Optimization of Maintenance and Renovation Project Selection Via Risk-Based Analysis at the IWK
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PROJECT DEFINITION

- The Redevelopment, Space & Leasing (RDSL) team oversee facility renovation and complex maintenance projects.
- Projects for the coming year are chosen at beginning of the fiscal year with a set budget. Project selection is limited based on available resources. This is a challenge, as numerous possible projects could be selected.
- The client finds often, at project budget allocation time, the most relevant projects at the time get selected. This makes project selection less informed in terms of risk analysis and budget optimization.

PROJECT SCOPE/OBJECTIVES

Inclusions
- Identifying facilities-based potential failure points in mechanical, electrical, and various other structures/systems.
- Proposing solutions for each of the identified issues.
- Solving small problems that can be immediately addressed throughout the project.
- Developing a model that is user-friendly to assist in future budget allocation.

Exclusions
- Problems stemming from the lack of space in the facility.
- Assessment of clinical processes.

Objectives
- Optimize allocation and spending of maintenance and renovation budget by conducting a thorough Failure Modes and Effects Analysis (FMEA) that captures as many potential failure points as possible and prioritizes based on Risk Profile Number (RPN) analysis.
- Create model/tool that will assist in budget allocation and project planning.
- Refine FMEA documentation and respective process.
- Redesign budget allocation process and develop SOPs.
- Address maintenance and renovation issues as they are encountered.

METHODS & ANALYSIS (FMEA)

- A practical and repeatable process for identifying and analyzing facility failure points was required. Furthermore, this process needed to result in a quantifiable and semi-objective assessment of facility failure points.
- FMEA discussions were conducted to score, and rank identified failure effects.

Criteria for FMEA Analysis

<table>
<thead>
<tr>
<th>Potential Failure Mode</th>
<th>Potential Failure Effect</th>
<th>Severity</th>
<th>Potential Causes</th>
<th>Occurrence</th>
<th>Current Process Controls</th>
<th>Detection</th>
<th>RPN</th>
<th>Action Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>In what ways can the step go wrong?</td>
<td>What is the impact on the customer if the failure mode is not prevented or corrected?</td>
<td>How severe is the effect on the customer?</td>
<td>What causes the step to go wrong (i.e., how could the failure mode occur)?</td>
<td>How frequently is the cause likely to occur?</td>
<td>What controls exist that either prevent or detect the failure?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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SOLUTIONS

Project Selection Tool – Excel application for optimizing project selection according to changes in RPN and available budget. The following is the mathematical formulation for the tool (resource scheduling component not included in tool):

Parameters for Sets

- \( n \): number of individual failure modes
- \( v \): number of combined individual failure modes that can be mitigated together
- \( m_i \): number of mitigation levels (projects) for failure mode \( i \)
- \( T \): number of planning periods in a year
- \( K \): number of types of resources to be considered in project planning

Decision Variables

- \( x_{ilt} \): 1, if project \( l \) is selected to start in period \( t \) to address FM \( i \); 0, otherwise

Indices

- \( i \): index of failure modes (FM), \( i \in I = \{1, ..., n\} \)
- \( q \): index of combined FM, \( q \in Q = \{n + 1, ..., n + v\} \)
- \( j \): index of individual FM combined in FM \( q \), \( j \in I_q \)
- \( l \): index of mitigation levels (projects), \( l \in L = \{1, ..., m_i\} \)
- \( t \): index of planning periods, \( t \in T = \{1, ..., T\} \)
- \( k \): index of resource types, \( k \in K = \{1, ..., K\} \)

Objective Function

Maximize \( \sum_{t=1}^{T} \sum_{l=1}^{T} \sum_{k=1}^{T} W_{ik} x_{ilt} \) subject to:

- Total cost of all selected projects cannot exceed the available budget:
  \( \sum_{t=1}^{T} \sum_{l=1}^{T} \sum_{k=1}^{T} c_{ikt} x_{ilt} \leq B \)
- Projects must finish before the end of the fiscal year (i.e., project \( i \) cannot start if it will end after \( T \)):
  \( \sum_{t=b_{ikt}}^{T} x_{ikt} = 0, v_i \in I \cup Q, v_i \in L_i \)
- Resource capacity must be satisfied in all time periods:
  \( \sum_{t=1}^{T} \sum_{l=1}^{T} \sum_{k=1}^{T} x_{ikt} \leq \text{Resource capacity} \)

RESULTS

1. The team delivered a list of 19 potential improvement projects that were scored and ranked according to the failure modes they would each address.

2. An improved project selection process was developed and presented to the client including standard work documentation, data collection tools, and a project selection tool.

3. Major progress was made on the top priority selected project including meetings and evaluations.