Automatic Reporting for Manpower Resources

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Abstract: In a consulting engineering firm with a matrix organization structure, project managers always need to negotiate with functional managers: the project managers require competent engineers for their projects but the functional managers have been constrained with the limited manpower resources they can provide. Therefore, a reliable, accurate, and timely report that presents a plan of manpower resources for project portfolios is crucial both for project managers and functional managers. However, this report is currently made manually, which takes a lot of time and cost. Also, it is prone to be erroneous. This project presents a novel method to automatically create a manpower planning report. According to the method, the information (roles, schedules, etc.) about the engineers in different projects is first collected. This information is automatically compiled, analyzed, and organized. This way, the involvement of an engineer in different projects can be retrieved, and the future plan for the engineer can be made. The method has been validated in a consulting firm for mining business with more than 100 employees. Experiments show that the conversion can be done automatically, and much time and cost can be saved with the method proposed in this project

1   Introduction

In most consulting engineering companies, they provide technical services and/or feasibility studies to owners, designers, etc. by their engineers and technicians. The engineers and technicians are important manpower resources for the companies to survive and thrive in the market. Therefore, there are many reasons for the companies to effectively and efficiently manage their manpower resources. For example, the effective and efficient management of the manpower resources in a consulting company could help the company assess how many engineers and technicians are available in every functional department. This gives an idea to the business development department in the company about how many potential projects the company could be involved in the future. The financial department in the company could use the availability and forecast of the manpower resources to predict the company's future costs and revenues. Also, manpower management is a tool that could be used for decision making in the processes for hiring temporary personnel during the life of a project, structuring the project workforce into groups and crews, and adjusting the duration of the project by changing the manpower requirements for the different deliverables.

In order to effectively and efficiently manage manpower resources, one critical step is to report manpower resources accurately and timely (Brandon, 1974). The accurate and timely report of manpower resource could help companies know exactly the availability of manpower resources and get the lead time to train new personnel to satisfy manpower requirements, if necessary. This is especially important for those consulting companies, considering these companies experience turnover all the times.

However, the current procedure for manpower resources reporting is labor intensive, time-consuming, and prone to errors. Typically, a manpower resource report has to be generated every month with the information of all the projects and activities that a consulting company is involved. In order to generate this report, the reporter has to collect the project information provided by the project manager in each project. Then, this information is re-arranged, so that different departments in the company could assess to the information that they are authorized (Figure 1).
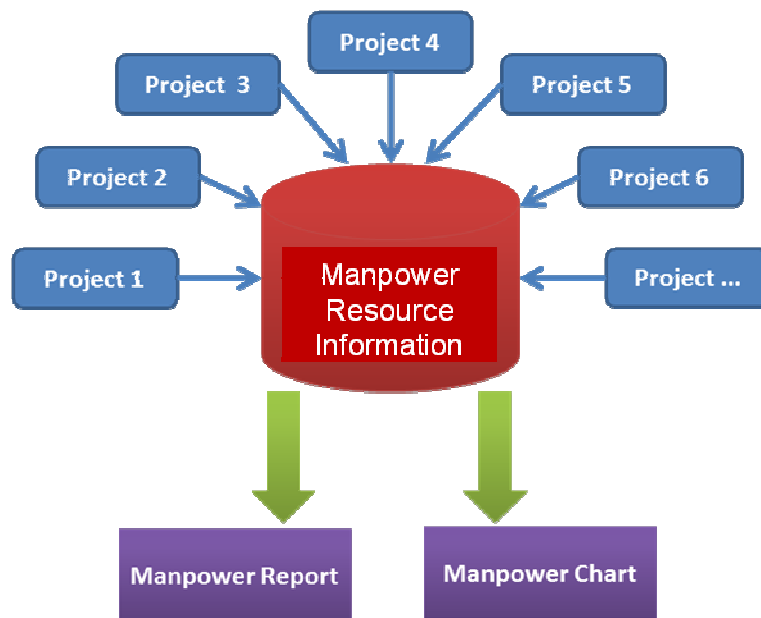

Figure 1: Manpower resource information collection and processing

This paper proposes a novel method to automate the current procedure for manpower resources reporting. Under the methodology, the manpower resource information (e.g. names and workload of engineers and technicians) in each project is first extracted. Then, this information is compiled and organized into a centralized table. This information is referred to the positions of the engineers and technicians in each functional department. This way, the manpower resource report for each department can be automatically generated.

Compared with the current procedure to generate manpower resources reports manually, the proposed method can produce manpower resources reports in an automatic, fast, and efficient manner. The method has been tested using the manpower resources data from a consulting company in mining and metallurgy, Met-Chem Inc. The test results show that the proposed method can help the company significantly reduce the time spent in the manpower resources reporting from tens of hours to tens of minutes, which is expected to save the company huge cost.

2   Related Work

Anderson and Woodhead (1981) mentioned that manpower resources are indispensable in an organization, but they are complex and unpredictable which may consume a large proportion of the effort to manage. For example, in order to implement the manpower resources reporting and planning, there are some prerequisites that have to be considered. First, certain people must be selected to carry out management plans. Also, it is necessary to implement management policies to identify the types of manpower resources available. Moreover, management standards and disciplines are required to measure the performance of the manpower resources and identify the definitions for the work.

Considering all these prerequisites, a typical procedure for manpower resources reporting include two parts. First, the project manager in a project collects the manpower resources information and reports it to the general manager in the company. The information collected by the project manager includes the scheduled and forecasted working load for each engineer or technician involved in the project (Figure 2). These engineers and technicians are organized based on their departments or functions. For each engineer or technician, both of their scheduled ("S" in the figure) and forecasted ("F" in the figure) working time are indicated. The scheduled working time is the baseline of the project planning, and the forecasted working time is updated regularly by the project manager.

DEPARTMENT / FUNCTION		11-févr	18-févr	25-févr	03-mars	10-mars	17-mars	24-mars	31-mars	07-avr	14-avr	21-avr	28-avr	05-mai	12-mai	19-mai	26-mai	02-juin	09-juin
															MAN-WEEKS				
PROJECT MANGEMENT																			
PROJECT MANAGER	S	0.3	0.3	0.6	0.6	0.6	0.6								0.2	0.4	0.4	0.4	0.4
TBD	F																	0.4	0.4
PROJECT ENGINEER	S																		
TBD	F																		
SECRETARIAL / DOCUMENT	S				1.0	0.4													
TBD	F																		
SENIOR ESTIMATOR	S			1.0	1.0														
TBD	F																		
FINANCIAL ANALYSIS	S																		
TO BE ANNOUNCED	F																		

Figure 2: Example of manpower resources reporting for one project

Once the manpower resources information for each project is collected and reported, this information is compiled into one table, as shown in Figure 3. The table includes all the projects that the engineers and technicians in the company are involved. Similar to the report for an individual project, these engineers and technicians are organized based on their departments or functions in the table. The table is useful to help the manager visualize the manpower planning of the entire company. However, the procedure is tedious and prone to errors, considering the company may be involved in many projects at the same time, and the manpower resources for each project have to be reported every month.

	02-juin	09-juin	16-juin	23-juin	30-juin	07-juil	14-juil	21-juil	28-juil
Civil	2.0	2.3	1.8	2.5	1.8	1.2	1.2	1.2	1.0
13 - Jurcze , Steven									
2010 AAA	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0
2010 BBB	0.6	0.4	0.8	0.8	0.6	0.0	0.0	0.0	0.0
2011 CCC	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2012 DDD	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.0
14 - Parent, Francois									
2010 BBB	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical	2.5	3.6	4.2	4.1	3.0	3.7	3.9	2.4	2.1
18 - Calota, Charles									
2010 AAA	0.2	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0
2010 BBB	0.5	0.5	0.5	0.5	0.0	0.0	0.5	0.0	0.0
2012 DDD	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.0

Figure 3: Example of manpower resources reporting for all projects

In order to facilitate the procedure for manpower resources reporting, certain resources loading functions have been added into existing commercial software tools, such as "Primavera P6" (Oracle, 2010) and "MS Project" (Microsoft, 2012). In these software tools, a project schedule is first created and then the manpower resources for each activity are assigned. This way, the manpower resources for the project

can be displayed along the progress of the project in a chart. The commercial software tools are useful for manpower resources reporting in complex projects that involve Engineering Procurement and Construction Management (EPCM). However, the cost and complexity associated to these software tools limit their wide use in consulting companies, especially those which only provide the service for feasibility studies without the need of creating complex project schedules. To the authors' personal experience, most project managers in consulting companies still use Excel spreadsheets to prepare and report the manpower resources involved in the projects rather than Primavera or MS Project.

3   Objective and Scope

The objective of this paper is to create a novel manpower resources reporting method for small or middle-sized consulting engineering companies. The method could rapidly generate the manpower resources reports with little human intervention. The reports should be arranged based on functional departments, so that the manger in each department could only access to their own reports. Also, the method is expected to be able to produce the forecast information about manpower resources requirement for each project portfolio in the near future. This way, the functional managers could make the corresponding adjustment based on this forecast information.

Consider most small or middle-sized consulting engineering companies have limited financial resources to update their software and hardware environments. The method is expected to be easy to implement without the need of major upgrade in software or hardware. Also, it should be easy to use without the need of providing much training for the manpower resources reporters who may not have much computer skills or background.

4   Proposed Methodology

The proposed method automates the current procedure for manpower resources reporting. The method includes three main steps. First, the manpower resources information for each project is extracted and adjusted from the report prepared by each project manager. Then, the information extracted from multiple projects is transferred, compiled and organized based on the engineers and technicians involved. The compiled information is referred to additional information related to the engineers and technicians to generate the manpower resources report for the general manager to review. Figure 4 illustrates the framework of the proposed method.
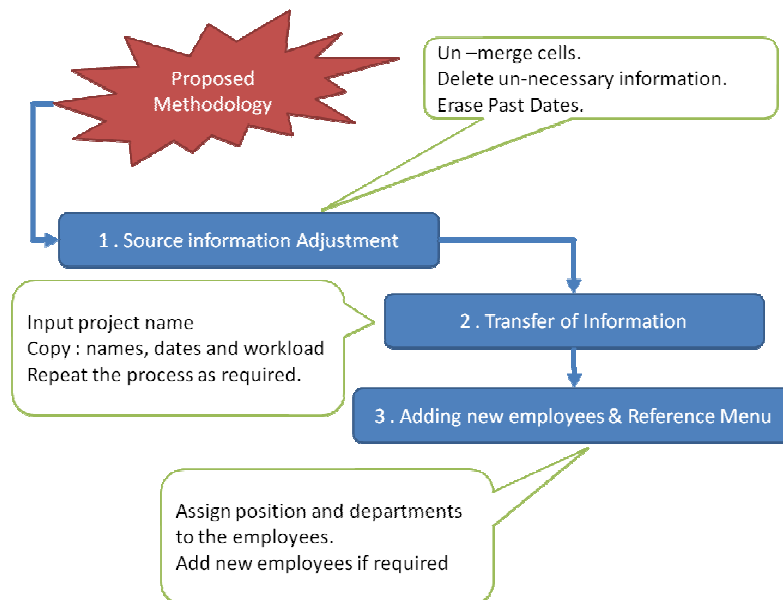

Figure 4: Proposed methodology

4.1   Manpower Resources Information Adjustment

In most consulting companies, there is a template prepared for each project manager to fill when he or she needs to report the manpower resources in the project to the companies. One example of such template has been illustrated in Figure 2. The template typically includes the information such as the actual and scheduled working hours for each engineer or technician involved in the project.

The first step in the proposed method is to automatically extract and adjust this information from the report. First, each line in the report is checked. The blank lines in the report are removed. Also, the information irrelevant to the manpower resources is bypassed. For example, the actual working hours and total working hours represent the time the engineers and technicians already spent in the project. They are not useful for manpower resources planning in the future. Therefore, when generating the report for manpower resources planning, this information is not extracted. The output of this step is a table which only includes the information necessary for the reporting purpose. One example of such table is illustrated in Figure 5.

	02-juin	09-juin	16-juin	23-juin	30-juin	07-juil	14-juil	21-juil	28-juil	04-août
M.J. Bones	0.6	0.6	0.6	0.6	0.8	0.8	0.6	1.4	0.6	0.4
Y. Carpenter		0.1		0.1		0.1		0.1		0.1
Scheduling					0.4	0.4	0.4			
J. Cirujano	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	
Secretary	0.2	0.1	0.2	0.2	0.4	0.6	0.6	0.1		
S. Rhodes	0.2	0.2	0.2	0.2	0.2	0.4	0.5	1.4	0.4	Vac.
R. Gonzalez										
S. Kraft	0.6	0.4	0.2		0.2					
R. Cole	0.8	0.8	0.6	0.6	0.4		0.2			
Y. Brown										
Tailings					1.0	1.0				
A. Gomez										
J. Carling	0.4	0.2	0.2							
S. Jones	0.6	0.4	0.8	0.8	0.6					
F. Perez	0.4	0.4								
F. Leicester	0.8	0.6	0.4			Vac.	Vac.			
S. Zhang	1.0	1.0	1.0	1.0	1.0					
D. Van Vasten	1.0	1.0	1.0	1.0	1.0	1.0	0.4	0.4		
Piping Engineer										
C. Casanova	0.5	0.5	0.5	0.5	Vac.	Vac.	0.5			

Figure 5: Example of Source Information Adjusted

4.2   Transfer of Information

Once the engineer and technician information is extracted from each project report, it is compiled into a centralized table. In the table, all the information from different projects is stored and organized based on the engineer or technician's name. If an engineer is involved in the projects multiple times, there will be the corresponding records for him or her in the table (Figure 6). The information collected from the project reports includes 1) the names of engineers or technicians,2) the projects that they are involved in, 3) the working date and load in the projects. Other information related to the engineers or technicians, such as their departments and positions, will be filled in the next step.

M.J. Bones	Employee	Position	Department	2010-AAA	16-juin	0.4
M.J. Bones	Employee	Position	Department	2010-AAA	23-juin	0.4
M.J. Bones	Employee	Position	Department	2010-AAA	30-juin	0.4
M.J. Bones	Employee	Position	Department	2010-AAA	07-juil	1.0
M.J. Bones	Employee	Position	Department	2010-AAA	14-juil	0.0
M.J. Bones	Employee	Position	Department	2010-AAA	21-juil	0.0
M.J. Bones	Employee	Position	Department	2010-AAA	28-juil	0.0
Y. Carpenter	Employee	Position	Department	2010-AAA	02-juin	0.0
Y. Carpenter	Employee	Position	Department	2010-AAA	09-juin	0.0

Figure 6: Tabular Table in progress

4.3 Adding New Employees and Reference Menu

The last step in the proposed method is to fill the departments and positions information for the engineers and technicians in the centralized table. In doing so, a reference menu is pre-prepared. One example of a reference menu can be found in Figure 7, where the detailed information about the engineers and technicians, such as their first names, last names, departments, and positions in the departments, is included. Each record in the centralized table is checked. If the engineer or technician's name can be found in the reference menu, his or her corresponding department and position information in the reference menu is located. This information is then extracted and filled into the centralized table. Otherwise, a new employee is assumed. The information related to that employee will be added into the menu by the operator for the reference in the future.

M.J. Bones	1	Mark Jones	Bones	Operations	Project Managers	1 - Bones, Mark Jones
Y. Carpenter	2	Yves	Carpenter	Operations	Manager	2 - Carpenter, Yves
J. Cirujano	3	Jose	Cirujano	Operations	Engineers	3 - Cirujano, Jose
S. Rhodes	4	Samuel	Rhodes	Process	Manager	4 - Rhodes, Samuel
S. Kraft	5	Sonia	Kraft	Process	Engineers	5 - Kraft, Sonia
R. Cole	6	Roman	Cole	Process	Engineers	6 - Cole, Roman
Y. Brown	7	Yves	Brown	Mining	Geologists	7 - Brown, Yves
D. Graham	8	David	Graham	Mining	Manager	8 - Graham, David
A. Gomez	9	Abel	Gomez	Mining	Designers	9 - Gomez, Abel
J. Carling	10	Jonathan	Carling	Mining	Engineers	10 - Carling, Jonathan
S. Jones	11	Steven	Jones	Civil	Engineers	11 - Jones, Steven
F. Perez	12	Francois	Perez	Civil	Designers	12 - Perez, Francois
F. Lefebvre	13	Francis	Leicester	Mechanical	Engineers	13 - Leicester, Francis

Figure 7: Example of Reference Menu

5 Implementation and Results

The proposed method has been implemented with Visual Basic for Applications (VBA) macro programming language developed by Microsoft®. VBA enables building user-defined functions into most Microsoft® office products, such as Word, Excel, and PowerPoint. Considering Microsoft® Excel has been widely accepted in the industry as the standard for spreadsheets, the implementation of the method with VBA could be used in most consulting companies. Figure 8 shows the screenshot of the main interface of the proposed method.
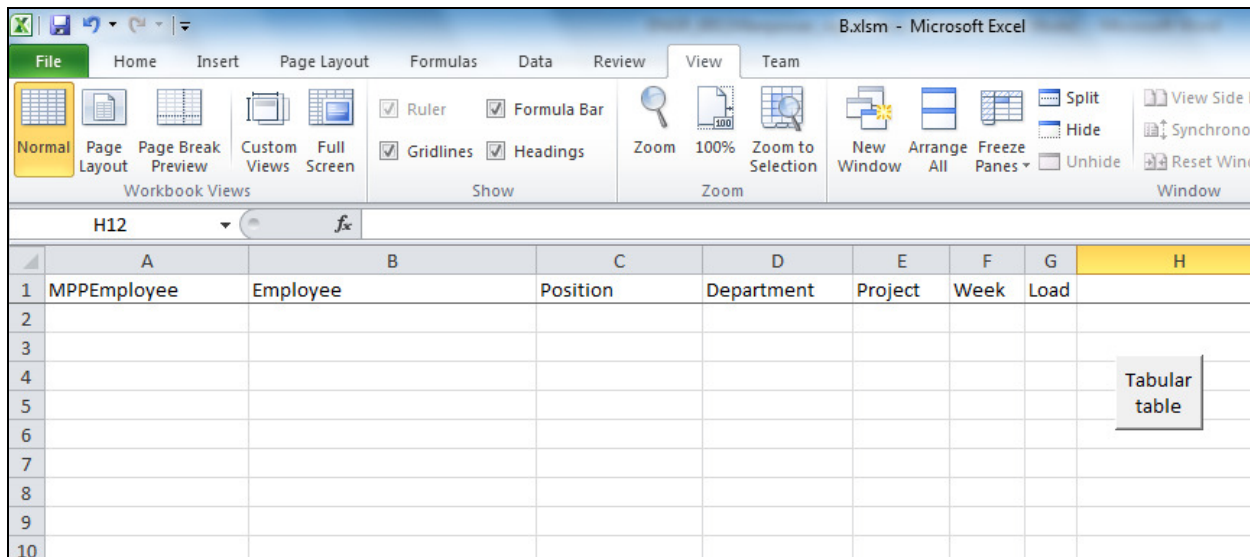

Figure 8: Main interface

The manpower resources data from five projects conducted by the Met-Chem Inc. were selected to test the effectiveness of the proposed method. All the projects were related to mining planning and mineral processing. Considering the confidential agreement, here, the fake project dates and names were used. Figure 9 illustrates an example of inputting the manpower resources data in one project into the centralized table. First, the "Tabular table" button is clicked to specify the project manpower resources data (Figure 9a). In this example, project "2010-AAA" is selected. Then, the manpower resources information in the project is copied into the table (Figure 9b).
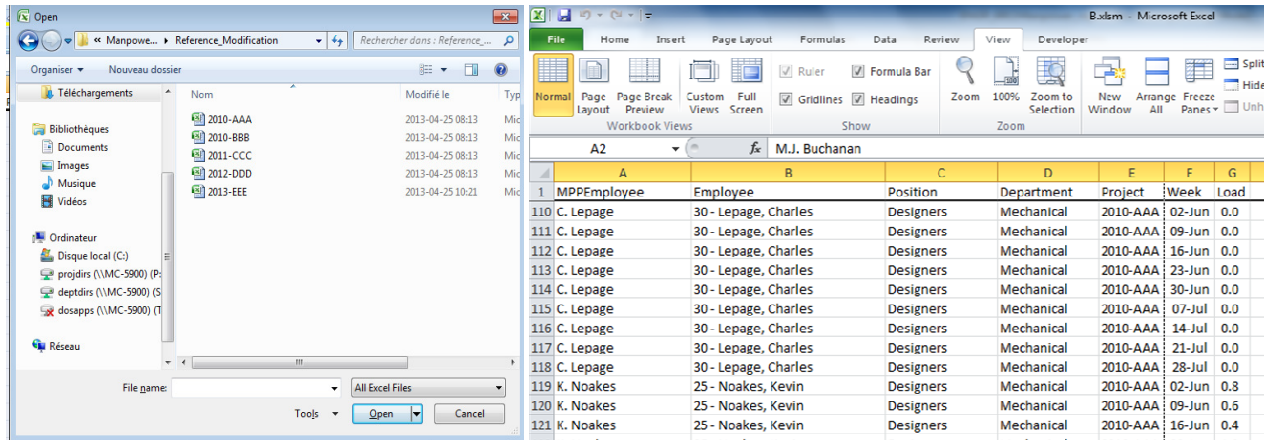
(a) Selecting a project   (b) Manpower resources information retrieved
Figure 9: Example of manpower resources information retrieval

When the manpower resources information from all five projects is put into the table, the user could automatically generate the manpower resource report that can be reviewed by the general manager (Figure 10). Also, the user could create a chart to illustrate the forecast about the total manpower resources requirements from the projects (Figure 11). This forecast would help the general manager make a wise and timely decision about the arrangement of manpower resources in different projects that the company is currently involved.

Manpower Planning												
	02-Jun	09-Jun	16-Jun	23-Jun	30-Jun	07-Jul	14-Jul	21-Jul	28-Jul	04-Aug	11-Aug	18-Aug
Civil	2.00	2.33	1.80	2.33	1.60	1.00	1.00	1.00	1.00	1.00	1.00	-
Engineers	1.60	1.93	1.80	2.33	1.60	1.00	1.00	1.00	1.00	1.00	1.00	-
13 - Jurcze , Steven	1.60	1.93	1.80	2.33	1.60	1.00	1.00	1.00	1.00	1.00	1.00	-
2010-AAA	-	0.53	-	0.53	-	-	-	-	-			
2010-BBB	0.60	0.40	0.80	0.80	0.60	-	-	-	-	-	-	-
2011-CCC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-
Designers	0.40	0.40	-	-	-	-	-	-	-	-	-	-
14 - Parent, Francois	0.40	0.40	-	-	-	-	-	-	-	-	-	-
2010-BBB	0.40	0.40	-	-	-	-	-	-	-	-	-	-
Automation	1.30	1.90	2.30	1.30	1.30	1.70	2.30	1.00	1.00	-	-	-
Engineers	1.30	1.30	1.30	1.30	1.30	1.30	2.30	1.00	1.00	-	-	-
21 - Langelier, Robert	0.30	0.30	0.30	0.30	0.30	0.30	0.30	-	-	-	-	-
2010-BBB	0.30	0.30	0.30	0.30	0.30	0.30	0.30	-	-	-	-	-
22 - Paul, Natalie	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-
2010-BBB	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-	-	-
44 - TBD, Automation Engineer	-	-	-	-	-	-	1.00	1.00	1.00	-	-	-
2011-CCC	-	-	-	-	-	-	1.00	1.00	1.00	-	-	-
Designers	-	0.60	1.00	-	-	0.40	-	-	-	-	-	-
X - TBD, Automaton Designer	-	0.60	1.00	-	-	0.40	-	-	-	-	-	-
2010-BBB	-	0.60	1.00	-	-	0.40	-	-	-	-	-	-

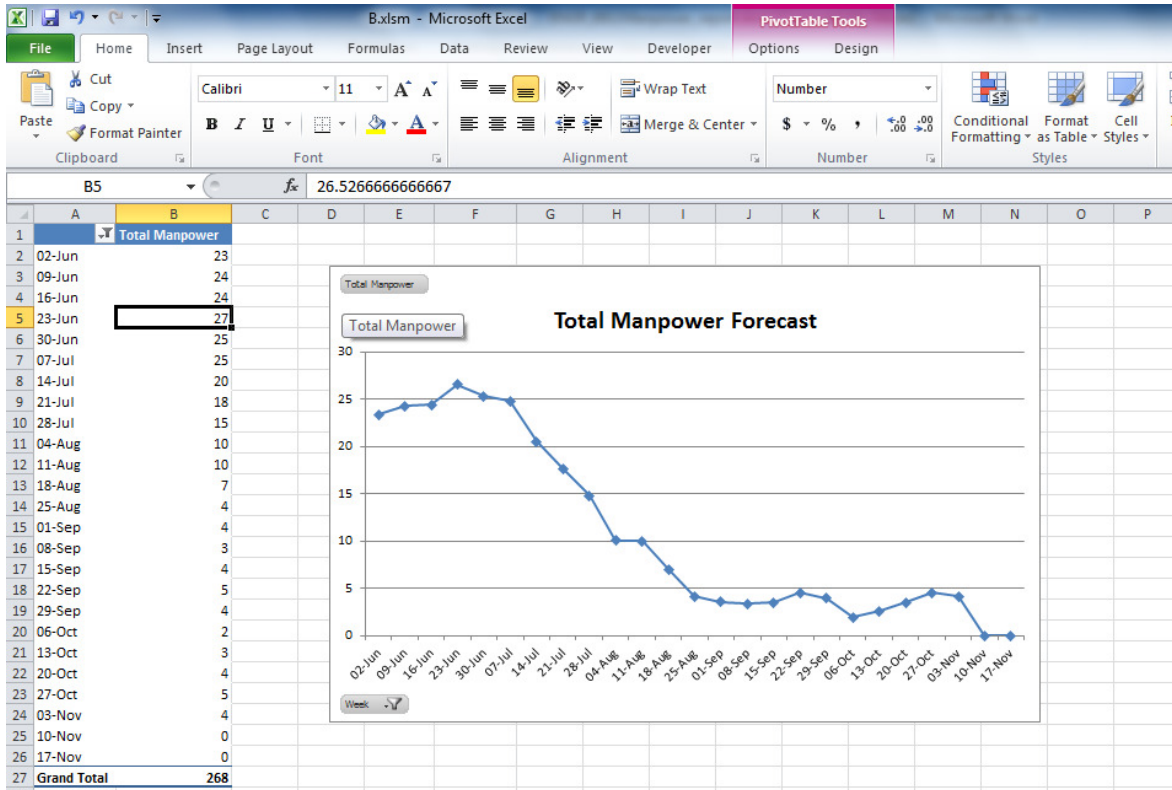Figure 10: Manpower resources report for the general manager

Figure 11: Manpower resources forecast

The proposed method is expected to accelerate the current manual procedure for manpower resources reporting. In order to show the benefits of using the proposed method for manpower resources reporting, the time required to create the manpower resources reports with and without the proposed method is recorded separately and then compared. According to the tests performed in the Met-Chem Inc., it was found that an experienced reporter typically required approximately 30 working hours to compile the manpower resources information from 12 -15 projects every time, and then report it to the general manager. If the proposed method is used, the time for the manpower resources information compilation and reporting could be reduced by 99.4%, which is approximately 10 minutes. Considering the median annual salary for a project administrator is $46,672 (PayScale 2013), the reduced time could help the company save the cost of $737 every time for manpower resources compilation and reporting. Typically, the manpower resources compilation and reporting are performed every month. Therefore, the total cost saving per year could reach around $8,844. All the comparison results are shown in Table 1.

Table 1: Time and cost saving for manpower resources reporting with the proposed method

Methods for Manpower Resource Reporting	Time Required	Hourly Cost	Total Cost per Report	Cost Saving per Year
Manual Procedure	30 hours	$24.7[1]	$741	$8,844[2]
Proposed Method	10 minutes		$4	

[1]Assume 36.4 working hours per week (HRSDC 2013) and 52 weeks per year
[2]Assume manpower resources information is compile and reported every month

6   Conclusions

The engineers and technicians are important manpower resources for consulting companies. In order to survive and thrive in the market, the companies need to effectively and efficiently manage these manpower resources. One critical step in the manpower resources management is to report manpower

resources accurately and timely, so that the general manager could make a wise and informed decision. However, the current procedure for manpower resources reporting is labor-intensive, time-consuming, and prone-to-error.

In this paper, a novel automatic method for manpower resources reporting has been proposed. Under the method, the manpower resource information in each project is extracted and compiled into a centralized table. This information is then referred to other information of the engineers and technicians in a reference menu. This way, the manpower resource report for each department can be automatically generated. Compared with the current manual procedure to generate manpower resources reports, the method proposed in this paper can produce manpower resources reports in an automatic, fast, and efficient manner. The method has been tested using the real project data from a consulting company in mining and metallurgy, Met-Chem Inc. The test results showed the effectiveness of the method, which can help the company significantly reduce the time and cost spent in the manpower resources reporting.

Acknowledgments

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Appendix - Pseudo Code for Automatic Manpower Resources Compilation and Reporting

```
Sub Test2()
Dim WSD As Worksheet
Dim WSM As Worksheet
Dim WB As Workbook
Dim Project As String
Set WB = ThisWorkbook
Set WSD = WB.Worksheets("Data")
Set WSM = WB.Worksheets("Menu")
Cells(Rows.Count, 5).End(xlUp).Offset(1).Value = InputBox(Prompt:="Input Project Name", Title:="Project Name")
Application.Dialogs(xlDialogOpen).Show
Project = ActiveWorkbook.Name
Range("A1").Activate
```

```vba
Range(Selection, Selection.SpecialCells(xlLastCell)).Copy
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, Application.CutCopyMode = False
Cells.MergeCells = False
Range("A:A,C:E,G:G").Delete
Range("B6").FormulaR1C1 = "Date"
Columns("B:B")AutoFilter
Range("B:B").AutoFilter Field:=1, Criteria1:=Array("A", "S", "TF", "TS", "="), Operator:=xlFilterValues. Delete
Totalcol = Cells(1, Columns.Count).End(xlToLeft).Offset(, 1).Column
Totalrow = Cells(Rows.Count, 1).End(xlUp).Row
Range(Cells(1, Totalcol), Cells(Rows.Count, Columns.Count)).EntireColumn.Delete
Dim ChkTotal As Range
Cells(1, 2).EntireColumn.Delete
Set ChkTotal = Range(Cells(2, Totalcol), Cells(Totalrow, Totalcol))
ChkTotal.FormulaR1C1 = "=SUM(RC2:RC[-1])"
Dim cell As Range
For Each cell In ChkTotal
    If cell = 0 Then
        cell.EntireRow.Delete
    End If
Next
ChkTotal.Clear
Range(Cells(1, Totalcol), Cells(Rows.Count, Columns.Count)).EntireColumn.Delete
Dim Selectdate As Date
Selectdate = InputBox(Prompt:="Enter the starting week", Title:="Initial Week Forecast", Default:="2012-01-31")
Cells.Find(What:=Selectdate, After:=ActiveCell, LookIn:=, SearchDirection:= xlNext, SearchFormat:=True).Activate
DelDate = ActiveCell.Offset(, -1).EntireColumn.Column
Range(Cells(1, 2), Cells(Rows.Count, DelDate)).Delete
Cells.Select
FinalRow = Cells(Rows.Count, 1).End(xlUp).Row
Finalcol = Cells(1, Columns.Count).End(xlToLeft).Column
For i = 2 To FinalRow
Workbooks(Project).Range(Cells(i, 2), Cells(i, Finalcol)).Copy
Windows("B.xlsm").Cells(Rows.Count, 7).End(xlUp).Offset(1).PasteSpecial Paste: Transpose:=True
Windows(Project).Range(Cells(1, 2), Cells(1, Finalcol)).Copy
Windows("B.xlsm") (Rows.Count, 6).End(xlUp).Offset(1).PasteSpecial Paste: Transpose:=True
Windows(Project).Cells(i, 1).Copy
Windows("B.xlsm").Cells(Rows.Count, 1).End(xlUp).Offset(1).Select
    Selection.PasteSpecial Paste:=xlPasteAll, Operation:=xlNone, SkipBlanks:= False, Transpose:=False
    On Error Resume Next
    Range("A1").CurrentRegion.SpecialCells(xlCellTypeBlanks).FormulaR1C1 = "=R[-1]C"
    Range("A1").CurrentRegion.Value = Range("A1").CurrentRegion.Value
Next i
FinLine = WSD.Cells(WSD.Rows.Count, 1).End(xlUp).Row
WSD.Range("A1").Resize(FinLine, 1).AdvancedFilter Action:=xlFilterCopy, copyToRange:=WSD.Range("I1")
FinalEmployee = WSD.Range("I" & WSD.Rows.Count).End(xlUp).Row
WSD.Range("J1").Value = "There?"
WSD.Range("J2:J" & FinalEmployee).FormulaR1C1 = "=ISNA(VLookup(RC[-1], EmLi, 1, False))"
NextRow = WSM.Range("A" & WSM.Rows.Count).End(xlUp).Row + 1
For i = 2 To FinalEmployee
    If WSD.Cells(i, 10).Value = True Then
        ThisEmployee = Cells(i, 9).Value
        WSM.Cells(NextRow, 1).Value = ThisEmployee
        WSM.Cells(NextRow, 2).Value = InputBox(Prompt:="Input # of " & ThisEmployee, Title:="New Employee#")
            NextRow = NextRow + 1
    End If
Next i
WSD.Range("I1:J" & FinalEmployee).Clear
FinalEmployee = WSM.Range("A" & WSM.Rows.Count).End(xlUp).Row
WSM.Range("A2:G" & FinalEmployee).Name = "EmLi"
WSD.Range("D2:D" & FinLine).FormulaR1C1 = "=VLOOKUP(RC1,EmLi,5,False)"
WSD.Range("B2:D" & FinLine).Value = Range("B2:D" & FinLine).Value
End Sub
```