**KHAS Faculty of Engineering and Natural Sciences**

**CMPE412 COMPUTER SIMULATION**

**PROJECT 2 REPORT**

**DISCRETE-EVENT SIMULATION OF AUTOMOTIVE PARTS MANUFACTURING LINE**

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# 1. INTRODUCTION

This project involves the development of a discrete-event simulation to model a high-volume automotive parts manufacturing line. The simulation aims to optimize throughput for a single product line, identify and mitigate production bottlenecks, and analyze the impacts of operational variables through scenario analysis. A bonus objective was to extend the simulation to handle multiple product types, introducing additional complexity and resource allocation challenges.

# 2. SYSTEM DESCRIPTION

The simulated manufacturing line is divided into several key phases:

* **Raw Material Handling**
* **Machining**
* **Assembly**
* **Quality Control**
* **Packaging**

Each stage includes specific machinery and labor requirements, with operations across multiple shifts. The simulation models these processes, resource allocations, and potential disruptions such as machine breakdowns.

# 3. SIMULATION DESIGN AND IMPLEMENTATION

**3.1 Tools Used**

The simulation was developed using Python with the **simpy** library, which is well-suited for event-driven simulation tasks.

**3.2 Code Functionality**

* **Resource Management**: Each stage of production has dedicated resources (machines and workers), which parts must request access to. This setup models real-world constraints on resource availability.
* **Process Flow**: Parts are processed sequentially through stages of loading, machining, assembling, inspecting, and packaging.
* **Breakdowns and Repairs**: Random breakdowns are simulated with interruptions in processing, requiring repairs before operations can resume.
* **Multiple Product Handling**: The simulation handles multiple product types by adjusting processing times and resource requirements.

**3.3 Implementation Details**

* **Events**: The system manages events such as the start and end of processes and machine breakdowns.
* **Data Collection**: Detailed logs are maintained for each part at every stage, including start and finish times, durations, and the product type.
* **Scenario Analysis**: Users can modify input variables like machine count and shift timing to simulate different operational conditions.

# 4. FINDINGS

The simulation provides detailed insights into the manufacturing process:

* **Throughput Optimization**: Initial runs indicate bottlenecks primarily in the machining and assembling stages due to limited machine availability.
* **Impact of Breakdowns**: Machine breakdowns significantly affect throughput, particularly when occurring in stages with fewer redundant resources.
* **Resource Utilization**: There is uneven resource utilization across shifts, suggesting potential areas for efficiency improvements.

# 5. RECOMMENDATIONS

* **Increase Resources**: Adding more machines or workers in bottleneck areas could improve overall throughput.
* **Improve Maintenance**: Implementing a proactive maintenance schedule could reduce the frequency and impact of machine breakdowns.
* **Balance Shifts**: Adjusting shift patterns to align better with workload peaks and troughs could enhance resource utilization.

# 6. CONCLUSION

The simulation meets the project's main objectives and the bonus challenge of handling multiple product types. It effectively models a complex manufacturing process, providing a valuable tool for operational analysis and decision-making.

# 7. FUTURE WORK

* **Enhanced User Interface**: Developing a user interface would allow easier manipulation of simulation parameters and real-time interaction.
* **Extended Scenario Testing**: More extensive scenario testing could help in further optimizing the production line.