The health resorts for tuberculosis sufferers were preferably separated in highland forests or coastal areas, where the afflicted had good access to fresh air and sun, and contagion could be kept limited. The dream of health, which the new architects had in mind, would similarly be realized in Le Corbusier's visions. But that the sanatoriums were associated with social isolation, which was to become a great burden in areas such as the Million Program, was probably not in their mind.

A type of social isolation, a phenomenon called *anomy*, would emerge as a threat to the wellbeing of residents of modernism's separated neighborhoods. Anomy is a sociological disease described by the sociologist Émile Durkheim (1858-1917). It occurs in newly built neighborhoods where norms, values, and social relationships are unclear. It leads to weak social control in combination with insecurity and increased prevalence of stress and hostility. Professor of psychiatry Johan Cullberg has emphasized that the concept of anomy is applicable to the Million Program Areas. Anomy can explain many negative reactions, such as alienation and difficulties in finding a function in a social context. This, in turn, can lead to difficulties in managing school and work, to asociality, abuse, and crime. Cullberg reported a six-fold increase in suicide rates compared to the national average in such an area (Cullberg, 1985). Social isolation also leads to an increased risk of cardiovascular disease (Caspi *et al.*, 2006).

One reason for building tall, sparsely arranged houses was to create plentiful access to fresh air and sun outdoors. A disadvantage is that the wind has free space. Without access to shelter, the wind in the Nordic countries is often cold, and cold wind makes us uncomfortable. We prefer to stay indoors.

Dust and bacteria are easily ventilated with air from open windows from two sides in apartments built in plain rows. The requirement for continuous air exchange was removed in the new Building Law of 1931, which was written in accordance to the modernism program. Town planners recommended instead thick houses with double rows of apartments. There are more apartments per staircase, but the apartments are not so easily ventilated. And in addition, you only get light from one direction. In his book *A Pattern Language*, Christopher Alexander wrote. "*When they have a choice, people will always gravitate to those rooms which have light on two sides, and leave the rooms which are lit only from one side unused and empty.*" (Alexander, 1977; Pattern 159).

Sunlight is healthy, warm, and beautiful. One major goal of the new city plans was to make access to sunlight optimal for all. The sun's UV rays stimulate the formation of vitamin D, which is good for health. To create a fair outcome in terms of access to equal amounts of sunlight, it was recommended that the houses should be oriented in the north-south direction, so that every apartment would get an equal exposure to sunlight,

either from the east or west. However, without the sun from the south, there is less light, especially during the winter.



Figure 1. Fittja, Södertörn, Sweden, part of the Million Program

Sun and fresh air are plentiful outdoors. It is important that the local environment is attractive, and that it is easily accessible. Inside the apartments, the UV rays are filtered by windows and the sunlight penetrating the glass and reaching the inside is not enough to stimulate vitamin D production. To sit outside at a safe and soft place in a sheltered yard with fresh air and sunlight filtering through the tree canopy is healthy. It also promotes social contacts and play for children. The modern, sparsely located and often wind-blown *towers in the park* without shelter, do not easily lend themselves to such high-quality leisure time. Also, children who live in high apartment blocks go out more rarely and parents are less able to supervise them, problems described by researchers (Svensson, 2010).

In short, the advocates of the modernism lacked knowledge of where and how to best utilize the sun's positive health effects. They also did not consider how people can sit outdoors protected against cold winds while children play in a varied, green, and safe environment.

In houses made with mass-produced building elements and modern solutions for ventilation and isolation, people have been affected by headaches, stuffy noses, redness, concentration difficulties, unexplained fatigue, and eye trouble, the so called *sick-building-syndrome*. It became so commonplace that the World Health Organization (WHO) in the 1980s described it as a major health problem.

Blue concrete was a common building material between 1929-75, the golden age of modernism. It contains significant amounts of carcinogenic radon. Radiation Safety Authority has calculated the number of cases of lung cancer in Sweden due to radon to about 500 cases annually.

People are sensitive to stress and can react with different symptoms such as stomach aches, headaches, nausea, loss of appetite, fatigue, vomiting, dizziness, breathing difficulties, and difficulty swallowing. Common causes of stress are loneliness, conflict, performance anxiety, bullying, and various forms of abuse. In a cohort of 1,333 children in elementary schools, stress symptoms were much higher in a Million Program area compared to a non-Million Program area (Alfvén, 1993); for stomach pains 27 percent higher, for head ache 31%, and for loss of appetite 13%. Stress also increases the risk of obesity in children and adults, a common problem in the Million Program areas.

Health and social problems have been described in terms of ill-health numbers, which are almost doubled in Million Program areas as compared to non-Million Program areas. The ill-health numbers consist of the number of sick-days' pay, unemployment benefit, sickness benefit, activity allowance, and average rehabilitation allowance per person and year. According to the *Statistiska Centralbyrån* calculations in 2008, these were in Million Program areas such as Fittja 42.9 days, Alby 44.6 days, Vårby 51.1 days, Rinkeby 54.1 days, Tensta 47.1 days, Rosengård 42.5 days, and Bergsjön 50.2 days. Compare this to traditional areas, for example Värmdö 24.0 days, Salem 24.8 days, Täby 20.7 days, and Vaxholm 25.1 days.

Ill-health numbers are affected by many different factors such as income level, the prevalence of unemployment, migration, traumatic experiences, physical activity, education, alcohol consumption, smoking, noise, stress, air pollution, and, of course, age and gender as well as city planning.

Mortality also increased in Million Program areas. The statistician Örjan Hemström at *Statistiska Centralbyrån* found that mortality during the period 2006-10 was 37% higher in the 30-64 years age group in the Million Program area of Norra Botkyrka as compared to the national average. The age range has been chosen so that differences in the age pyramid in the compared areas should not affect the results.

The city planning including architecture style are certainly important factors that should be included in discussions and analyses of the number of sick-days' pay and mortality.

Ill health as a consequence of modern urban planning has prompted criticism from WHO (Barton *et al.*, 2009). The organization has criticized the functionally separated city with unattractive, segregated residential areas. It is noted that diseases such as obesity and cardiovascular disease are related to social isolation, social polarization, long routes to and from work, car dependency, and a sedentary lifestyle.

The improvements in health among the general population in Sweden during the 20th century, were not the result of the conquest of the modernism program of urban areas. It was a consequence of improved working conditions and good access to nutritious food, improved hygiene, central heating, running water, and drainage. Medical progress and the general improvement of the control of infectious diseases by vaccination, antibiotics and infections have also been of great importance.

This is easy to understand by studding the conditions in houses that remain from the 17th, 18th, and the early 19th centuries. Today they are not afflicted with higher morbidity such as tuberculosis and never with rickets or diphtheria. The red wooden gutters on Åsöberget in Stockholm, where tuberculosis and other infectious diseases ravaged among poor workers in the 19th century, are today attractive and the residents generally have good health. Today you find tuberculosis primarily in the housing of the

Million Program among immigrants from countries where tuberculosis is common. Occasional cases of rickets also occur in these areas due to an imbalanced diet, deficiency outdoor life, and clothing that blocks UV light.

It was not the older architecture that caused sickness and death. It was poverty, famine and poor living conditions.

In summary. The hypothesis that modernist ideas about form, production and urban planning are better for health than traditional architecture has not been verified. On the contrary, morbidity and mortality are higher in the Million Program areas. The discrepancy can be explained by negative stress and the Million Program areas being catalysts for segregation between well-off and less well-off people, creating a chasm between those who can choose a place of residence and those who cannot. The Million Program have thereby reinforced, instead of counteracted inequality in society. Inequality is per se known to increase rates of disease (Marmot, 2015).

Hypothesis 2 — Houses built according to the principles of the modernism program promote more harmonious people.

The attractiveness of a residential area may determine who resides there. The price per square meter of housing determines who can afford to live there. These factors also influence the socio-economic structure of an area as well as distribution of equality and segregation, well-being and unemployment, joy and discouragement, good morals and crime.

The Södermalm area in Stockholm illustrates what determines whether a residential area is attractive or not? In the Middle Ages it was countryside. In the 17th, 18th, and 19th centuries many factories of different kinds were located there: candle and textile factories, tanneries, breweries, cork factories, and sugar mills. Workers dominated the population and Södermalm became a so-called subclass area. Today, the factories are gone, and the houses are well equipped with modern standards and sanitation. The old workers' barracks have become attractive and highly sought-after.

In the areas of the Million Program, conditions are different. The housing had from the beginning good sanitation, good standards in the kitchen and bathroom, and no factories in the vicinity. However, the shape of the houses and the city-planning was generally perceived as unattractive and many, if they could, avoided settling down there. This resulted in negative spirals with segregation and social problems.

It was not only in Sweden that this took place. Many residential areas of the world built during the 1960s and 70s, according to the principles of Le Corbusier and Walter Gropius, quickly became problem areas. People found them unattractive and those who could chose other housing. People with a poor economic situation and social problems, the unemployed and immigrants, psychologically sick people and criminals became more abundant in these areas. This phenomenon was described by the author Jane Jacobs as an 'instant slum' in her book, *The Death and Life of Great American Cities*. She protested against the development of the large urban area projects planned in the 1950s and 1960s. She wrote: "*But look what we have built with the first several billions: low-income projects that become worse centers of delinquency, vandalism, and general social hopelessness than the slums they were supposed to replace.*" (Jacobs, 1962, p. 13). She even managed to prevent a planned demolition of Greenwich Village in New York, today a multi-cultural and popular residential area.



Figure 2. Norsborg, Botkyrka Municipality, Stockholm, Sweden, part of the Million Program

Instant slums have been observed in residential areas built according to the modernism program throughout the world. The term slum is not relevant in Sweden but many neighborhoods built in the 1960s and 70s quickly developed social insecurity, and anonymity in combination with widespread unemployment and high crime rates such as in Fittja, Alby, Norsborg, Vårby gård, Akalla, Tensta-Hjulsta-Rinkeby in the Stockholm area, Rosengård in Malmö and Bergsjön, Hammarkullen, Gråsten, Hjällbo, and Angered in Gothenburg. See Figure 2.

In an article in the journal *Modern Psychology* 2010, the architect Julia Svensson specified six physical causes of discomfort in the Million Program areas (Svensson, 2010). They are:

1. The inhabitants and their children do not enjoy living in high-rise buildings, as their residences are too high up, and few residents spend time outdoors in common places and play areas.
2. The mass-produced houses are perceived as rigid and inhospitable.
3. The roads near the houses pose a risk of accidents, and noise from traffic is disturbing.
4. The lack of large parks is experienced negatively, the green areas around the high-rise buildings are too small to create recreation.
5. The lack of complexity and variety is experienced as negative.
6. The wind around the high-rise buildings, without the provision of wind-protected areas, causes discomfort.

Le Corbusier claimed that older architecture made people disharmonious, but the new architecture, with right angles, creates harmony and *l'esprit nouveau*. *“If you tear from your heart and from your soul the strict concepts of the house and study the question from one critical and objective point of view, you arrive at the healthy house, the serial*

house, healthy (and moral as well) and beautiful through the aesthetics of the tools of work” (Le Corbusier, 1925, p.187). However, the results of the modernism program are the opposite. A Survey of *Security and Social Life in Tensta / Hjulsta*, a typical and representative Million Program area, performed by Svenska Bostäder (2006), describes an area plagued by crime and insecurity, violations of women’s rights, rape and abuse. As much as 40 percent of the residents report that they are very often or quite often worried about being subjected to violent crimes. Many wish they could leave the area: 33 percent had serious plans to move and 13 percent had decided to move soon. Similar problems exist in the other Million Programs areas.

In summary. Neighborhoods built according to the principles of Le Corbusier introduced and developed by the Modernist Sextet in Sweden, did not create conditions for more harmonious people with better morals. On the contrary, many of these areas soon became beset by social problems.

Hypothesis 3 — Houses built according to the principles of the modernism program lead to lower costs.

The Million Program and other modernist housing areas were built according to the principles of mass production. Taylorism describes how work can be made more efficient through specialization and centralization. This was applied by Henry Ford for his mass production of cheap cars and it was reasonable to presume that houses could be produced in a similar way. The *Modernism Sextet* launched the principle of mass production in their book and manifesto *acceptera* according to Le Corbusier’s model and they convinced decision-makers that the mass production of housing would lower costs. The Million Program was therefore designed as a construction project for large companies such as Skanska, NCC and PEAB.

But was it cheaper? The costs for multi-family houses traditionally built decades before 1965 were in fact lower, when the Million Program started, evidence contrary to the claim that mass production had an economic benefit. See Table 1.

Table 1 - Construction cost in SEK/m², multi-family house, new buildings. Adjusted according to 1914 CPI

Year	Cost per m ²	Year	Cost per m ²
1958	156	1967	186
1960	154	1969	186
1962	155	1971	160
1964	161	1972	175

Source: Statistiska Centralbyrån 1973

It has been convincingly shown that cars can be mass-produced cheaply. But mass-producing cheap housing is not easily accomplished. The researcher Kurt Psilander found that smaller construction companies tend to build more varied houses with better quality. It may come as a surprise that small businesses also build more cheaply. Psilander showed in a study that the smaller companies’ total construction costs were just under SEK 15,000/m² (14,767 = SEK 336/m² according to the Consumer Price Index 1914), as compared with the bigger construction companies’ costs of SEK 19,000 kr/m² (18,830 = 428 kr/m² according to the Consumer Price Index 1914). Thus, the big companies were more than 27% more expensive (Psilander, 2008). This data cannot be applied directly to housing projects of the modern program decades earlier, but it shows

that well-planned investments in small construction companies have economically beneficial. Had they also built more in wood, popular in older days, it would have also reduced production costs (Sathre & Gustavsson, 2009).

Over a longer period of time there were increased costs for repairs due to the low standards of the materials used and the need for architectural renewal due to feelings of discomfort among the inhabitants and damage to the houses.

An article in the International Herald Tribune described the problems with the residential areas in France built according to the same principles as those in the Million Program (International Herald Tribune, 2011). The Parisian suburb La Courneuve 4000, built in the 1960s, was presented with pomp and beautiful speeches at an exhibition at Grand Palais in Paris as a residential area that would meet people's needs for comfort and well-being. The keywords were mass production and *separation et uniformité* in accordance with the city plans of Le Corbusier. This was realized in the form of large, tall, square-shaped residential houses without proximity to shops, work or public transport. In addition, the quality was poor, the houses rapidly developed leaks and breakages, and the elevators stopped working. It became an instant slum area with discontent, social problems, high unemployment, crime, abuse, and segregation. The area has undergone repeated upgrades for 25 years, but without success.

Housing complex after housing complex, all with evocative names like Renoir, Ravel, Debussy and Balzac, have been demolished. Overall, the costs were very high. At least 19 similar areas in France with a total of 150,000 apartments in houses with similar problems were demolished by blasting and many more are to be demolished.

In the Million Program area where I worked as a doctor in the 1980s, extensive renovations were necessary, and changes were needed to increase variation in the rigid appearance of the houses. Construction costs for these renovations were as large as the original costs, according to information from the building firm *Botkyrkabyggen*.

Continued decay in the Million Program areas has been difficult to prevent. 264,000 apartments were renovated before 2014 and many more are to be renovated for several hundreds of billion kronor. To the construction and repair costs very large social costs must be added. In short - the Million Program has been an expensive deal.

In conclusion. The claim that houses built according to the principles of modernism lead to lower costs cannot be sustained. On the contrary, the costs for the Million Program have been high, very high including the social costs.

5. Final conclusions

Popper's hypothetical-deductive method of hypothesis-testing falsifies Le Corbusier's theses that his city plans would create good health, harmony and economy. Thus, there are good reasons to reformulate the solutions on how to build cities for health, harmony and in good economy.

Straight lines and right angles can be used in scientific contexts but are not science in itself. Mass production is neither objective nor scientific, merely a mode of production. So, what remains of modernism's nonsensical pretenses to represent objectivity and science? Nothing?

The dream of the Million Program as a big democratic project has crash-landed in reality. The evidence shows that these environments became catalysts for segregation

and breeding grounds for ill health and social problems. They created a society built on the basis of a corporate plan, with urban areas comprised of segregated areas connected by highways and vehicles with a ruling elite in the center, while less well-off people housed in anonymous concrete boxes in the periphery. Certainly, there was light, air and green between the houses; but health and morale did not improve there as claimed.

It is widely believed that economic concerns were the main justification for the Million Program. However, economic concerns would have been better addressed in other ways. There were popular neighborhoods built in Sweden in the 1920s, produced at prices workers could afford, which would have been a better basis for the new urban planning. Had many of the smaller construction companies built the Million Program, they could have created a more rich and varied architecture with reduced costs without mass production.

It was claimed that the architecture of the new modern program was superior without a need to be tested first. A basic problem with the new modernism program is that it is not scientific and rational as has been previously asserted. Instead it is unscientific and irrational, with the pseudo-scientific appearance of rationality. But there is an important choice to be made, as Popper stated, the one between irrationalism and rationalism. The former leads to the erroneous assumption that one's beliefs are superior.

An irrational movement that is uncritical and arrogant leads to stagnation. Ideas that lose contact with reality eventually become vacuous idealism. This same logic applies to socialism petrified in communism, liberalism petrified in capitalism, or architecture petrified in dogmatic modernism.

The conclusions of this study are in accordance with the disclosures of Le Corbusier as a dishonest fascist, the understanding of his endless failures of his proposals and projects, and the devastating influence he has had on architecture of today (Millais, 2017; Brussat, 2017; Dalrymple, 2017; Salingaros, 2018; Barancy, 2015). There are good reasons to find new ways how to build cities for health, harmony, and a prosperous economy.

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