

UNIVERSITY OF TEXAS AT DALLAS
SYSTEM ENGINEERING AND MANAGEMENT
SYSM6309 – ADVANCED REQUIREMENTS ENGINEERING

BILL OF MATERIALS GENERATION AUTOMATION

FINAL TERM PAPER

By: Adi Nugroho

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Submitted to:

Dr. Lawrence Chung

Abstract

Bill of materials is one document that plays an important role in a project, especially in the telecommunications business. This document reflects the expertise of a service provider company to select an appropriate solution in order to enhance and maintain their network operation excellence. Any errors that present in BOM generation process will not only produce delay on the project is being executed but also indirectly affect the performance of the network itself. Moreover BOM has important role on defining the customer's project budget as well. Every single penny will be matters to the customers. That is mean; every single lack or excess material might make them lose their business. However sometimes the BOM process itself often overlooked since many people underestimate this document's creation, including sales and pricing manager. When they got some pressure from customer in the end they will force us, engineering team, to complete these documents in a short period of time which is very risky to errors that may occur. In the other hand, we faced another problem in our internal department like lack of resources due to company policy or high salaries of the contract engineers. This BOM generation automation is dedicated to facilitate the company's internal process, provide better and excellent services to customer and also in order to meet department's efficiency targets announced by company's top management team.

1. Introduction

1.1 Motivation

The motivation of this paper is to create better understanding in redefining requirement engineering for automation tools that already build earlier during my project with one customer in telecommunication industry. Hopefully in the future requirement engineering knowledge that I have is able to make a significant contribution in new tools development process that might be made.

1.2 Problem

As mentioned before, generating BOM is a critical process in a project both for our customer and customer. This work can be categorized as time consuming job and need high accuracy when placing the proper materials with its quantity. Moreover the project scalability itself will increase the risk so is the processing time hence can make us loose the control when there is a lot of revision, like drop and insert, that being made. Since this is the first time we create the automation, there are so many requirements that might not defined properly. Thus the purpose of this paper is to review and redefine the automation's requirements from basic like:

- Who is the stakeholder?
- What are their requirements?
- How can we fulfill the stakeholder's requirements?

- What is our limitation to fulfill those requirements?
- How can we check if a requirement is satisfied?

1.3 Solution

The requirements from the stakeholders to create BOM within limited time and in high accuracy makes us to come up with automation solution using web based tools. At this time we think that this is the based solution. However it might need some improvement in the future based on the lesson learned so is the new requirement from the stakeholders.

1.4 Related Work

This BOM automation is not a new thing. There are so many similar software and tools like the one we build. Our tools basically only dedicated for specific project that we were working and might not applicable in other projects or other industries.

1.5 Outline

Section 2 of this paper talks in general about Bill of Materials Generation Automation requirements engineering. The focus of the challenges discussed here will be presented in section 3. Section 4 describes my investigation about the automation that we build and the finding as well. This research paper ends with the conclusions in section 5.

2. Bill of Materials Generation Automation

In order to have better idea about the process in creating a BOM, please refer to Appendix A. The initial project creation begin with pre-sale activities where sales manager and solution manager work together to create the new business. After the customer gives good signal for the new contract then our team, engineering, start involve on the pre-sales by providing high level design.

When the contract had been signed by customer, the next step is resources collection. Project manager has to find the technician and crew who will do the installation on site. And for engineering, we have to find a designer based on the project scale.

After all resources are ready then we continue with the design process. In parallel, project manager will conduct the site survey and give the report to engineering team as one of input for the design.

Output of the design will be design document plus site survey result, and based on this document we have to generate the BOM in order to provide basic calculation on the pricing to the sales team. Basic calculation means the equipment's pricing only, before they add more services pricing, local materials quote, as well as margin for the sales itself. All of these calculations will be bundled as PO draft. Customer must review it first before issuing the PO to our company.

Then after we receive the PO, the solution manager will order all

equipment and in parallel, the project manager must preparing the warehouse and all activities related to logistic handling, like how they will provide temporary storage for unimplemented equipment and how they will deliver those equipment to each sites.

The rollout phase will start as soon as the equipment is ready. Project manager are responsible for this project execution, meanwhile sales and solution manager will monitor the rollout process. If they have question about the project's time frame or budget, they can ask the project manager to provide it anytime during the rollout phase. The engineering provide integration support services for the field team if they meet problem that they cannot solve by them self.

Every time the implementation and integration have been done for one site, the acceptance test will be conducted and both parties must attend it. After the test has been done the work well as expected then customer will sign the document. At this point we can say that the project has been executed for that site. The same process will be executed for all sites until the last one and the project will be closed. Even the project was closed; the sales manager still has responsibility to give project review report.

The high level process is already explained and we can conclude that the stakeholder will be the customer, sales manager, solution manager, and project manager.

Now we can continue with the requirement for the BOM itself. For more detail about the requirements please refer to Appendix B which contains both Functional Diagram and Non-Functional Diagram.

For the class diagram which explain how the system work is shown on Appendix C. So basically the automation was replacing the manual work. The input and output file beside it and the external process will be same as in the manual work. The automation system part of the diagram shows how we can fulfill the stakeholder requirements.

3. Challenge

The challenges and limitations that we have to fulfill those requirements are as mentioned by list below:

- The database engine and software that we used to build the automation tools are still using trial version which did not give us a lot of options to do more.
- The human resources who involve the automation development are still in learning curve. Programmer still learning how to understand the telecom technology and in the other hand the telecom engineers are not 100% aware about the limitation that the programmer have. It will take time for both to build this cross competence.

- The timeline given by the stakeholder is quite challenging since we have to build everything from zero.

The way that we check if we satisfy the requirement or not were by having continues discussion with the stakeholder. We also created other tools to check the output of the system beside the most conservative way that is manual checking with random samples.

4. Investigating and Finding

We are aware that there are still many limitations in the tools that we created. Some errors on the output are still detected. We still found about 0.5% errors generated by the tools. After we trace it we found that the problem came from the input files. Some data on the input files are not consistent nor following the proper standard. The workaround for this issue will be more socialization to the design engineer and the site survey crew. We have to inform them completely and accurately about what kind of things that must be done. This effort at least will minimize error during the input files creation.

The second thing is the algorithms that we used to build the system core basically are only applicable for this project. We cannot re-use it when the solutions are changed or the customer is different. For this issue we already create a tool to trace and to list all parameters including their behavior as programmer's guidance.

The last thing that we found was the system's GUI is not user friendly and need some improvement. Errors messages are still detected and need more effort to clean up this kind of thing.

5. Conclusion

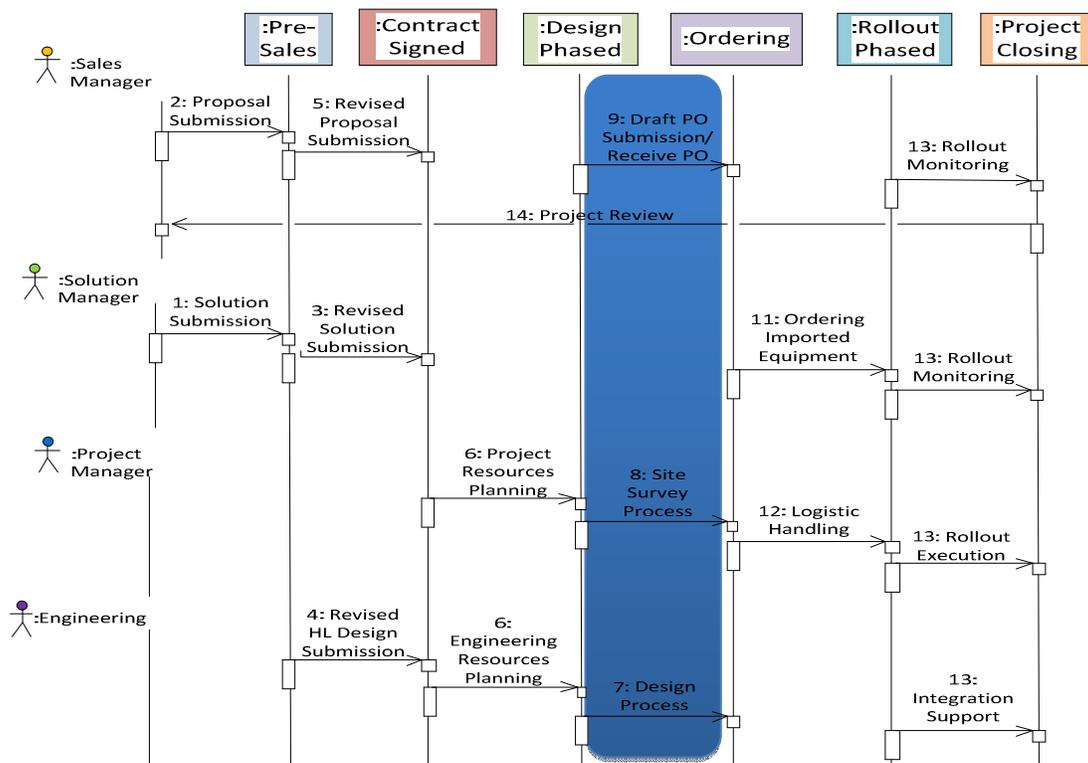
In general we can say that we successfully fulfill the requirements from stakeholder even it is not 100%.

It boosts the engineering team performance by generating the BOM thousands time faster than manual work. Moreover it also can minimize the error during BOM generation up to 0.5%.

References

- [1] *Non-Functional Requirements in Software Engineering*, L. Chung, B. Nixon, E. Yu and J. Mylopoulos, Kluwer Academic Publishing, 2000
- [2] *System and Software Requirements Engineering: Tutorial*, R. H. Thayer and M. Dortman (Editors), IEEE Computer Society Press
- [3] *Requirements Engineering: Processes and Techniques*, G. Kotonya and I. Sommerville, John Wiley Sons
- [4] *Requirements Engineering - A Good Practice Guide*, I. Sommerville and P. Sawyer, Wiley

Appendix A



Appendix B

Functional Requirement

- System shall accept input files in Excel format.
- System shall copy all information from input files to a dedicated server's database.
- System shall generate output files in Excel format.
- System shall provide one page for "file uploads" as interface to upload input files.
- System shall require standard template for the input files.
- System shall provide input files per customer on "file uploads" page.
- System shall provide input files per market on "file uploads" page.
- System shall provide option to select certain input files on "file uploads" page.
- System shall provide version for every upload process on "file uploads" page.
- System shall provide 2 different options, major and minor version on "file uploads" page.
- System shall provide comment area for every upload process on "file uploads" page.
- System shall provide "browse button" to select input files from user's local drive on "file uploads" page.
- System shall have validation process to minimize the error up to 0.1% maximum on "file uploads" page.
- System shall provide "validate and upload" button to start data validation and uploading process on "file uploads" page.
- System shall have a feedback or warning announcer to tell user that the input files has some errors.
- System shall display all version number, date, user email, and upload comment that already submitted to "file upload" page for history tracking purposes.

- System shall provide one page for "BOM generation" as interface to generate BOM.
- System shall generate standard template for the BOM.
- System shall provide BOM generation per customer on "BOM generation" page.
- System shall provide BOM generation per market on "BOM generation" page.
- System shall provide option to select certain 2 BOM type: preliminary and final on "BOM generation" page.
- System shall provide version for every BOM generation process on "BOM generation" page.
- System shall provide 2 different options, major and minor version on "BOM generation" page.
- System shall provide comment area for every upload process on "BOM generation" page.
- System shall provide "generate BOM in Excel" button to proceed generating BOM in Excel.
- System shall provide BOM in Excel file and this file must be downloadable to user's local drive.
- System shall display all version number, date, user email, BOM generation comment and also all BOM versions that already submitted on "BOM generation" page for history tracking purposes.
- System shall give option for user to save, save as, open or cancel the BOM generation file on "BOM Generation" page.
- System shall generate BOM based on requirement as below:
 - Use 1 antenna for 1+0, 1+1, and 2+0 link configuration.
 - Use 1 radio for 1+0 and use 2 radio for 1+1 and 2+0 link configuration.
 - 1+1 radio configuration need additional asymmetric power splitter with quantity 1.
 - 2+0 radio configuration need integrator with quantity 1.
 - All antenna's and radio's frequency, diameter, polarization, capacity, modulation, strength level, must match with the link configuration.
 - All cables should follow "cable length" input file and must be chosen based on 50m, 100m, or 300m granularity.
 - All connector quantity should be calculated based on cable's calculation result.
 - Every 1 radio need 1 modem unit.
 - Site with up to 2 radio will need 1 small indoor unit.
 - Site with 3-5 radio will need 1 medium indoor unit.
 - Site with 6-10 radio will need 2 medium indoor unit.
 - Basic software shall be added for each indoor unit.
 - Capacity software shall follow the capacity stated on link configuration.
 - Protection software shall be added for 1+1 link configuration.

Non-Functional Requirement

- System shall generate the BOM with processing time less than 15 seconds per market.
- System shall have error less than 0.1%.
- System's shall meet availability target 99.9%.
- System's website shall be inside company network for security purposes.
- System shall block all access from external network.
- System shall provide feature for password recovery.
- System shall provide admin page to accept user registration, add new user, and remove user.
- System shall provide welcome page for user to register, enter system using user name and password, and request for password recovery.
- System shall provide registration process to create account for user.
- System shall reject registration from email that already exist in database.
- System shall provide registration verification process to add user.
- System shall create account and password for registered user.
- System shall allow registered user to enter system, upload, download and generate the BOM base on privilege as below:
 - Common user: enter and download.
 - Special user: enter, upload, generate, and download.
- System shall allow user to download the latest information on the database through tracker feature.
- System shall provide user friendly GUI.
- System shall have re-use process for different customers or projects or markets.
- System shall provide custom process for different customers or projects or markets.

Appendix C

