RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.

Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

Application of automation and business intelligence in regulated real estate transactions

Leandro Daroit Feil
Lawyer. Bachelor of Laws from Universidade Paranaense (UNIPAR), specialist in Tax Law from the Brazilian Institute of Tax Studies (IBET), and currently studying Theology.

RESUMO
As transações imobiliárias reguladas dependem de documentos, prazos, verificações de titularidade, controles de integridade e decisões tomadas por múltiplos profissionais. Este artigo analisa como a automação de processos e a business intelligence (BI) podem ser aplicadas à gestão dessas operações sem substituir o julgamento jurídico, técnico e financeiro. Por meio de revisão narrativa e análise documental, articulam-se estudos sobre proptech e transformação digital, normas de gestão da informação, diretrizes de due diligence, prevenção à lavagem de dinheiro, proteção de dados e gestão de riscos de inteligência artificial. Propõe-se um modelo integrado com mapeamento de processos, repositório documental governado, regras automatizadas, painéis de indicadores, controles de exceção e supervisão humana. Conclui-se que os ganhos de eficiência dependem da qualidade dos dados, da rastreabilidade, da segregação de funções, da validação jurídica e da governança contínua; a automação mal desenhada apenas acelera erros e amplia riscos em larga escala.
Palavras-chave: automação; business intelligence; transações imobiliárias; due diligence; governança de dados; tecnologia jurídica.

ABSTRACT
Regulated real estate transactions depend on documents, deadlines, title verification, integrity controls and decisions made by multiple professionals. This article examines how process automation and business intelligence (BI) can be applied to such operations without replacing legal, technical and financial judgment. Through a narrative review and documentary analysis, it integrates studies on proptech and digital transformation, information management standards, due diligence guidance, anti-money laundering, data protection and artificial intelligence risk management. An integrated model is proposed, comprising process mapping, a governed document repository, automated rules, indicator dashboards, exception controls and human oversight. The study concludes that efficiency gains depend on data quality, traceability, segregation of duties, legal validation and continuous governance; poorly designed automation merely accelerates errors and amplifies risks at scale.
Keywords: automation; business intelligence; real estate transactions; due diligence; data governance; legal technology.

1 INTRODUCTION

Real estate transactions are chains of decisions, not isolated acts. Identifying the parties and analyzing ownership, encumbrances, licenses, taxes, physical condition, financing, contracts, closing and registration create mutual dependencies. When these steps are managed through e-mail and disconnected spreadsheets, the risk of conflicting versions, missed deadlines and incomplete evidence increases.

Proptech refers to technologies applied to real estate, construction, transactions and property management. Baum (2017) organized the field into waves of development and highlighted the transition from isolated tools to platforms and data. Wang (2023), in a systematic review, identified

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

machine learning, information management, analytics and big data as central research themes in smart real estate.

Automation and business intelligence (BI) serve different functions. Automation executes predefined tasks or rules; BI integrates and presents data to support decision-making. Neither one, on its own, determines validity, risk or convenience. The hypothesis of this article is that their combination can increase traceability and control, provided that it is subordinated to legal and informational governance.

The research problem consists of defining how large-scale legal operations practices can be adapted to regulated real estate transactions without reducing due diligence to a checklist or turning indicators into automatic decisions. The objective is to propose an application model based on processes, data, exceptions and oversight.

2 METHODOLOGY

The research is qualitative, exploratory and descriptive, based on a narrative review and documentary analysis. Studies published between 2005 and 2024 on proptech, process management, business intelligence and blockchain were consulted, together with documents issued by RICS, FATF, ISO, NIST and the European Union and with Brazilian legislation. Sources published after 2024 were excluded, and earlier classic works were retained when conceptually necessary.

The analysis was organized into eight axes: regulatory complexity; process management; automation; business intelligence; document management; due diligence and compliance; data protection and artificial intelligence; and implementation and indicators. The method neither measures financial return nor validates specific software. The recommendations must be adapted to the jurisdiction, the asset and the risk profile.

3 REGULATORY COMPLEXITY AND ARCHITECTURE OF REAL ESTATE TRANSACTIONS

Real estate regulation combines private law and public controls. Contracts coexist with registration, urban planning, environmental, tax, anti-money laundering, financing and data protection requirements. Technology must represent these layers without assuming uniformity across countries, states or municipalities.

Due diligence is a risk-oriented investigation process. RICS (2023) notes that the scope of due diligence procedures must be adapted to the location, the asset and the mandate. This caveat prevents

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.
Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

a global checklist from being treated as a substitute for contextual analysis.

The property is only one of the data objects. People, companies, beneficial owners, contracts, licenses, guarantees and sources of funds must also be considered. FATF (2022) highlights the vulnerabilities of the sector to money laundering and the importance of identifying the beneficial owner and applying due diligence proportionate to risk.

A transaction has critical events: approval, fulfillment of conditions precedent, signature, payment and registration. Each event depends on evidence and authority. Automating a deadline without linking it to a document, assigning it to a responsible person and requiring evidence of completion creates the appearance of control, but not effective control.

Regulations also change. Rules encoded in software may become obsolete without version management. The design must record the normative source, the jurisdiction, the period of validity, the person responsible for validation and the review date. Critical rules should not be changed directly in production without approval.

The first component of the model is a regulatory taxonomy that connects process, obligation, evidence, deadline and responsible party. This structure allows administrative tasks to be automated while preserving the issues that require interpretation or a decision by a competent authority.

4 PROCESS-BASED LEGAL MANAGEMENT AND OPERATIONAL DESIGN

Process management describes activities, inputs, outputs, decisions and responsibilities. Dumas *et al.* (2018) treat business process management as a cycle of identification, discovery, analysis, redesign, implementation and monitoring. Applying this approach to the real estate sector requires mapping the actual workflow before digitizing it.

Process maps should distinguish standardized work from specialized decision-making. Requesting a certificate, confirming receipt of payment and issuing due-date alerts are automatable tasks; interpreting the chain of title, zoning restrictions or contractual risks requires a competent professional. This separation reduces inappropriate automation.

Roles can be formalized through responsibility matrices. In high-impact controls, the requester, executor, reviewer and approver should not be the same person. Segregation of duties reduces the risk of undetected changes and creates an accountability trail.

Exceptions are part of the process. A divergent document, a foreign party, a complex corporate structure or a restrictive registry entry may require the standard flow to be interrupted. Systems that force completion despite such exceptions produce data that are formally complete but materially false.

Visual status management should reflect objective criteria. “Completed” must mean evidence

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.
Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

accepted by an authorized person; "pending" must indicate the item, the responsible party and the deadline; "blocked" must state the cause and the escalation path. Vague statuses prevent reliable BI.
The second component is a process model with risk gateways, segregation of duties and acceptance criteria. Automation is introduced after the redesign, which avoids digitally reproducing redundancies and weak controls.

5 AUTOMATION OF WORKFLOWS, DOCUMENTS AND DEADLINE CONTROL

Rule-based automation can create tasks, validate fields, calculate dates, request documents and issue alerts. Its value lies in operational consistency. Davenport and Kirby (2016) argue that automation must be accompanied by a redesign of human work rather than interpreted merely as replacement.
Deadlines must take into account the triggering event, the calendar, suspensions, the jurisdiction and the responsible party. Any automatic calculation should display the rule applied and allow review. Graduated alerts with escalation are more effective than a single notification close to the due date.
Document management requires versioning, metadata, access control and retention. The ISO 19650 series, although developed for information on the built environment and building information modelling (BIM), offers useful principles for life-cycle information management and common data environments (ISO, 2018; 2020). Its application to transactional work requires adaptation.
Text recognition and extraction can locate parties, dates and clauses, but errors are possible. Extracted fields should indicate their source and confidence level, with human validation for relevant decisions. The original document must be preserved and linked to the derived data.
Electronic signatures and approval workflows increase traceability when identity, authority and integrity are verified. Their validity depends on the applicable legislation and on the form required for the transaction; not every real estate transaction admits the same type of signature.
The third component is automation governed by versioned rules, evidence and exception handling. The goal is to reduce repetitive tasks and follow-up errors without turning legal reasoning into an invisible command.

6 BUSINESS INTELLIGENCE AND INDICATORS FOR DECISION-MAKING

Business intelligence integrates data from multiple sources to provide operational visibility. Chen, Chiang and Storey (2012) describe the evolution of business intelligence and analytics from structured data collection to the analysis of large volumes and new data formats. In real estate, data quality and provenance remain essential.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.
Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

Process indicators include the duration of each step, pending items, rework, rejected documents and compliance with deadlines. Risk indicators may reveal exceptions, geographic concentration, irregularities and exposure. They support decisions, but they neither prove causality nor replace asset valuation.

Dashboards should allow data to be disaggregated. Overall averages may mask delays associated with a specific jurisdiction, document type or supplier. Drill-down functionality links each indicator to the underlying process and evidence, avoiding figures that cannot be verified.

Definitions must be integrated into the data catalog. “Time to close”, for example, depends on the start and end milestones and on the pauses taken into account. Without shared definitions, teams produce different metrics under the same name. Semantic governance is therefore a prerequisite for BI.

Kok, Koponen and Martínez-Barbosa (2017) discuss how big data is changing real estate analysis, but they also show its dependence on granular data. Models built on biased, incomplete or incorrect samples can reproduce distortions and create a false sense of precision.

The fourth component is a balanced dashboard of efficiency, quality, risk and compliance indicators. Targets should not reward speed alone, since a fast closing may coexist with deficient due diligence. Indicators must be interpreted by qualified professionals.

7 DOCUMENT MANAGEMENT, INTEROPERABILITY AND DATA QUALITY

Documents and data are not equivalent. A contract contains context, qualifications and relationships that may be lost when fields are extracted. The system must therefore maintain the link between structured information and its documentary source, allowing auditing and reinterpretation.

Data quality involves completeness, accuracy, timeliness, consistency, uniqueness and lineage. ISO 8000 sets out principles for data quality (ISO, 2022); its value in the model is to guide measurable controls. Certification or conformity cannot be presumed from conceptual adoption alone.

Interoperability reduces re-keying between repositories, workflows, BI tools and external systems. Open standards, consistent application programming interfaces (APIs) and stable identifiers reduce errors, but they also expand the attack surface. Each integration requires authentication, authorization, logging and failure handling.

BIM and digital models can support technical due diligence when available. ISO 19650 organizes information management throughout the asset life cycle, while the Industry Foundation Classes (IFC) format facilitates exchange between applications. These resources do not replace inspections, technical reports or validation of the legal status of the property.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.
Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

Retention policies should balance legal obligations, the defense of rights and data minimization. Keeping everything indefinitely increases cost and exposure, whereas deleting records too early may destroy evidence. The document classification scheme must define the retention period, its legal basis, litigation holds and verifiable disposal.

The fifth component is a governed information environment, with a single source of truth, versioning, metadata, interoperability and retention rules. Reliable BI is a consequence of controlled data; it does not, on its own, correct inconsistent documentation.

8 DUE DILIGENCE, INTEGRITY AND REGULATORY CONTROLS

Due diligence should be proportionate to risk rather than uniform for the sake of convenience. FATF (2022) recommends understanding the money laundering risks of the sector and verifying beneficial owners. Automation can screen lists and request information, but complex ownership structures require investigation.

Know-your-customer procedures and the verification of sources of funds and related parties may involve sensitive data and different local obligations. The system must record the source, date, result and decision of each check. A name match is a signal for review, not proof of identity or wrongdoing.

Legal due diligence connects ownership, encumbrances, litigation, contracts and powers of representation. Technical due diligence examines physical condition, maintenance, safety and regulatory compliance. Financial due diligence tests revenues, costs and assumptions. The platform should integrate these conclusions without erasing professional expertise.

Environmental and urban planning risks are highly dependent on local context. Geospatial layers can support screening, but outdated maps or inadequate resolution generate errors. Every automated result must state its source, coverage and date.

Controls should generate evidence of execution. A checklist item marked as complete without a supporting document or a reviewer does not demonstrate diligence. Audit trails need to record who did what, what was verified, which source was used, when it was done and which exception was accepted.

The sixth component is a due diligence matrix that relates risk, test, evidence, decision and escalation. Automation supports coverage and consistency; responsibility remains with authorized roles.

9 DATA PROTECTION, CYBERSECURITY AND ARTIFICIAL INTELLIGENCE RISKS

Real estate transactions involve identification data, assets, income, bank accounts, signatures and

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.

Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

location. The Brazilian General Data Protection Law (LGPD) and the European General Data Protection Regulation (GDPR) establish principles of purpose limitation, necessity, security and accountability, according to their territorial scope. A global document repository cannot assume a single legal basis for all processing operations.

Privacy by design requires data, purposes, access, transfers, retention and incident handling to be mapped before automation is implemented. User profiles should follow the principle of least privilege, and test environments should not use real data without necessity and adequate protection.

Cybersecurity must keep pace with integrations and vendors. The NIST Cybersecurity Framework 2.0 (NIST, 2024) adds the Govern function to the Identify, Protect, Detect, Respond and Recover functions. Contracts with technology providers should regulate controls, incidents, subcontracting, business continuity and exit.

Artificial intelligence (AI) can classify documents, summarize clauses or identify anomalies, but it introduces risks of hallucination, bias, opacity and drift. The NIST AI Risk Management Framework (AI RMF 1.0) organizes risk management into the Govern, Map, Measure and Manage functions (NIST, 2023). High-impact systems require validation and oversight.

Automated decisions should not reject an opportunity, accept a legal risk or recommend an investment without appropriate review. Explainability must be proportionate to impact. Users should be informed of the system's limitations and have a channel to contest or correct data.

The seventh component is integrated technology governance: system inventory, impact assessment, testing, monitoring, incident management and decommissioning. Responsible innovation includes the ability to discontinue a tool when its risks outweigh its benefits.

10 IMPLEMENTATION, INDICATORS AND CONTINUOUS IMPROVEMENT

Implementation should begin with a well-defined use case. Automating document requests and deadline tracking is less risky than automating the conclusion of due diligence. Pilot projects should compare the baseline, errors, processing time and review workload before any expansion.

The team needs to combine expertise in law, real estate, processes, data, security and user experience. Technology developed without user participation tends to generate workarounds and parallel spreadsheets. Participatory governance increases engagement and reveals exceptions that were not visible in the initial design.

Implementation indicators include adoption, automated tasks, human interventions, false-positive alerts, rework, incidents and user satisfaction. Estimated savings should take into account licenses, integration, maintenance, training, review and failures.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

RCMOS – Revista Científica Multidisciplinar O Saber.
ISSN: 2675-9128. São Paulo-SP.
Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

Periodic audits verify rules, access rights, versions, indicators and samples of transactions. Findings should result in an action plan with an owner and a deadline. Control without remediation produces documentation, not improvement.

Wang (2023) observes that smart real estate is still an emerging and concentrated field, which calls for caution when generalizing results. Future research should compare jurisdictions, asset types and levels of data maturity, using quality metrics and not only productivity measures.

The eighth component is the improvement cycle: map, pilot, measure, review and scale. Scaling should be a consequence of a stable process and reliable data; premature expansion multiplies exceptions and hidden costs.

11 CONCLUSION

Automation and business intelligence can improve the management of regulated real estate transactions by increasing traceability, consistency and visibility. However, this benefit depends on an architecture that connects obligation, process, evidence, deadline and responsibility.

The proposed model brings together a regulatory taxonomy, process design, controlled automation, balanced BI, a governed document environment, a due diligence matrix, technology governance and continuous improvement. These components prevent digital transformation from being treated as the isolated acquisition of software.

Automation is best suited to repetitive and verifiable tasks. Legal interpretation, technical assessment, the acceptance of exceptions and investment decisions require competent professionals, and human oversight must be substantive and documented.

BI does not create quality where data are inconsistent. Definitions, lineage, updating and access must be governed, and indicators should balance speed, quality, risk and compliance in order to discourage shortcuts.

Due diligence and integrity require a risk-proportionate approach. FATF, RICS, ISO and NIST provide useful benchmarks, but their application depends on scope and jurisdiction, and no general standard eliminates local requirements.

It is concluded that large-scale legal operations methodologies can be transferred to the real estate sector when adapted to the asset life cycle and to the applicable regulation. The sustainable advantage lies not in automating a greater number of decisions, but in making the process more verifiable, responsive and secure.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

REFERENCES

BAUM, A. *PropTech 3.0: the future of real estate*. Oxford: University of Oxford, 2017.

BRASIL. Lei nº 13.709, de 14 de agosto de 2018. Lei Geral de Proteção de Dados Pessoais (LGPD). *Diário Oficial da União*: Brasília, DF, 15 ago. 2018.

CHEN, H.; CHIANG, R. H. L.; STOREY, V. C. Business intelligence and analytics: from big data to big impact. *MIS Quarterly*, v. 36, n. 4, p. 1165-1188, 2012. DOI: 10.2307/41703503.

DAVENPORT, T. H.; KIRBY, J. *Only humans need apply*: winners and losers in the age of smart machines. New York: Harper Business, 2016.

DUMAS, M. *et al. Fundamentals of business process management*. 2. ed. Berlin: Springer, 2018. DOI: 10.1007/978-3-662-56509-4.

EUROPEAN UNION. Regulation (EU) 2016/679: General Data Protection Regulation. *Official Journal of the European Union*, L 119, 4 May 2016.

FINANCIAL ACTION TASK FORCE (FATF). *Risk-based approach guidance for the real estate sector*. Paris: FATF, 2022.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). *ISO 19650-1:2018*: organization and digitization of information about buildings and civil engineering works. Geneva: ISO, 2018.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). *ISO 19650-3:2020*: information management using building information modelling – operational phase of the assets. Geneva: ISO, 2020.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). *ISO 19650-5:2020*: security-minded approach to information management. Geneva: ISO, 2020.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO). *ISO 8000-1:2022*: data quality – overview. Geneva: ISO, 2022.

KOK, N.; KOPONEN, E.; MARTÍNEZ-BARBOSA, C. Big data in real estate? From manual appraisal to automated valuation. *The Journal of Portfolio Management*, v. 43, n. 6, p. 202-211, 2017. DOI: 10.3905/jpm.2017.43.6.202.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST). *Artificial Intelligence Risk Management Framework (AI RMF 1.0)*. Gaithersburg: NIST, 2023.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST). *The NIST Cybersecurity Framework (CSF) 2.0*. Gaithersburg: NIST, 2024.

ROYAL INSTITUTION OF CHARTERED SURVEYORS (RICS). *Technical due diligence of commercial property*. London: RICS, 2023.

ROYAL INSTITUTION OF CHARTERED SURVEYORS (RICS). *RICS Tech Partner Program*

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.

Ano V, v.2 2024 | submissão: 08/10/2024 | aceito: 11/11/2024 | publicação: 15/12/2024

Survey 2023. London: RICS, 2023.

SAARI, A. *et al.* Blockchain in real estate: recent developments and empirical applications. *Land Use Policy*, v. 121, 106334, 2022. DOI: 10.1016/j.landusepol.2022.106334.

TAGLIARO, C.; BELLINTANI, S.; CRESPI, G. R. Property meets technology: cross-country comparison and general framework. *Journal of Property Investment & Finance*, v. 39, n. 2, p. 125-143, 2021. DOI: 10.1108/JPIF-09-2019-0126.

WANG, F. The present and future of the digital transformation of real estate: a systematic review of smart real estate. *Business Informatics*, v. 17, n. 2, p. 85-97, 2023. DOI: 10.17323/2587-814X.2023.2.85.97.

Este é um artigo publicado em acesso aberto (Open Access) sob a licença CreativeCommons Attribution, que permite uso, distribuição e reprodução em qualquer meio, sem restrições desde que o trabalho original seja corretamente citado.