

Bucharest University of Economic Studies

Business Administration Doctoral School I



PHD THESIS

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Title of the PhD-Thesis:

**PERFORMANCE IMPROVEMENT POSSIBILITIES OF THE
REAL ESTATE SECTOR IN THE CONTEXT OF SUSTAINABLE
DEVELOPMENT AND INDUSTRY 4.0**

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b) Keywords

organizational performance, real estate sector, sustainable development, industry 4.0, business models, resilience, sustainable investments.

c) Summary

The doctoral thesis addresses opportunities to improve performance in the real estate sector in the context of sustainable development and Industry 4.0.

The starting point is an analysis of current approaches to sustainability and business models in the real estate sector, highlighting sector-specific aspects related to existing methods of performance evaluation and the integration of sustainability factors in connection with Industry 4.0.

The research then focuses on sustainability and business models in real estate, as well as on the long-term economic and ecological assessment of business performance from an interdisciplinary perspective. In addition, the thesis examines information security management systems in the real estate sector, including specific issues related to resilience and artificial intelligence in this field.

Taking into account the results of these studies and the doctoral candidate's professional experience, the emphasis is placed on real estate investments as a strategic factor for improving business performance.

Accordingly, an original measurement method is developed to enhance organizational performance through sustainable investment decisions in the real estate business. The proposed measurement method was tested in practice, with data collected through a questionnaire-based study.

As a result of the research conducted, the doctoral candidate provides solutions to support alternative investment decision-making in the real estate sector within the requirements of sustainable development. The benefits, as well as the limitations and constraints of applying the proposed method, are highlighted, along with future opportunities for further development.

As part of the research, the definition and significance of sustainability in business valuation, including its foundations and current developments, were identified. In this context, sustainability-related values in valuation were determined and used for the subsequent and related research. The integration of sustainability into company valuation has developed from a voluntary supplement into an important strategic task. Companies benefit not only from improved access to financial

resources and markets, but also from greater resilience to various risks and from long-term competitive advantages by including environmental, social and governance criteria in their valuations and decisions. Companies that understand and implement this important strategy are successful in the long term while also making a positive contribution to society.

The study on sustainability reporting under the European Sustainability Reporting Standards in the context of the Corporate Sustainability Reporting Directive in the real estate sector produced clear and consistent results. The findings from theory and practice show that the standards can help enable clear and comparable sustainability reporting. In particular, the introduction of specific key figures on topics such as CO₂ emissions and energy efficiency improves the basis for investment decisions. This allows capital to be directed more specifically into sustainable real estate. It also influences stakeholder perception. Another important finding is that tenants, municipalities and the public are increasingly placing greater value on sustainability. Open and credible reporting strengthens trust in the company and improves its reputation.

The identification of traditional business valuation methods in the real estate sector is essential, as these methods provide a fundamental basis. The multiplier method offers a quick and easily understandable assessment of market values. Its reliability increases significantly when comparable companies are selected carefully and the underlying key figures are current and reliable. The asset-based valuation method appears particularly appropriate in the real estate sector due to its objectivity and transparency.

Furthermore, it is important to disclose the challenges involved in considering sustainability aspects in the real estate sector. Digitalization offers many opportunities for the real estate industry: it can make processes more efficient, enable better decisions and promote sustainable development. To achieve this, however, companies must carefully address data availability, data quality and the establishment of a sustainable data infrastructure. Only when technical, economic, ecological, legal and ethical issues are considered together can companies benefit from digital transformation in the long term.

In the study on the challenges, opportunities and ecological responsibility of investments in the real estate sector, the challenges, opportunities and responsibilities had to be identified. The present work reveals many opportunities in the field of sustainability and also shows the associated risks. It analyzed various literature sources and differentiated between the three dimensions of sustainability. The findings are as follows: first, challenges arise from economic target conflicts, social tensions, regulatory uncertainty and insufficient implementation competence; second, opportunities arise in particular through long-term value enhancement and risk reduction; third,

ecological responsibility functions as a normative and practical framework for sustainable strategies. Overall, it becomes clear that sustainability in the real estate sector is not an additional module, but a new system with considerable potential.

The financial approaches to valuing sustainable companies in the real estate sector were extensively analyzed and identified. In summary, sustainable finance has a strong influence on the real estate sector. It changes both strategic investment decisions and the daily management of real estate, leading toward greater sustainability.

Within the chapter on the circular economy as a driver of sustainability in the real estate sector, the key positions were identified. The results of the regression analysis show that resource efficiency and energy productivity in particular have a significant influence on the circular material use rate. A positive relationship was identified for resource efficiency: the more efficient the use of resources, the higher the circular use of materials. Interestingly, a negative relationship was found for energy productivity. This indicates that there are still unused efficiency potentials in existing processes that do not automatically lead to higher circular performance.

In the study on sustainability in the real estate sector, the current state of the industry was identified. The study shows that the life-cycle approach, meaning the consideration of all phases of a building from planning to demolition, can be significantly improved through digital technologies. With specialized software, buildings can be monitored and optimized more effectively throughout their entire life cycle. Industry 4.0 and Industry 5.0 represent two phases of digital transformation in industry. Industry 4.0 focuses on the automation and digitalization of production processes. Typical features include connected systems, sensors, autonomous machines and the Internet of Things. Industry 5.0, however, is no longer concerned only with making processes more efficient. Its focus is on effective cooperation between humans and machines. Robots are not intended to replace people, but to support them, for example in heavy, monotonous or dangerous tasks.

The identification of the results of the study on audit findings in the field of information management systems, with a particular application possibility in the real estate sector, was successful. Digitalized organizations with smart building technology or cloud-based solutions showed more technical weaknesses, for example in network security, physical access or data encryption. Systems were often in place, but were not sufficiently integrated into the ISMS or were technically outdated. In buildings with older infrastructure, physical security issues occurred more frequently, such as unsecured technical rooms. An ISMS alone is not sufficient; what matters is how well it is integrated into everyday operations. The results confirm the hypotheses: technical complexity increases the risk of deviations, and companies subject to mandatory requirements

perform better. Overall, there is still significant potential for improvement in the real estate sector, especially in connecting technology, organization and security culture.

The study of the current level of information security in the real estate sector identified the current security level. The evaluation clearly shows that metrics and structured assessment methods are still used only to a limited extent in the real estate sector, especially compared with industrial and financial companies. A close relationship can be observed: the more advanced the information security management system is, the more and better metrics are used, and the more likely it is that reporting processes meet audit requirements. The study shows that if real estate companies introduce and systematically use information security indicators, they can increase efficiency, better control risks and pass audits more successfully. Despite its broad scope of application, the standard remains very general and does not provide specific requirements for typical processes in the real estate sector.

It is also important in this context to identify approaches to risk management systems in the real estate sector. The study shows that risk analyses in the real estate sector are not purely an IT issue. They must be understood as a joint task of various departments, in which technical, organizational and strategic risks are considered together. Only in this way can an ISMS be effectively implemented and operated on a permanent basis, with measurable benefits for security, compliance and the preservation of real estate value. Practical recommendations for professionals in the real estate sector can be derived from the study results: first, a uniform risk method should be introduced within the company; second, risk analyses should be integrated into existing systems, allowing master data, measures and technical objects to be directly linked; third, clear roles and processes should be defined. Risk analysis should not be the isolated responsibility of individual departments.

The study on resilience in the real estate sector identified resilience factors. The present study examines resilience in the real estate sector in the context of the transition from Industry 4.0 to Industry 5.0. A significant increase in resilience can be achieved through the effective integration of human creativity and technical precision. Real estate portfolios should be actively aligned toward resilient and sustainable properties in order to secure stable long-term returns. Social and ecological responsibility should be strengthened through the use of intelligent technologies to increase user satisfaction and improve the quality of living and working environments. Social interaction and community building can be promoted through technological networking and digitally supported communal spaces. Targeted measures are also needed to strengthen the circular economy and reduce the ecological footprint of real estate portfolios. The transition from Industry 4.0 to Industry

5.0 therefore represents not only technological progress, but above all the integration of technological, social and ecological aspects into a holistic and sustainable resilience approach. Several starting points arise for future research. Particularly important are the empirical verification and further development of the identified technologies. The real estate sector is therefore faced with both the task and the opportunity to understand resilience not as a mandatory obligation, but as a fixed component of its future viability and long-term competitiveness.

The identification of AI-related aspects in the real estate sector was carried out in the study on artificial intelligence in the real estate industry. The following results were obtained. The findings of the systematic literature review clearly show that the use of artificial intelligence in the real estate sector offers many possible applications and already provides important impulses for innovation. At the same time, it becomes clear that practical implementation, despite its great potential, is still associated with considerable challenges. These mainly concern technical, organizational and cultural aspects. Several conclusions can be drawn from the results. Regarding the maturity level of AI applications, AI technologies are already well developed in some areas, such as real estate valuation. In addition to technical and organizational issues, the acceptance of AI by employees and customers also plays an important role. In conclusion, AI already plays a transformative role today. This role will become even stronger in the future. The perspectives presented provide clear guidance in this regard.

As part of the dissertation, a measurement method was identified under the title: Real estate investments as a strategic success factor: development of a measurement method to improve corporate performance through sustainable investment decisions. This dissertation addressed a highly relevant topic. The residential real estate stock urgently needs energy-related modernization. Necessary investments are usually only made when they are economically reasonable for the investor. This decision is shaped by many parameters. The most important parameters are refinancing capacity, capital costs and risk. Regulatory sustainability targets are not the primary driver for investors, as they do not trigger direct cash flows for the investor. This is where the dissertation begins. Investors need a verifiable, conservative and standardizable measurement method to subject modernization decisions in residential real estate to a business-based assessment. This method should meet both academic requirements and practical needs. The method makes an important contribution to improving corporate performance in real estate companies. It makes key investment decisions measurable and comparable. Most investor decisions are prioritized according to financial viability and are rarely driven by opportunistic convictions. Therefore, the method should not be a matter of negotiation, but a clear decision-making instrument. Through the method,

the result cannot be artificially improved or “calculated positively”. The hypothetical residual value assumption was also eliminated, since it can have a considerable influence while at the same time involving a high degree of uncertainty. The dissertation showed that the exclusive use of basic parameters can lead to misinterpretations. The net present value alone is not sufficiently meaningful to make a reliable investment decision. Small deviations in r and T can already lead to significantly different results. A sensitivity analysis reveals when an investment becomes positive or negative due to a change in framework conditions and parameters. This awareness is essential. Therefore, the sensitivity analysis is not an optional appendix to the method, but an integral component of it. The mathematical logic behind r and T is that the attractiveness of the investment increases when T rises and r decreases. Conversely, the attractiveness of the investment decreases when T is lower and r increases. For example, a project that is clearly negative at $T = 10$ and $r = 6\%$ may already become positive at $T = 20$ and $r = 4\%$. It is understood that the measure costs have not changed; only the parameters T and r have been adjusted.

The research result of this dissertation is that, under the conservative baseline, the advantage of measures from an investor perspective depends almost exclusively on cash flow. This result is limited to the residential real estate stock, and cash flow is the sum of cash inflows and outflows. These are further influenced by the interest rate and the investment horizon. The structure is comparable to a net present value logic. This allows the problem to be reduced, as the question now shifts to the amount of sustainable future cash flows and the level of investment after subsidies. Two further relevant questions are the interest rate and the observation period; however, here the investor’s assumptions are decisive. The method is built on the basis of the essential parameters, which are of course supplemented by further parameters, as explained below.

The application to eleven properties clearly demonstrated which investments are advantageous. The results, also confirmed by the sensitivity analysis, clearly show which investments should be preferred. In the baseline scenario, the results were clearly distinguished between positive and negative properties or investment alternatives. The sensitivity analysis showed that some properties that are negative in the analysis can change into positive or remain negative depending on the parameter assumptions. This finding is important because the investment parameters are shaped by the investor’s risk assessment and investment horizon. The investor can therefore make a conscious decision in favor of a different term or interest rate if this corresponds to the investor’s strategy.

Some cases are already positive under the required parameters and remain positive in almost all constellations of the extensive sensitivity analysis. This means that the initial situation is so

favorable that interest rate and time horizon have only a limited effect on the result. The risk is therefore relatively low, since changes in the environment and in the parameters can be compensated to a certain extent. These investments should be prioritized. In the baseline scenario, some cases are close to zero. These cases can quickly become positive when the parameters of interest rate and time horizon change, as the sensitivity analysis shows. However, the risk in these cases increases if the parameters do not fully materialize, as the case can then turn negative. The challenge is that these cases represent the largest share in practice. Therefore, such investments must be examined carefully and reviewed through sensitivity analysis. Within the framework of decision alternatives, management can assess whether the investment should be carried out in the intended scope or not. The negative cases remain negative in almost all constellations. They have only a very late tipping point in relation to interest rate and time horizon. These investments should generally be postponed. Here, the decision situation is clear: the investments should not be made. The results can also be used as a reason to review the parameters if the results do not appear plausible. This applies, for example, to a large property with full occupancy. Since such properties, as mentioned above, are almost always positive, a review of the parameters, especially the net investment, is essential.

The dissertation identifies three implications. First, prioritization should be based on robustness rather than only on point values. The sensitivity logic shows that decisions should not depend solely on the baseline result. A project that is slightly positive may turn negative with only a slight increase in capital costs. A project that is close to zero may become highly positive if T is increased. This classification enables the prioritization of investment decisions.

Second, control should be based on a small number of reliable input variables. The developed method places the user within a framework that does not take personal preferences into account. Even the “construction instinct” is excluded from the investment decision. Only the parameters are relevant in the method.

The objective was achieved, as a method was developed that meets the stated requirements. The method can represent the cash flows from the investor’s perspective, meaning incoming and outgoing cash flows, and relate them to the interest rate and the investment horizon. Since the investments are calculated over very long periods, no residual value benefit was deliberately included, as this cannot be reliably determined over such a long period. Therefore, the residual value benefit is set as $\Delta TV = 0$. Furthermore, only income increases permitted at the time of investment were taken into account, as only these can be realized with a relatively high degree of probability. OPEX effects through maintenance can also be determined relatively precisely. This

ensures that the method is not driven by speculative assumptions, but by verifiable parameters. The method is not a simple formula, but a measurement and evaluation process. This method was complemented by standardized data collection using questionnaires. The questionnaires were transcribed, plausibility-checked and evaluated. A sensitivity analysis was then carried out. The process components and sequence ensure reproducibility and auditability. This dissertation shows that such measurement methods have high practical and scientific relevance for the residential real estate stock. The method allows investment decisions under refinancing restrictions to be made comparable and assessable. The main contribution of this dissertation lies in its strict landlord-side cash flow perspective, the clear representation of the refinancing limit through income increases, the exclusion of residual values and the integration of sensitivity analysis. The evaluation of the questionnaires shows that the assessment according to the method leads to clear results and therefore serves as a decision-making aid for investments.

The final core statement is as follows: Sustainable modernization decisions in the residential real estate stock become viable in the measurement method only when additional income and OPEX effects cover the net investment under realistic capital costs and investment horizons. Sensitivity is therefore an essential component of the decision logic.