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CASE STUDY OF THE APPLICATION OF A DATA-DRIVEN PROGRAM FOR REAL ESTATE MANAGEMENT

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Abstract: It is commonly known that the Montreal metropolitan area's real estate is getting older. Most of the tools available for building management are built to manage bigger residential buildings. In the past, it became clear to the actors in the real estate industry that managing tools for large buildings becomes quickly profitable for the owners. However, in the Montreal metropolitan area, those types of residential buildings represent a minority of the real estate. Regarding smaller residential rental buildings, few tools are available and applicable. Therefore, the owners or managers of this type of residential building rely on their judgement to decide. They also base their budgets on those decisions. This type of management increases the risk of unexpected events caused by poor component maintenance. Planned interventions would reduce the risk of those events occurring. This case study presents a tool to plan interventions in small and medium residential rental buildings. The objective is to show an overview of the building's actual state to see in advance the various interventions to be planned for the next 50 years. This case study will show the benefits of using that tool in a selected building.

1 Project overview

The objective of this study is to create a knowledge-based system to plan interventions in small and medium residential rental buildings to optimize the investments while insuring the assets. The result is a dashboard that summarizes the building's actual condition and helps the manager establish the annual budgets and schedule future short- and long-term interventions. In this case study, one can applied the developed tool to a residential rental building in the Montreal metropolitan area. This building is a 3-story brick cladding building with exterior access stairs.

2 State of affairs

The real estate industry occupies a very important place in the global economy, including In Quebec. Indeed, as described in a report from JLR, real estate transactions accounted for 8% to 13% of Quebec's GDP (gross domestic product) between 2007 and 2016 (Etude JLR 2016). Most of these real estate transactions took place in the residential sector.

Because real estate and, more specifically, the residential sector are so important to Quebec's economy, many public and private organizations investigate various issues in this industry each year. The profitability, mortgage rates, real estate values, insurance, works and maintenance are some elements for which the real estate industry in Quebec provides annual data. Those data are used to create many tools and documents that are available to help the owners manage their buildings. For example, several companies have addressed the issue to allow building owners to better predict their spending. Many approaches have been analyzed to optimize maintenance interventions compared to their costs (Atapattu,

Setune et Zhang 2014) (Kim 2006). However, many organizations keep their knowledge to themselves. Therefore, it is hard for small- and medium-building managers and owners to plan all interventions in advance. As CMHC stated, property owners should expect to spend between 1% and 5% of the building's value on annual maintenance, including recurring work, emergencies and preventative work. Indeed, the owners must try to find the best balance between preventive maintenance and the risk of emergencies (Horner, El-Haram et Munns 1997).

This case study will take the information mentioned above and focus on giving the building owners and managers a better way to plan interventions for their buildings in the future, more specifically the operation management of small and medium residential buildings in the Montreal Metropolitan Area (CMA). Existing solutions will be presented, the methodology will be explained and the results will be analyzed.

In the market, some associations, organizations, applications and software are available. For example, the CMHC (Canadian Mortgage and Housing Corporation) provides a lot of data about Canadian real estate. Furthermore, BOMA Quebec, Corpiq and APQ are some associations of owners who provide documents on the management of properties. Finally, several applications and some software, such as Hopem, Maestro dashboard (Foucault and Leclerc 2003) and Proprio Expert, allow data entry and budgeting for the work to be undertaken.

However, these resources do not help knowledge capitalization. Therefore, despite their relevance, the managers must rely on their own expertise to evaluate and estimate the budgets for operations and maintenance required. Less data is indeed available for the management of small or medium residential rental buildings due to:

- These buildings' small size in comparison to large rental or commercial complexes,
- The owners' overall view of their buildings given their small size, and
- The owners' few written records of the past interventions on their buildings.

3 Objective and methodology

The objective of this study is to create a knowledge-based system to plan interventions in small and medium residential rental buildings to optimize the investments while insuring the assets. The result is a dashboard that summarizes the building's actual condition and helps the manager establish the annual budgets and schedule future short- and long-term interventions.

This case study is based on an average building in Montreal. It is a 3-floor residential rental building built in the '50s, with a brick cladding and outdoor access stairs.

This work shows how operations and maintenance planning could be estimated accurately based on a knowledge-based system by correlating data and using cluster and associative knowledge. The current building information is compared to historical data to make predictions. This knowledge base is dynamic and decomposes buildings in standard elements according to the Master Format work breakdown structure. Comparing the building to existing data is based on the case-based reasoning method (CBR). As described in Laetitia (2003), data collection involves several steps, namely:

- Data acquisition following observations and research
- Data preprocessing
- Data search and selection for the creation of a model

The database in question in this study contains information from 30 residential rental properties in the Greater Montreal area entered since the 2000s. For each intervention, many data are necessary, including the date of the intervention, the element, its code, its specifications and other information (e.g. cost, quantity, quality, etc.). The codification system includes the importance of the intervention (Replacement (100%), Rehabilitation (10-30%), Repair (<10%), Routine maintenance, and Emergency (<24h)). Figure 1 below shows two examples of the data-entry form. The collected information helps feed the main database, which groups information by category and building type.

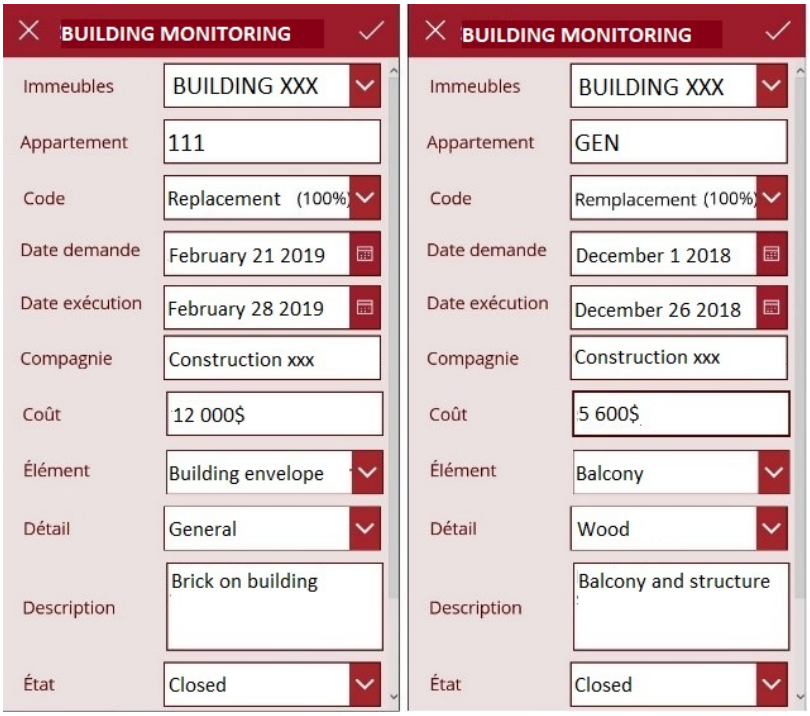
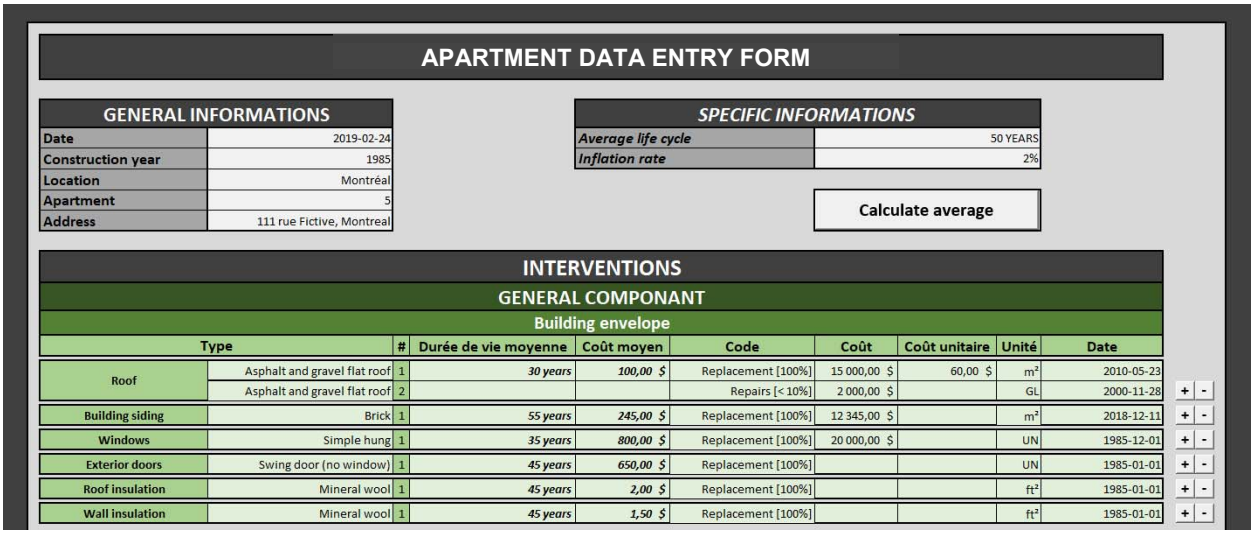


Figure 1 Two examples of the data-entry form for the database

The obtained analysis assists in the planning of annual interventions according to each element category. The estimation takes into consideration the type and importance (quantities, quality, difficulties, etc.) of the intervention compared to the previously collected data in the database. Figure 3 and Figure 4 show the obtained results for the present case study. First, the various interventions known and carried out on the building since its construction are entered in the specific form. Interventions are classified by the building's general components, individual apartments' specific components and recurring maintenance. Figure 2 shows the specific building entry form. The idea is to assemble all the known information with the owner's best knowledge and to give him or her, on the dashboard, a more accurate estimation for the planned interventions for the next 50 years.



APARTMENT DATA ENTRY FORM

GENERAL INFORMATIONS	
Date	2019-02-24
Construction year	1985
Location	Montréal
Apartment	5
Address	111 rue Fictive, Montreal

SPECIFIC INFORMATIONS	
Average life cycle	50 YEARS
Inflation rate	2%

Calculate average

INTERVENTIONS

GENERAL COMPONANT

Building envelope

Type		#	Durée de vie moyenne	Coût moyen	Code	Coût	Coût unitaire	Unité	Date
Roof	Asphalt and gravel flat roof	1	*30 years*	*100,00 $*	Replacement [100%]	15 000,00 $	60,00 $	m²	2010-05-23
	Asphalt and gravel flat roof	2			Repairs [< 10%]	2 000,00 $		GL	2000-11-28
Building siding	Brick	1	*55 years*	*245,00 $*	Replacement [100%]	12 345,00 $		m²	2018-12-11
Windows	Simple hung	1	*35 years*	*800,00 $*	Replacement [100%]	20 000,00 $		UN	1985-12-01
Exterior doors	Swing door (no window)	1	*45 years*	*650,00 $*	Replacement [100%]			UN	1985-01-01
Roof insulation	Mineral wool	1	*45 years*	*2,00 $*	Replacement [100%]			ft²	1985-01-01
Wall insulation	Mineral wool	1	*45 years*	*1,50 $*	Replacement [100%]			ft²	1985-01-01

Figure 2 Specific building entry form

4 Results, discussion and conclusion

Once all the interventions are entered in the specific building entry form, they are inserted into the dashboard under one of the five categories listed in the legend shown in Figure 3. The general components of the building identified in the dashboard are as follows:

- Building envelope
- Ventilation
- Electricity
- Pluming
- Fire protection
- Structure
- Landscaping and earthwork
- Routine maintenance
- Apartments' interior component

For each of the elements in the data-entry form shown in Figure 2, six maintenance methods could be identified: replacement, rehabilitation, repairs, maintenance, emergency and soon to be replaced, as shown in figure 3.

As an example of *a Replacement (100%)*, the cost is calculated by comparison with similar elements, quality, conditions and lifetimes using the case-based reasoning algorithm. An average cost, a standard deviation and a lifetime are then proposed to the manager. Based on that data, the manager has to define the estimated cost, as shown in red in Figure 3.

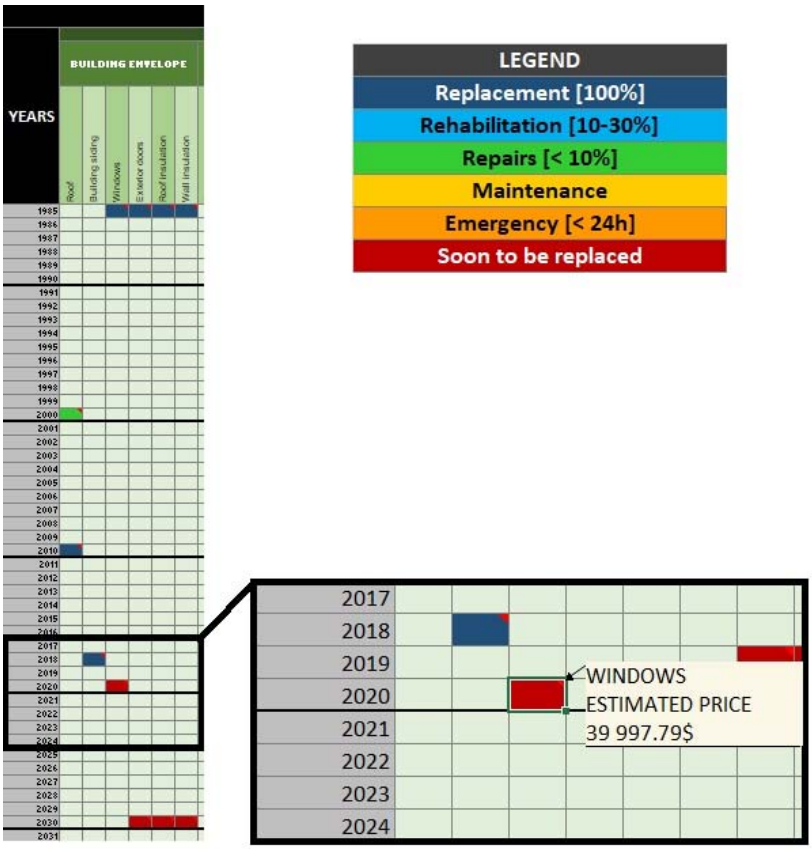


Figure 3 Results presented for the next 50 years per element

The results obtained in the dashboard are also analyzed and formatted by percentage and by category. The percentages for this specific building are shown in Figure 4. Furthermore, those results can be compared to the information in the database. This analysis reveal whether some interventions could be optimized.

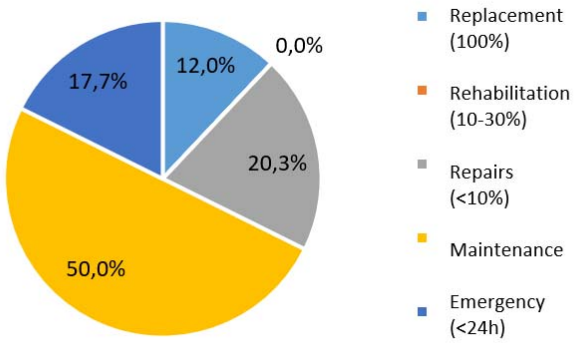


Figure 4 Statistics for annual interventions for the building

Although the proposed system covers most of the building elements, some items remain missing from the database for which no information has been obtained, such as the actual state of the buildings' foundations. In fact, the database has its limits because some information is hard to obtain or analyze. In addition, the database is only based on 30 small and medium buildings. On the other hand, it is important to understand that the database is dynamic and that the results will become increasingly precise in the future.

5 References

Atapattu, K., , S. Sujeeva, and Z. Guomin. *An Innovative Software Tool for Enhenced Building Life Cycle Management and Maintenance Forecasting Deployed Via Cloud.* Melbourne: School of Civil Environnemental and Chemical Engineering RMIT University, 2014.

Julien, M., and N. Bérault. "Gestion de la maintenance." *Contech batiment formations,* Montreal, Quebec, Canada.

Corporation des Propriétaires du Québec. *Programme d'entretien*. Montreal: Collège de l'immobilier formations, 2017.

Etude, J. L. R. 2016. "L'immobilier dans l'économie Québécoise." *Journal JLR Solutions Financières*, Montreal, Canada.

Foucault, J-P, and G. Leclerc, . *Le Tableau de Bord Maestro pour la Gestion des Installations.* Montréal: Presses internationales Polytechnique, 2003.

Horner, R. M. W., M. A. El-Haram, and A. K. Munns. "Building Maintenance Strategy: A New Management Approach." *Journal of Quality in Maintenance Engineering* 3, no. 4 (1997): 273-280.

Kim, R. "Predictive Maintenance: A Key to Maximizing Property Value." *Buildings Journal* 100, no. 8 (2006): 64-65.

Laetitia, J. Métaheuristiquespour l'extraction de connaissances: "Application à la Génomique." Lille: *Université des Sciences et Technologies*, 2003.

SCHL (Société Canadienne d'hypothèque et de Logement). *Classeur de Planification du Remplacement d'immobilisations.* City: Government of Canada, 2013.

Société d'habitation du Québec. *Guide de Réhabilitation*. City: Government of Quebec, 2018.