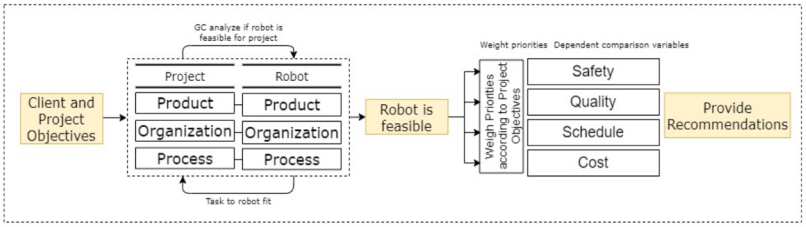
CEE 327: Robotics Evaluation Framework - Cynthia Brosque, Martin Fischer

Name:
Robot:
GC:

Answers:

x 1. What is the robot purpose?
2. What are the goals to introduce a robot for this task?
3. What does the customer value about the task output?



x **General guide**

1) Enter the data sources for your project (REF tab)
2) Assess Product, Organization, Process feasibility (POP tab)
3) If feasible evaluate SQSC (SQSC tab)
4) Assign preference weights to SQSC according to the project goals (SQSC tab)
5) Evaluate results (Decision Matrix tab)

Fill the highlighted cells
Keep track of the effort to compare the robotic and manual method
Insert link to time tracking spreadsheet (for the class Project only)

x **1. Data and Data Sources**

Available data	Data source	Quant	Qual
Robot Product	patent	X	X
Project Product	BIM		
	2D plans...		
Organizations			
Robot and Manual Process			
Health and Safety			
Quality			
Schedule			
Cost			

2. POP

	POP	Manual construction	Robot	Initial feasibility check
x	**Product**			
	Single / Multi-task			OK
	Interior / Exterior			
	Hardware			
	Mobility			
	Degree of mechanization /			
	Control interface			
	Software / sensors			
	Power and communications			
	Weight			
	Clearance			
	Site conditions			
	Reach (workspace)			
	Materials			
	Area			
	Location			
	Project type(s)			
	Number of units of work / zone			
x	**Organization**			
	Unions			
	Types of skills and experience			
	Labor supply			
	Organization integration			
	# Organizations			
	Stakeholders			
	Team experience in using robots			
x	**Process**			
	Process changes			
	Number of handoffs of information			
	Data acquisition and types			
	QC			
	Progress reports			
	Detailed workflows		https://drive.google.com/file/d/1TEF32oYM	Example - insert link to process
	Comments			

3. SQSC Comparison

	SQCS	Units	Manual	Robot	Comments	Preference Weight
Safety	Incidents	#			Risk level of the task for work procedures and also for the robot	
	Insurance rates	$				
	Ergonomics	% Heavy work load hours/total task				
	Hazardous work	N=0/Y=1, Qualitative			Describe conditions (qualitative	
Quality	Accuracy	mm				
	Repeatability	mm				
	Rework	%				
	Material waste	Kg				
Schedule	Cycle time	Seconds per unit			Insert link/capture (Project, PO, Excel, Alice, ...)	
	1 zone	Days			Insert link/capture (Project, PO, Excel, Alice, ...)	
	Full Project	Days			Insert link/capture (Project, PO, Excel, Alice, ...)	
Cost	Labor cost	$/h				
	Labor hours	man-hours				
	Materials (tools)	$				
	Coordination	$/m2				
	Training	$/h				
	Robot service	$/m2				
	Maintenance Fees	$			If the robot is offered as product	
	Area	m2			Input final values from Purchase Tab	
	Total	$			<-- here	
Comments					Recommendation: Evaluate	**0**

To complete this tab the evaluator should possess the ability to break down the Safety, Quality, Schedule, and Costs to the object-action-resource units that are different between the robotic vs manual method. For example, if the new process consists of manual and robotic steps, is it possible to break down the manual costs to establish a basis

Schedule

You may use Project, P6, Excel or other to illustrate schedule comparisons

x **4. Decision Matrix (TOPSIS method)**

Weight =	0				0				0			0	
	Safety				**Quality**				**Schedule**			**Costs**	
	# Incidents	Insurance rate	Ergonomics	Unhealthy work conditions	Accuracy	Repeatability	Rework	Material waste	Cycle time	Schedule 1 zone	Schedule 4 zones	Total	
Manual	-	0	0%	0	0	0	0%	-	0	0	0	$0.00	
Robot	-	0	0.00%	0	0	0	0%	-	0	0	0	$0.00	
Normalized Matrix													
Manual													
Robot													
Weighted Matrix													
Manual													
Robot													
A + / -													
A+													
A-													
Manual													
Si+													
Si-													
Robot													
Si+													
Si-													

	Ci	Rank
Manual	#DIV/0!	#DIV/0!
Robot	#DIV/0!	#DIV/0!

Comments:

x **5. Sensitivity Study**

Schedule Sensitivity	Manual	Robot	Case Selector
LIVE CASE	0	0	1
1 Base Case (SQSC)	0	0	
2 Assumption 1			
3 Assumption 2			

Cost Sensitivity	Manual	Robot	Case Selector
LIVE CASE	$0	$0	1
1 Base Case (SQSC)	$0	$0	
2 Assumption 1			
3 Assumption 2			

Results Table CI	**Manual**	**Robot**
1 Base Case	#DIV/0!	#DIV/0!
2 Assumption 1	#DIV/0!	#DIV/0!
3 Assumption 2	#DIV/0!	#DIV/0!

Our goal is to create a flexible model that allows our Decision Matrix to change based on different "CASES" we have created.

We can do this with either the "=CHOOSE" formula, or the "=OFFSET" formula in Excel. The LIVE CASE flows through the model.

Enable Excel --> Options --> Formulas --> Enable Iterative Calculations

6. Robot Purchase Analysis

		BALANCE SHEET										INCOME STATEMENT				
		ASSETS					LIABILITIES			OWNERS' EQUITY						
ITEM	TRANSACTION	Cash	A/R	Prepaid Exp	PP&E	Accum. Dep.	A/P	Accrued Liab	Long Term Debt	Paid In Capital	Earnings	Job Rev	Job Exp	Dep. Exp	Interest Exp	SG&A Exp
	Manual Costs															
1	Liability insurance															
2	BIM Engineering Coordination															
3	Labor Expense												-			
4	Material Expense (LIDAR)				-											
5	Management Expense												-			
6	Depr. - LIDAR					#DIV/0!								#DIV/0!		
7	Interest - Bank Loan							-								
8	**Subtotal**	-	-	-	-	#DIV/0!	-	-	-	-	-	-	-	#DIV/0!	-	-
9	**Total**										#DIV/0!	#DIV/0!				
	Robot Costs															
1	Purchase Robot				-				-							
2	Material Expense Purchase Lida	-			-											
3	BIM Engineering Coordination												-			
4	Labor Expense												-			
5	Robot Operator												-			
6	Management Expense												-			
7	Depr. - Robot (life of equipment)					#DIV/0!								#DIV/0!		
8	Robot Maintenance													-		
9	Interest - Bank Loan							#DIV/0!							#DIV/0!	
10	**Subtotal**	-	-	-	-	#DIV/0!	-	#DIV/0!	-	-	-	-	-	#DIV/0!	#DIV/0!	-
11	**Total**										#DIV/0!	#DIV/0!				

	Assumptions	
12	Number of projects/year	
13	Life of robot	
14	Interest	0
15	Operator expense/mo	

PAYBACK ANALYSIS - YEAR 1

		Cash	Project 1	Project 2	Project 3	Project 4
1	Robot Cost (Purchase cost)	-				
2	Savings in Job expenses		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
3	**Total**	-	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

4	**ROBOT PAYBACK (projects)** *assuming 4 pr	-
5	**ROBOT PAYBACK (yr)**	-
6	ROI (Project 1)	0.0%
7	ROI (Projects 1 to 6)	0.0%
8	**IRR**	#VALUE!
9	**MoM**	#DIV/0!