Budget

1. How accurate do you think the calculations are? Would you be ready to make the offer based on the calculations? What aspects are missing from the calculation model?

- I think the calculation is good enough to make an offer that is favourable for the developer. I will send the offer to the client and have it as a point for further discussion.

- I think the calculation model misses unplanned feature requests, stakeholder alignment, scope management, bugs and testing, which can significantly raise the cost. Especially given that this is a group of students, we can easily fall into work more than promises. However the good thing is as a startup, we should learn more and fast first, before making money.

How would the calculations change if the offer had been asked from an established software company?

For an established company, the cost driver will be different from a group of students, thus impacting the offers. I believe the offer from established companies will be usually higher than students.

Cost drivers	Students	Experts
Prowess of personnel (PERS)	Less skill and experienced, so cost may be lower	Highly skillful developers thus cost can be higher
Complexity of the project (RCPX)	Group of students may feel the project more challenging than experts	Experts may feel this project less challenging due to small KLOC of 3.8
Reuse (RUSE)	Students can reuse public components, but the reuse is not really high	Usually established company can have high level of reusable code for client project
Demands of platform (PDIF)	The demands and constraints set by standard warehouse management should be similar for both students and experts	
Experience of personnel (PREX)	Less skill and experienced, so cost may be lower	Highly skillful developers thus cost can be higher
Facilities (FCIL)	Group of students may have lower cost of facilities	Established company usually has higher cost of facilities
Schedule (SCED)	Expectation for group of student usually lower, thus deadlines and schedule impact will be less strict	Established company usually need to work for tighter deadline and higher expectation from client

What software engineering related issues the calculations reveal? How would you take those into consideration when starting the development project?
Budgeting for software engineering is really hard even when we have a calculation model. A rule of thumb is to expect the development delay can be 2 to 3 times the plan.

Appendix

Acquisition

I estimate that the warehouse management software should have:
- 3 views: Warehouse view, container data form, and driver view
- 2 reports: Container pick-up report, and automatic weekly report
- 7 data tables:
    1. Container information (for the warehouse view and container data form)
    2. Driver information (for the driver view)
    3. Pick-up information (for the driver view and warehouse staff functionality)
    4. Delivery information (for the driver view)
    5. SMS/Email information (for sending notifications from warehouse staff to drivers)
    6. Container pick-up report data
    7. Automatic weekly report data

Thus using the Cocomo II Acquisition composition, the total cost is 2.05 person months to acquire the software.

In-House Development

I estimate the function points as follow
- External Inputs (EIs): **5**
    - Container data form input
    - Driver input for pick-up information
    - Driver input for delivery information
    - Warehouse staff input for pick-up scheduling
    - Automatic weekly report input

- External Outputs (EOs): **3**
    - Warehouse view output (browsing container information)
    - Container pick-up report output
    - Automatic weekly report output

- External Inquiries (EQs): **2**
    - user inquires the information of the containers in warehouse view
    - Driver inquires the information of the containers, which are sent by sms/email from warehouse staff

- Internal Logical Files (ILFs): **7**
    - Container information database

- ○ Driver information database
- ○ Pick-up information
- ○ Delivery information
- ○ SMS/Email information
- ○ Container pick-up report data
- ○ Automatic weekly report data
- External Interface Files (EIFs): 0

The data elements can be at least 10:
1. Content of the container
2. RFID tag information
3. Basic information about containers
4. Pick-up time for containers
5. Delivery time for containers
6. SMS or email information for notifications
7. Pick-up times
8. Number of incoming containers
9. Number of outgoing containers
10. Container content categories

Person-months (not including vacations)	11.0	Person-months
Estimated length	11.0	months
Average salaries(gross)	3,500.0	€
Size of the team	4.0	persons
Gross salary	38,500.0	€
Side costs	25.0	%
Mandatory ancillary costs of salary	9,625.0	€
Holiday pay for the project	3,080.0	€
Total wage costs	**51,205.0**	**€**
Work and software components purchased elsewhere	2,000.0	€	Subscription to cloud, database and other software purchases.
Server costs	2,000.0	€	Software purchases
Trips (eg to customer meetings)	1,200.0	€	customer meetings and logistical expenses.
Other costs (eg printed matter)	1,000.0	€	Miscellaneous
Total other costs	**6,200.0**	**€**
Office rent per month	350.0	€
Other fixed costs per month (cleaning, office equipment, etc.)	450.0	€
Employees in the company	6.0	persons
Personal developer per person tools and software licenses	800.0	€
Overhead	3.3	%
Rents allocated to the project	641.7	€
Project-specific tools and software licenses	244.4	€
Other fixed costs that are allocated to the project	825.0	€
Total fixed / overhead costs	**1,711.1**	**€**
TOTAL PROJECT COSTS	**59,116.1**	**€**
Profit margin (percentage)	25.0	%
Profit	14,779.0	€
TAX-FREE PRICE OF THE PROJECT (VAT 0%)	**73,895.1**	**€**
TAX PRICE OF THE PROJECT (VAT 24%)	**91,630.0**	**€**

Application composition:

Forms:	Tables in database								
views:	<4	<8	8+			Very low	4		
<3						Low	7		
3-7		3	0			Normal	13		
>8						High	25		
						Very high	50		
Reports:	Tables in database								
sections:	<4	<8	8+						
0 or 1							Complexity weight		
2 or 3		2				Object type	Simple	Medium	Difficult
4+						Screen	1	2	3
						Report	2	5	8
3GL components:	0					3GL			10
Reuse%:	10								

Object points:	16	
NOP New Object Point:	14.4	*(Object points) * (100 - Reuse%) / 100'*
PROD Developers experience and skills:	Low	7
PM Person months:	2.057142857	person months *NOP / PROD*

Function Point Analysis: STUDENT GROUP

Internal Logical File ILF					External Output EO				
		Data elements					Data elements		
Forms	1-19	20-50	51+		Filetypes	1-5	6-19	20+	
1		0	0		0 tai 1	0	0	0	
2-5		0	0		2-3	0	3	0	
6+	7	0	0		4+	0	0	0	

External Interface File EIF					External Inquiry EQ				
		Data elements					Data elements		
Forms	1-19	20-50	51+		Filetypes	1-5	6-19	20+	
1	0	0	0		0 tai 1	0	0	0	
2-5	0	0	0		2-3	0	2	0	
6+	0	0	0		4+	0	0	0	

External Input EI						Complexity		
		Data elements				Low	Average	High
Filetypes	1-4	5-15	16+		ILF	7	10	15
0 tai 1	0	0	0		EIF	5	7	10
2-3	0	0	0		EI	3	4	6
4+	0	5	0		EO	4	5	7
					EQ	3	4	6

ILF UFPt:	70
EIF UFPt:	0
EI UFPt:	30
EO UFPt:	15
EQ UFPt:	8

UFP total:	123
KLOC / Size:	3.567 Default is the C++ (1 FP = 29 LOC)

Scale Factor B

PredictabilityPREC		High	0.02	Very low	0.05
Flexibility of development PLEX		Very High	0.01	Low	0.04
Risk removal RESL		High	0.02	Average	0.03
Team coherence	TEAM	Very High	0.01	High	0.02
Maturity of process	PMAT	High	0.02	Very High	0.01
				Extreme	0
B:	1.09				

Effort Adjustment Factors EAF

Cost Drivers:				Very low	0.5	Very low		1.5
Prowess of personnel (PERS)		Average	1	Low	0.75	Low		1.25
Complexity of the project (RCPX)		High	1.1	Average	1	Average		1
Reuse (RUSE)		Average	1	High	1.1	High		0.75
Demands of platform (PDIF)		Average	1	Very High	1.3	Very High		0.65
Experience of personel (PREX)		Average	1	Extreme	1.5	Extreme		0.5
Facilities (FCIL)		Average	1					
Schedule (SCED)		Average	1					

EAF	1.1

Working hours estimation:

A-constant:	2.45	Boehm et al. (1997)
Nominal workload:	9.798880775 per.months	PM = A*size^B
Total workload:	10.77876885 per.months	PM * EAF

Function Point Analysis: EXPERT GROUP

Internal Logical File ILF					External Output EO				
		Data elements					Data elements		
Forms	1-19	20-50	51+		Filetypes	1-5	6-19	20+	
1		0	0		0 tai 1	0	0	0	
2-5		0	0		2-3	0	3	0	
6+	7	0	0		4+	0	0	0	

External Interface File EIF					External Inquiry EQ				
		Data elements					Data elements		
Forms	1-19	20-50	51+		Filetypes	1-5	6-19	20+	
1	0	0	0		0 tai 1	0	0	0	
2-5	0	0	0		2-3	0	2	0	
6+	0	0	0		4+	0	0	0	

External Input EI						Complexity		
		Data elements				Low	Average	High
Filetypes	1-4	5-15	16+		ILF	7	10	15
0 tai 1	0	0	0		EIF	5	7	10
2-3	0	0	0		EI	3	4	6
4+	0	5	0		EO	4	5	7
					EQ	3	4	6

ILF UFPt:	70
EIF UFPt:	0
EI UFPt:	30
EO UFPt:	15
EQ UFPt:	8

UFP total:	123
KLOC / Size:	3.567 Default is the C++ (1 FP = 29 LOC)

Scale Factor B

PredictabilityPREC		High	0.02	Very low	0.05
Flexibility of development PLEX		Very High	0.01	Low	0.04
Risk removal RESL		High	0.02	Average	0.03
Team coherence	TEAM	Very High	0.01	High	0.02
Maturity of process	PMAT	High	0.02	Very High	0.01
				Extreme	0
B:	1.09				

Effort Adjustment Factors EAF

Cost Drivers:				Very low	0.5	Very low	1.5
Prowess of personel (PERS)		Very High	1.3	Low	0.75	Low	1.25
Complexity of the project (RCPX)		Low	0.75	Average	1	Average	1
Reuse (RUSE)		High	1.1	High	1.1	High	0.75
Demands of platform (PDIF)		Average	1	Very High	1.3	Very High	0.65
Experience of personel (PREX)		Very High	1.3	Extreme	1.5	Extreme	0.5
Facilities (FCIL)		High	1.1				
Schedule (SCED)		High	1.1				

EAF	1.6870425

Working hours estimation:

A-constant:	2.45	Boehm et al. (1997)
Nominal workload:	9.798880775 per.months	*PM = A*size^B*
Total workload:	16.53112832 per.months	PM * EAF