MTAT.03.244 – Software Economics

Final Exam – 10 January 2012

(60 points)

Notes:

- The exam is open-book and open-laptop. Web browsing is allowed, but you are not allowed to use e-mail clients nor instant messaging clients.
- If you find that there is not enough information in the text below to answer a given question, and you need to make additional assumptions, please write down your assumptions together with your answer.
- The exam consists of two independent parts. You can complete the second part without having completed the first one.
- You may submit your exam on paper, or you may submit it as a ".doc", ".pdf", ".zip" or ".rar" file, using the memory stick to be circulated at the end of the exam. Make sure your exam has been copied before you leave.

Context: Selver Supermarkets and Curbside Pickup

Selver (www.selver.eu) is an Estonian-based supermarket chain consisting of 34 stores, employing 2500 people, with annual sales of 300 million euros (2010 number) and a net profit of 10 million euros.

Selver is considering the possibility of offering a new service that has recently picked up in other countries like the US and France. The service is called "Grocery Curbside Pickup" and allows customers to order their shopping cart online and pick it up from a dedicated loading bay at their store of choice. Supermarket staff assembles the shopping cart during the hour preceding the pick-up time chosen by the customer.

Curbside pickup is already offered by international retailers such as Harris Teeter in the US. These previous experiences have put into evidence two of the advantages of offering this service, namely:

- In the short term it allows a first mover (innovative company) to differentiate itself in a highly competitive market like grocery retail. This differentiation leads to improved brand image and additional customers.
- In the middle and long term, this system has the potential to bring down costs for retail chains by allowing them to further automate their check-out process and to adopt better inventory management tactics, especially for fresh products (e.g. dairy products, meat).

Selver hired consultancy firm *StrategicPartners* to do a market analysis and to assess the potential benefits of offering curbside pickup. As a result of this analysis, StrategicPartners recommended that Selver introduces the curbside pickup service in 10 of their stores with a minimum order size of 30 euros. In the first year, Selver could expect 50 purchases per store per day (350 days per year) and the cost of the average shopping cart would be 50 euro. Their analysis also showed that 90% of the sales would come from existing customers switching from normal shopping to curbside pickup. In other words, these purchases would occur anyway regardless of whether curbside pickup is

introduced or not. The remaining 10% of online purchases would not occur without curbside pickup, meaning that these purchases would bring additional revenue. StrategicPartners also expects that the sales through curbside pickup will double in Year 2, and increase by another 50% in Year 3 (with respect to Year 2). In Years 4 and 5 sales are expected to be the same as in Year 3.

Part I. Cost Estimation (30 points)

StrategicPartners wrote the following key requirements for the online ordering application that Selver would need to deploy in order to enable curbside pickup.

1. The application should allow a customer to create a user account. In order to create a user account, a customer should provide their name, home address, one or two phone numbers and an e-mail address (which will become their username). Confirmation of registration, including the initial password, is sent to the designated e-mail address.
2. The application should allow a customer to login to the system. When a user logins, they see their current shopping cart if they have a shopping cart not yet checked-out.
3. The application should provide a password recovery feature based on the customer's e-mail address.
4. The application should allow authenticated users to view their history of orders, including orders that have not yet been picked-up and orders that have already been picked-up.
5. The application should allow authenticated users to create a new shopping cart from scratch if they do not have a "current" shopping cart yet. In this case the new shopping cart is initially empty. When creating a new shopping cart, a user has to specify the store from which they plan to pickup the shopping cart.
6. The application should allow authenticated users to create a new shopping cart based on any of the orders stored in their history of purchases. In this case, the new shopping cart is initialized with the contents of the previous order. As in requirement 7, a new shopping cart can only be created if the user does not yet have a shopping cart that has not been checked-out.
7. The application should allow users to view the top-level categories of products available in the store (e.g. fresh food, frozen food, cleaning products, etc.). Categories are arranged hierarchically, meaning that one category can have sub-categories (e.g. frozen vegetables is a sub-category of frozen foods).
8. The application should allow users to "expand" a given category. For example, users can expand category "frozen foods" and view the sub-categories under it, then expand the category "frozen vegetables" and view the list of products in this category.
9. The application should allow users to "collapse" a category that is currently expanded. In this case, all the sub-categories and products below that category are not shown anymore.
10. The application should allow users to view the details of a product. The details of a product are: the product ID, picture, name, short description, price per unit and whether or not the product is available on stock or not.
11. The application should allow a user to add a product that is available on to his shopping cart. When adding a product to the shopping cart, the customer should specify the number of units of that product to be added.

12. The application should allow users to view the contents of their shopping cart.
13. The application should allow users to delete an item from their shopping cart.
14. The application should allow users to empty their shopping cart.
15. The application should allow users to check-out their shopping cart. To check-out, the user has to provide the pickup time, the name shown in their credit card, their credit card number, credit card security code and credit card's expiry date. Once this information is submitted, the credit card payment is validated with the credit card provider of Selver. If the payment is successful, the shopping cart becomes an "order" and is added to the history of orders of the customer. If the payment is rejected, an error message is given and the user is returned to the check-out screen.
16. The application should allow users to logout.
17. The application should be available in Estonian and Russian.

Note that in this first version of the application, users will not be allowed to edit an order after it has been placed. A possibility of expanding the system in this direction will be considered after the initial application is in use. Also, the above requirements do not take into account error messages that arise due to concurrent access, e.g. a user adds an item to a product but when checking out, the product is no longer available.

A separate application will be developed to enable employees at Selver stores to view the list of "pending orders" assigned to a given store, and to mark an order as "ready for pickup" or as "picked-up", and other functions related to fulfilling an online order.

Selver has asked their long-term supplier of IT services, namely WorkingMouse, to estimate of the cost of developing and operating the online ordering application.

The online ordering application will interact with two existing information systems at Selver: the catalogue of products sold by Selver and the inventory system of Selver. The catalogue contains the hierarchy of products sold by Selver (a relation between categories and sub-categories and a relation between categories and products). Also, the catalogue provides detailed information for each product (product ID, image file reference, name, description, price). Finally, the catalogue provides information about the available stores (for each store, the store's identifier and store's name). The inventory system provides real-time information about the available stock of each product. Specifically, given a product ID and a store ID, the inventory system can provide the number of units of that product currently available at that store.

Q1. Give an estimate of the number of unadjusted function points (FPs) of the online ordering system, excluding requirement 17 – multilingual support. Your estimate does not need to be extremely detailed. Instead, you can provide an estimate as follows. For each requirement, give an estimated number of transaction FPs for that requirement and a short explanation for this estimate. Do not count every single DET, but instead make a rough estimation of DETs. Next, specify which ILF and EIFs are involved in the online ordering system and give an estimate of the FPs for each ILF and each EIF. Finally add up all the FPs. Note that you only have to analyze the FPs of the online ordering application. You do not need to analyze the FPs of the application that Selver employees will use to track pending orders. **[25 points: 1 point per requirement + 9 points for ILFs and EIFs]**

Q2. Give an estimate of the cost and time required to develop the online ordering application. You may use Cocomo or one of the manual cost estimation techniques described in the paper "Six Forms of Cost Estimation" (see list of "readings" of the

course). If you use Cocomo, you should use unadjusted function points as the basis for the estimate. Also, if using Cocomo, you should justify each cost factor/scale driver that you set to a value other than "nominal". If you use a manual estimation technique, please specify which phases/activities you include in the work breakdown structure. You should assume a cost per man-hour of EUR 40. **[5 points]**

Part II. Business Case (30 points)

Q3. Prepare a business case for this project. For this business case, we can take the baseline scenario as the one where nothing is done. This scenario has zero cost and zero revenue. Therefore, it is not necessary to analyze the difference of cash-flows between a baseline scenario and an upside scenario, i.e. the scenario where the curbside pickup project is performed. Only the upside scenario is needed. The business case should include discounted cash flow, NPV, IRR and payback period. Please use the NPV, IRR and payback period to justify rejection or acceptance of the project. **[30 points]**

The following assumptions should be made:
- The discount factor is 25%
- As customers using curbside pickup will pay online and hence shelves would need to be restocked less often, StrategicPartners assumes that Selver will be able to realize the following cost savings: They will use one cashier/shelf-loader less per store in the first year. One such employee costs 15.000 Euros per year. In the second year, they would save one additional cashier/shelf loader per store. In the third year they would save 3 cashier/shelf loaders per store in total. This number will stay constant for years 4 and 5.
- It has been shown in other countries that customers who use curbside pickup are willing to pay a handling fee. StrategicPartners suggests setting a handling fee of 1 EUR per purchase.
- To enable curbside pickup, a special area (called *pickup bay*) will need to be built in each participating store, where shopping carts will be loaded/unloaded. Selver estimates it would cost around 20.000 euros to set up each pickup bay (upfront cost). Maintenance of each pickup bay is expected to cost 2.000 EUR per year.
- Selver would need to pay a project manager to oversee the project in years 1 and 2. The project manager would cost 30.000 EUR per year.
- Marketing the new service is expected to cost 50.000 EUR upfront (this sum will be paid exactly when the project starts). Additionally, 50.000 EUR of additional marketing expenses are expected in the first year.
- Regardless of the estimate that you obtained in Part I, please assume that Selver would invest 100.000 upfront for software development and 10.000 EUR for software maintenance per year (including cost of servers, which Selver rents from a datacenter provider). No additional costs for IT infrastructure are assumed.
- Each pickup bay will be staffed by 2 full-time employees per store in the first year, each one with a salary cost of 15.000 euros per year. At the beginning of the second year this number would rise to 4 employees per store and it will remain that way in subsequent years.
- For simplicity, you can assume that neither taxes nor depreciation need to be taken into account in the analysis.
- The curbside pickup system will have a lifetime of 5 years.

Disclaimer: Although based on a real-world company, the above case study is fictitious and does not reflect the views or plans of the company in question.