
The New Timetable Era: The Single ‘W’ Concept and Timetable Hub

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Abstract The main of this paper is to deliver our insight on timetable solution based on our 3 years of experience in within the Malaysian Higher Education sectors. This paper is written purely on the basis of consultant point of view rather than from a researchers expert opinion. Most of the findings are basically from our survey both qualitatively and quantitatively which are then compile and reviewed by our consultants for our development stages. Our close proximity with our pool of clients has helped our Research and Development team of consultants to develop our timetable software called Timetabler Plus initiated from version 1.0 till version 3.0 in the last 3 years. Efforts taken in solving most of the colleges, polytechnics, institutions and universities constraints and demands were built around our interest to know more and solve more. This is what this paper is all about; sharing our experiences as a timetable consultant and also our vision for the new era of timetable solutions called timetable hub.

Keywords Timetabling Solution · Commercial Product · Timetabling Process · ‘W’ Concept · Timetable Hub

1 Introduction

Timetabler Plus (T-Plus) is a commercial timetabling software designed to solve timetabling problem in all education institutions. With the tag word of “ultimate timetabling solution for schools, colleges and universities”, the ultimate mission of T-Plus is to become a universal timetabling application for all kinds of education timetabling problems. From

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a humble beginning as an in-house developed timetabling software, it has evolved into a full scale commercial software that is capable of handling diverse timetabling scenario in different education institution ranging from schools, colleges, polytechnics and universities. Since its intervention in Malaysia education market, it has made some kind of impact by securing 45 satisfied clients and currently launching it latest v3.0.

This paper provides our insight on timetable solution, purely from the commercial point of view. It is written based on our 3 years of experience in providing consultation and timetabling solution to diverse education institutions within the Malaysian Higher Education sectors. Our close proximity with our pool of clients has helped us to develop in-depth understanding of the actual problems faced by most of the industry users and knowing their actual demands for a good timetabling solution. These findings have helped us to develop T-Plus initiated from version 1.0 till version 3.0 in the last three years. This is what this paper is all about; sharing our experiences as a timetable consultant with the hope to bridge the gap between theory and practice, education and industry, and also our vision for the new era of timetable solutions called timetable hub.

At this point, we would like to strongly emphasis that this paper is lacking in some of kind of proper referencing at this moment as this paper is purely citing issues and solutions based on the practical experience having solved 45 clients based on personal consultation and coaching. Currently, this paper also does not follow a proper academic research guideline due to the time constraint. Discussion will be focused in areas of timetable issues, our analysis, our strategy, consistent problems faced by our consultants and The Future of Timetable Solution will be outlined throughout this paper.

2 Common Timetable issues in Malaysian Higher Education

From our three years of timetable consultation within Malaysian Higher Education, having closely knitted relationship with our clients has given our RD consultants opportunity to explore timetable issues ranging from minor to major problems.

In each of our 45 institutions, they faced common timetable issues either in macro or micro level. Every institution face both the micro and macro level of timetable issues during the same period or time or at different time and the degree of the problems may also varies in each institution.

Macro level involved the management level across the institutions or even the governing body when related to government institution in Malaysia. Sometimes political changes and top level changes in the management level within the Education Ministry level could result in big impact on the macro level of timetable issues. As for private colleges, there is a different set of macro level issue being commonly identified. Decisions by the management to maximize profits and implement cost efficiencies could result in lack of resources while trying to cater for each individual student demanding for different combination of subject. These may result in major constraints and conflicts in the timetable issues. In summary, Macro level usually may cause the whole timetable that has been either ready or even running to be re-adjusted in the major or minor scale. However from our experience, most macro level issues will have a major impact on the timetable output. The worst case scenario is when there is no warning sign and the changes need to take place immediately without any room of negotiation.

Micro level issues usually involved internal decision making between Head of Department or individual request by certain lecturers and the timetable coordinators level of kindness. In the normal human behavior, most timetable coordinator will only make changes to those that they feel close to them or called favourable buddies. Other common micro level issues are the Repeaters issues and staff deployment issues due to the shortage of staffs or staff turnover issues. However in most micro level cases, they are usually not as serious issues compared to macro level and can be solved in a shorter period of time. In both macro and micro level, there is one common platform which needs to be avoided, which is clashing. Clashing issue is the main reason why institutions decide to engage timetable consultants like us. We realized that improper timetable planning and the occurrence of micro and macro level issues are the major contributions to this Clashing issues. In some occasions, in order to meet the demand of micro and macro level issue there is a possibility that clashing issue could not be avoided. From our experience, the inflexibility of macro issues are more prompt to the greater possible of the incurrence of Compulsory Clashing.

Another common timetable issues within most privately-owned is the examination timetable. Examination can cause a big headache for timetable coordinators who need manage incoming examination timetable with some courses that are still running clashes need to be avoided by recognizing available rooms and available lecturers for invigilators for within the examination schedule. Another issue can arise in the examination problem is when each student subject enrolment is unique from another student commonly found in the privately run colleges which maximize profits and minimize costs.

3 Concept of ‘W’ Timetable Creation Cycle

From our survey and analysis citing all the common timetable problems, we have realized that all the problems are part of the one common element; lack of understanding of timetable concept. In our last 3 years R and D, we have realized that there is no common platform or even a formula for creating quality timetable. Despite the vast availability of benchmark and measurement techniques in academic timetable research, it is not known if such a benchmark ever exists for commercial timetable product. Therefore it is difficult for commercial users to compare one software with another. It is important to note that there is a huge different between evaluating a commercial timetable solution to an academic one. In an academic exercise, the primary interest is to evaluate the efficiency and effectiveness of the timetable generating algorithm. Efficiency and effectiveness refer to the ability of the timetabling algorithm to create a timetable output that satisfies most of the hard and soft constraints in the shortest timeframe. Commercial users, on the other hand are more interested in the timetabling process. Timetabling process can be summarized as from raw data to an acceptable timetable output. This is the reason why we proposed the W concept, which represents a single cycle in producing workable timetable. Achieving a single W is the ideal of every commercial timetable process.

The single W model concept is shown in Figure 1. This is regarded as the perfect timetable creation cycle for each timetable creation process. Table 1 summarizes the activities in each of these processes in the W cycle.

This W concept can act like a base formula in the creation process of perfect timetable for both user and also software developer. Achieving a single W is the ulti-

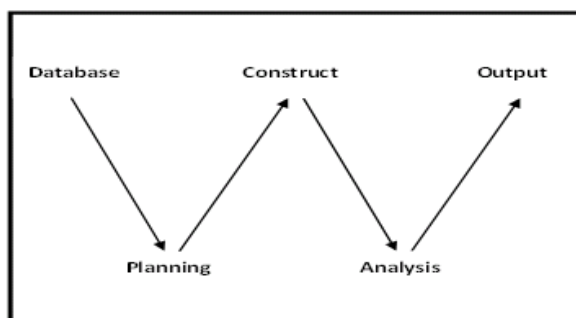


Fig. 1 Single W Model Concept (The perfect model for timetable creation cycle)

Table 1 Activities in ‘W’ Cycle

Processes	Activities
Preparation of database (Database)	<ul style="list-style-type: none"> - Course List - Lecturer List - Room List
Planning by management (Planning)	<ul style="list-style-type: none"> - Who teaches What. of lectures/labs/tutorials per subject per week - Rooms allocation per department - Merging classes according to demand - Relief/Part-timer lecturers/teachers - No of group of student for each batch - Start and End time inclusion of break time - List of prioritize subjects. (Eg: subjects having 3 hrs or more duration, compulsory subjects etc) - Plan and Understand all the Constraint
Execution: Constructing timetable (Construct)	<ul style="list-style-type: none"> - Construct Start and End time - Listing all available room - Analyze and identify constraints for batch of students, courses and lecturers - Construct timetable for (as sequence): <ol style="list-style-type: none"> 1. prioritize subjects 2. remaining subjects
Analyze the completed timetable (Analysis)	<ul style="list-style-type: none"> - No clashes for batch of student, courses, rooms and lecturers. - All offered subjects are included into the timetable with the right constraints. - Lecturer timetable daily/weekly workload/schedule - Student timetable - daily distribution of lessons in a week - Rooms utilization
Output and distribution process (Output)	<ul style="list-style-type: none"> - Output need to be copied again to the right template

mate target and goal for every timetable coordinator as it saves time and resources. In order for a perfect W concept to works, timetable coordinator needs to understand each of the W components; Database, Planning, Construct, Analysis and Output. These five W components are also a good guide for a new timetable coordinator who has no knowledge on timetable creation cycle.

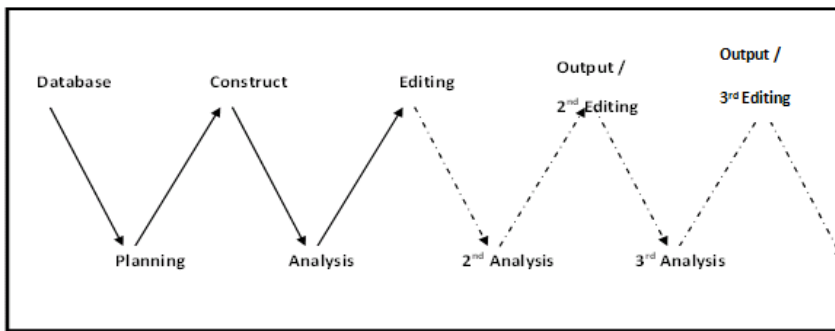


Fig. 2 Multiple W Models (Commonly found in the Conventional way concept)

In practice it is quite impossible to obtain a perfect W. Many modifications would come along the way which will disrupt the perfect 'W'. This results in the multiple 'W' cycle as shown in figure 2. The quality of timetabling process in commercial world is measured by the ability to minimize the 'W' cycle, ultimately to the perfect 'W' (i.e. a single cycle). Large W cycles denote inefficiency in timetable creation process.

As it is obvious from the 'W' cycle, construction of timetable is just one of the processes. From the commercial point of view, good timetabling software is not only software that is capable to generate the output in the shortest period of time, but is also capable to assist in other processes in the cycle. One particularly important feature which is often neglected is the ability of the software to manage micro changes (editing) to the result without affecting those that are already in their desired place.

In this paper, we are proposing the W concept as a benchmark to measure commercial timetable applications. The quality of a commercial timetable solution is measured by its ability to minimize the number of W cycles. The development and improvement of any timetable system should also take into account of W principles. In this paper, based on our experience, we will explain about the relationship of our software being developed in the last 3 years based on the W concept.

4 Introduction to Timetabler Plus

When Timetabler Plus (T-Plus) is being introduced in July 2007, its main mission is to be the ultimate timetabling solution for schools, colleges and universities. T-Plus is carefully designed and constantly updated to cater the needs and demands of the timetabling process. Table 2 summarizes the features of Timetabler Plus.

With friendly icons and lightweight standalone application, T-Plus has made some kind of impact since v1.2 in July 2007 launching by securing 45 satisfied clients and currently launching its latest v3.0. Apart from providing excellent technical support service, our professional consultants provide training and consultancy packages to our clients.

4.1 The Plus Factors of Timetabler Plus

Timetabler Plus offers various constraints setting for each/all:

Table 2 Summary of T-Plus Features Benefit

Features	Benefits
Enables simultaneous constraints setting for Program, Batch, Subject and Lecturer	Fast, efficient optimization with complete user control
Managing the allocation of specific constraints in subjects and lecturers using the TREE STRUCTURE terminology (PARENT and CHILD concept)	High flexibility and reusability in the creation producing better result for any type of educational institution
USER-FRIENDLY interface with native Windows icon	Easy to learn and use even for non- computer literate
Integration with MS EXCEL for database and printing purpose with various printing format available	Transferring of the current database for new user made easy. Final output simple to customize
AUTOMATED GENERATE button function based on constraints settings PLUS the option of Manual Allocation	Reduction in Cost, Time and Manpower. Clash Free Result (Auto-Generate) and Reminder (Manual Allocation)
(Latest Edition v2.8) Print preview for Individual Lecturer, Room, Day and even Batch of Student with customized Header and Footer	Faster in Analyzing the output and Quicker in Producing the Final Output

1. Lecturer(s) Constraints/Preference:
 - Specific time or day he/she does not want to teach and
 - Preferred Room/s
 - Avoid Teaching Consecutively
2. Constraints for Each Program/Department/Faculty/Batch of Student/ Subject(s):
 - Specific time or day to Include/Exclude
 - Preferred Room/s
 - Same Subject (different day) or Merging Request (Same Time Slot)
 - Adjacent Classes
 - Same Room for a particular group of students
3. Room Constraint/ Specific Room Types:
 - Each Room Capacity
 - Each Room Function/Equipment
4. Style of Generating Output (Generate Constraint):
5. Prefer to start the class in the early morning, afternoon or evening
6. Prefer the 1st class to start on 1st Day of the week (Monday) or last Day of the Week (Friday)
7. User can have the choice for 2 hours class or more to span across the General Break
8. Rooms can be optimized according to the capacity

Timetabler Plus also offers various output formats for individual/master timetable for:

- Lecturer
- Batch of Student
- Room
- By Day

There are three ways for users to print their finalized timetable:

1. Exporting to Microsoft Excel
2. Print directly from Timetabler Plus
3. Export to HTML

4.2 Timetabler Plus W Concept

Any good timetable software is measured by its ability to minimize the W cycle, ideally achieving a single W. Other than the W concept, there is not known type of measurement or benchmark that can act as a tool to differentiate the quality amongst timetable software. We have committed our development of Timetabler Plus software in line with the single W concept, trying to automate every process in the W cycle. While we understand that a perfect W difficult to achieve (unless it is a small organization with small timetable), our goal is to help organization minimizes the W cycle. Table 3 outlines the timetable creation processes and activities using Timetabler Plus in relation to improving every process in the 'W' cycle.

5 Timetabler Plus Strategies

One of the key misconceptions of the users is that a timetabling solution is like a silver bullet to their timetabling problem. This is indeed untrue. Many of the problems lie in the human aspects as well as in planning and management. Our experience with timetabling consultation since July 2007 made us realized that almost all timetable problems could not be solved by many timetable solutions due to lack of understanding between timetable coordinators with the timetable solutions and vice versa. Therefore in order for Timetabler Plus to make a good impact, we have devised a structured strategy to deal with each of our clients in three Cs steps: **C**onsultation, **C**ustomized Timetable, and **C**ustomized Training.

5.1 Consultation

Consultation is the key to understanding clients problems. Understanding our clients unique scenario is the key to successful implementation. For that reason, our consultant will first be consulted about all their timetable issues. Our experience has shown that understanding just their demand and constraints are not sufficient to make a quality timetable. We will need to understand the traditional way or sometimes what we called customary way of creating the timetable. Even within the same organization, different department may have different set of customary demand which may even differ when new person takes over as a new Head of Department (micro level of constraints). Based on the understanding of clients problem, Timetabler Plus will be customized to cater to the needs of our clients. The crux of the challenge lies in the ability of Timetabler Plus to adapt to different clients scenario without having to customize the software at the code level.

Table 3 Process of Timetable Creation using Timetabler Plus

Processes	Activities
Planning by management and Database preparation	<ul style="list-style-type: none"> - Conventional planning and database preparation applies - Database can be easily exported from the ready-made Timetabler Plus Excel - Course, lecturer and room list can be categorized according to department. - Future editing can be done easily - Construct the general timetable structure; general timeline and list of room. - High flexibility in designing timetable structure.
Data entry and Constraint Setting	<ul style="list-style-type: none"> - Modeling data and constraints in tree structure with parent and child relationship. - Future editing will be easily done in the existing tree structure. - Apply constraint simultaneously for each faculty, program, and batch of student, subject, lesson and lecturer according to individual demand.
Auto-Generate	<ul style="list-style-type: none"> - Generating the timetable according to preference and priority - Various generating options, offsetting between fast and quality output. - Incremental generating of output to allow timetable coordinator to build timetable incrementally.
Analyze the result and Edit (if required) simultaneously	<ul style="list-style-type: none"> - Fast track on changes with quick analysis results - Locking feature to preserve desirable output - Various analysis techniques to analyze various data
Output and distribution process	<ul style="list-style-type: none"> - Offer various formats of output; Native output, Excel, and Html - Customizable output to suite to different organizations needs - Use independent file concept to enable easy management of multiple scenario. - Multiple file concept also make timetable process easily recyclable.

5.2 Customized Timetabler Plus

Based on our consultation inputs, we will try to accommodate all the demands and constraints by creating a custom timetable structure for our clients. Here lies the key strength of Timetabler Plus. As Timetabler Plus uses a model driven approach, it is really up to the creativity of the timetable consultant to model the constraints. Similar problem can be model in different way as long as the end result is the same. Not all features of Timetabler Plus is required by all client, therefore we only expose those that are of their concern.

5.3 Customized Training

Finally, we construct a Customized Training program for our clients to enable their timetable problems and demands to be solved using Timetabler Plus software. This may need a proper guidance by our consultants and priority is given for older generation

while more attention to bigger organizations. The training programs may even differ for each department in the similar institutions as demands may vary from one another. We usually customized the training program based on demand driven and the uniqueness of each individual/department/institutions. Our main objective at the end of the training session is for our clients to enjoy constructing quality timetable using Timetabler Plus by optimizing the full functions of the software.

6 Impact of Human Character in Timetable Software Implementation

In each of our clients, that we have consulted and trained, we usually faced some problems that can be described as consistent problems which are found in most institutions. These problems usually cause some kind of irregularity in the flow of our training program in relation to timing and productivity. It is called the Human Character and even though each human portrayed different set of characters, they usually have a common element; Demand. This consistent Demand problem in Human Character will affect the single W concept as planned in our training packages. From our findings, Demand problems are commonly categorized accordingly:

- **Demand for Attention:** Usually for older generation who is resistant to change. This is due to lack of confidence in using the computer as they are prone to do anything manually.
Impact: Too much time spent on them while other coordinators may be accidentally being ignored or lesser time attended to cater their needs.
- **Demand for Excuse from Attendance:** Usually occurs for those that are forced to be inside the training program. Involuntary participants are being obliged to follow orders from higher authority or to gain credit hours for attending the training program.
Impact: This kind of character usually gives a negative impact to the others and at times they may even create unnecessary scenes that can result in depress or moody environment. The matter can be worst if each department timetable is dependent on other department progress rate in completing the timetable output.
- **Demand for Reasoning:** This usually happen when someone is too enthusiast with the training program or even the Timetabler Plus. He or she will usually wants his/her voice or opinion being heard and sometimes can even dominate the entire training sessions.
Impact: This character can have both positive and negative implications. On the negative side, all the participants may be frustrated with too many questions being posed by the individual and it can also create some kind of ill feeling due to the limelight being extensively shown to him/her.
- **Demand for Retraining:** This behavior is normally occurred when there is new timetable coordinator replacing the experienced ones. This is a common scene in any institutions due to the rotation of staff responsibility, change in management, higher posting and staff turnover. There are two main issues in connection to new coordinators. Firstly they need to understand the technique of creation of timetable in accordance of their department/institution demands, constraints and customary way. The other is the need to understand the functions of Timetabler Plus software. Another scenario is when existing timetable coordinator who has been trained once will request for another retraining program due to the fact that they only construct

the timetable twice annually and in between there could be a minimum of three months lapse. By the time they need to create new semester timetable they might have forgotten all the functions of Timetabler Plus.

Impact: Main impact of this kind of human behavior will contribute to the quality of the new semester timetable output. Not all institutions have annual budget for the retraining program or there is even some cases whereby there is no unanimous decision by all timetable coordinators to spend time and money for another session of training. The critical impact may even cause some timetable coordinators to abandon Timetabler Plus and even return the conventional (manual method) way.

The human character if ignored may have negative consequence on the success of timetable software implementation. It will be unfortunate if a timetable solution is rejected, not because it cannot cater for the organization needs, but due to the negative image portray by human as a result of their resistive behavior.

7 The Future of Timetable Solution

In our 3 years of timetable research and consultation within the Malaysian Higher Education institutions, the human behavior factors which were described earlier as consistent problems need to be eliminated in order for the single W concept to be achievable. In contrast, many software houses will argue that a good algorithm, friendly interface and informative output may solve all the timetabling problems. Even till this stage, our consultants have been working very hard to make Timetabler Plus the ultimate timetabling solution in the market. However, as time goes by and all the efforts are being done to accomplish this mission, our Timetabler Plus is still unable to solve the consistent problem caused by human behavior.

Therefore, we have come out with another solution which will result in the single W concept to be more achievable. Quality timetable is a perfect single W concept and we believe all efforts need to be aimed in achieving this mission. In this paper and conference, we will like to propose a service oriented timetable solution called Timetable Hub that will eliminate the problems caused by Human behavior thus resulting in a quality timetable output within the single W concept.

7.1 Timetable Hub: New Era of Timetable Solution

Every timetable software in the market including Timetabler Plus has been trying hard to be the ultimate timetabling solution with better algorithm, interactive interface and customized output while forgetting that a single W concept can only be achieved if there is no barrier in the human behavior. In every timetable process, each stage indicated at the single W concept outline the importance of every stage connecting one to another in order to produce a quality output. Normally the relationship between human behavior factors and software is critical at the Construct stage whereby any human elements may influence the result of the subsequent stage; Analysis and Output. Therefore it can be claimed that the quality of timetable lies heavily at this Construct stage which will then acknowledge the importance of relationship between human factors and the software itself. Table 4 outlines our observation on some of the most common human behaviours that have impact on software implementation (particularly in timetabling software).

Table 4 Human Behavior Factors vs Software

Human Factors	Behavior	Impact to Software
Age Factor		How do the icons, language and functions of software be able to accommodate different types of young, middle and old age contributors?
Attitude		Any software in the market will not be able to directly influence the attitude of the user. Definitely those with positive attitude will be able to finish the Construct process better and quicker than those with negative attitude
Computer Literacy		Will the system be able to provide valuable assistance (Video Tutorial, Easy Manual, Trainer and Help Support) with user friendliness of icons and functions for all level of computer literacy?
Environment Pressure		Will the system be able to influence how each individual in the timetable committee within similar institutions react to one another and thus contribute to the peer pressure? Will the system be able to eliminate ill feeling between colleagues? Will the system be able to reduce the pressure of timetable coordinators due to the Macro and Micro issues in the institutions?

Based on our survey, it is understood that within some of our clients, Timetabler Plus was able to gain a single W concept as they are able to anticipate micro, macro and human behavior issues at the planning stage. Commonly, just like any other software, human behavior will usually influence the Auto-Generate process in the Construct stage in the Timetabler Plus W cycle. Therefore, the introduction of Timetable Hub will be able to fill the gap between human behavior factors and software in the Construct Stage within the single W concept. Timetable Hub will be an application based on Software As a Service (SAS) where clients who engaged the service will be required to input the necessary data, constraints and requests (demands and customary behavior), while the 'Construct' stage will be handle by the service provider. The aim is to take out what the end users is not concern with. The system will Auto-Construct to produce few outputs that will then allow the user to choose from varieties of them based on their preferences. From the chosen output, user will then analyze with their preferences. Changes or request can be made in the given template. Once confirmation about the result, the output will then be able to be printed out in different type of format requested by the user. Further changes in the timetable can be accessible through the given templates and the process of output will then be repeated again.

Since the system will be 100% responsible (without any human interference) for the Construct stage, it will be able to eliminate the Human Factor vs System problem as discussed before. Even the changes to be made can be done easily and the output can be customized according to the clients demands. Furthermore the upgrading of the software or system will not hinder the clients ability to indulge in the creating quality timetable without even learning about the latest upgraded functions.

8 Conclusion

As we are currently living and highly dependent on technology to solve our daily problems, we sometimes failed to realize the importance of human behavior factors in influencing the quality of any kind of output. Constructing timetable has always been a challenge for software house to produce solution comprise of good algorithm, friendly interface and informative output. A single W concept can be the tool to measure the qualities of any kind of timetabling solution in the market. From a timetable consultant point of view, the new era for timetable solution is called Timetable Hub which is able to eliminate the human behavior in the single W concept cycle.

For more information about Timetabler Plus, please visit
<http://www.timetablerplus.com>.