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JISC



OAKLEIGH
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Timetabling and resource scheduling

A study of administrative processes

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Selected Acronym Glossary

Acronym	Full text
AOC	Association of Colleges
ARC	Academic Registrars Council
AUA	Association of University Administrators
AUDE	Association of University Directors of Estates
AV	Audio Visual
EMA	Education Maintenance Allowance
FE	Further Education
FEC	Further Education College
HE	Higher Education
HEI	Higher Education Institution
HR	Human Resources
ILR	Individualised Learner Record
JISC	Joint Information Systems Committee
MIS	Management Information System
PGCE	Postgraduate Certificate in Education
SROC	Student Record Officers' Conference
UCAS	University and College Admissions Service
VLE	Virtual Learning Environment

1.0 Executive Summary

1.1 Introduction

The purpose of this report is to summarise the common processes in use in higher and further education for timetabling and resource scheduling; considering the extent to which processes are supported by technology and identifying the most significant shared challenges. The report summarises a number of 'building blocks' which consultees have reported as the foundations for successful practice.

In addition the report considers the relationship between timetabling and resource scheduling and significant related processes, such as the curriculum management process.

The report has been informed by consultation with appropriate bodies representing the higher and further education sectors, and suppliers of timetabling information systems during the summer of 2008. This umbrella perspective has then been expanded through a series of 8 regional consultative workshops attended by those working with timetabling and resource scheduling processes at the institution level. In total 95 individuals participated in these workshops, representing 59 institutions from across the UK. Attendees reflected a broad range of management responsibility in relation to the processes, including both strategic development and transaction based activity.

1.2 Approaches to timetabling

Timetabling and resource scheduling processes are complex and mirror the diversity of higher and further education institutions across the UK.

For the purposes of enabling discussion and allowing stakeholders to engage with the processes described in this report, we have identified four common approaches to timetabling and resource scheduling. These are defined through the 'central' or 'distributed' management of:

- **Requirements identification:** identifying all requirements for teaching and learning activities, including room capacity, staff allocation, and consideration of any constraints impacting when and where the activity can be scheduled.
- **Scheduling:** identifying date and time of learning activity, taking account of any conflicts in staff, student and location availability.
- **Location allocation:** allocation of rooms and other resources (excluding staff allocation) to a teaching and learning activity, taking account of any conflicts in staff, student and location availability.

The following four model approaches have been identified:

- a. Distributed requirements identification, scheduling and location allocation.
- b. Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations.
- c. Distributed requirements identification and scheduling – central location allocation.
- d. Distributed requirements identification – central scheduling and location allocation.

Following these activities there will be a process of timetable refinement and publication (amending the draft timetable in order to overcome any identified issues and changes, and communication of this to staff, students and other stakeholders). This can occur at either a central or distributed level.

The approach adopted by any one institution is affected by a number of interlinked 'drivers' – that is to say internal or external forces which have influenced the development of timetabling and resource scheduling processes over time. Such drivers include, but are not limited to:

- Efficient use of resources including acceptable utilisation of available locations for teaching and learning and use of teaching staff time.
- Complexity of the curriculum, such as the extent of non-traditional provision.
- Locus of control relating to the procurement and implementation of supporting technology, and ownership of process development.
- Culture of the institution in relation to the prioritisation and accommodation of staff availability preferences, focus on student experience, and efficient utilisation of resources.
- Student recruitment and retention, including the measurement of student attendance through the timetabling process and direction of appropriate support.
- Physical layout of the institution including the existence of distinct campus sites with discreet processes for management of the timetable.
- Non teaching activities, such as the priority of using available locations in the delivery of conferences, or ad hoc room bookings.
- Enhancing the student experience through development of a 'student focussed' timetable.
- FE specific drivers including the monitoring of attendance and reporting on student enrolment and retention as a requirement of funding models within this sector.

It is possible to loosely associate these drivers with particular types of institution; however the heterogeneous nature of the education and skills sector means that there will always be an exception to the rule.

1.3 The relationship between timetabling and other administrative processes

Timetabling and resource scheduling processes are highly information intensive and require accurate collation of information relating to staff, students, curriculum, and locations – and association of these elements.

The outcomes of numerous administrative processes affect this information and mean that timetabling 'can feel like it's at the end of every other process'.

The most significant processes impacting timetabling are the:

- Curriculum management process through which existing programmes of study and modules are modified or discontinued, and new offering introduced.
- Processes providing information relating to student association with programmes of study, modules, and learning activities, including the application, enrolment, and progression processes.
- Staff human resources process through which staff workload and module allocation may be managed.
- Estates management process through which the existing pool of locations is extended, reduced and redeveloped.

Within the FE sector, the specified contact teaching hours for each student are likely to be the primary information driver for the timetabling and resource scheduling process, in order to produce a timetable that will meet the specified contact time requirements.

Numerous other process relationships are possible, and the extent to which timetabling and resource scheduling processes are dependent on information as an output of other processes is one of the major challenges facing timetabling staff.

1.4 The relationship between timetabling, curriculum development and delivery

Consultees identified that changes to the curriculum offering and the way in which this is delivered are likely to be determined by academic staff working within an academic department of the institution. It was suggested that few institutions fully manage impact on timetabling and resource scheduling processes when considering changes to the curriculum and the way in which this is delivered. The primary drivers for changes to the curriculum include the:

- Performance of existing programme offering and identification of modifications which may boost recruitment and retention.
- Workload of existing academic staff.
- Identification of new sources of income through delivery of new programmes.

Changes to existing offering and the introduction of new programmes of study are likely to be submitted to validation and quality management processes at both an academic department and central institution level. Consultees reported that likely resource implications were commonly considered at this point, such as the need for additional staff, and locations with specific resources, such as laboratories and portable equipment. However the extent to which these decisions are made using management information derived through the timetable, and the involvement of timetabling staff in advising likely implications on the timetabling process was identified as an area that could be developed.

Institutions which combine distributed requirements identification with central scheduling and location allocation may be more likely to consider timetabling implications during the curriculum management process. This is likely to be as a result of other drivers for this approach to management of the timetabling process, such as limited locations for teaching and learning, and complex delivery methods, such as many shared modules. Where institutions are more 'space wealthy', changes to the curriculum and the way in which this is delivered may have less of an impact on the timetabling and resource scheduling process.

1.5 The extent to which processes are supported by technology

Comments from consultees suggest that almost all institutions make use of a timetabling information system either across the institution or at a distributed level within certain academic departments. However the extent to which the full functionality of the system is adopted varies greatly. A minority of institutions or academic departments may develop their timetable without the use of a timetabling system. Where a system is used this will commonly offer differing levels of functionality in relation to:

- Storing information relevant to the timetable.
- Production of the timetable.
- Publication of the timetable.

More advanced functionality allowing linkage with other process areas may be available.

Whilst a number of workshop participants could identify specific functional issues with the timetabling system used at their institution, in the context of their work such as potential improvements to the user interface, many consultees reported that the current market offering is rich and extensive, with functionality of timetabling information systems often not fully implemented due to the need to invest significantly in major change

programmes and system integration; or the dependence on extensive accurate information as a result of other processes.

This is not to say that consultees have been unable to identify areas where the technical offering could be expanded, or that improvements resulting in the full use of currently available functionality cannot be implemented.

Within FE, functionality allowing recording student information, development of the timetable, and attendance monitoring may be available as part of an integrated product, or significantly integrated series of products. This is driven by the importance of reporting on student enrolment and retention within the FE sector. Within the higher education sector, system integration will be less common, although transfer of information from other systems to a timetabling information system has been reported.

Functionality to support the management of work placements at partner sites, and the existence of a single product enabling the management of timetabling and conference management are two areas that have been identified as challenging to manage through use of existing off the shelf systems.

1.6 The most significant challenges

The most significant challenges and constraints relating to timetabling and resource scheduling have been identified as:

Policy

- Conflicting priorities result in challenges to the timetable quality e.g. accommodating staff preferences regarding availability for teaching, against efficient utilisation of resources.
- Information held or potentially held within timetabling information systems may not be used to inform important decisions (e.g. modifications to the curriculum, development of the estate).

Process

- Information allowing timetabling planning is dependent on many other processes. Information is often available late and is subject to change, as a consequence planning of the timetable and preparation of the timetabling system may need to proceed with inaccurate data.
- A surplus of locations may be requested by academic departments in order to ensure adequate space. These requests may not be cancelled once delivery has started.
- Timetabling requirements may change for a number of reasons relating to the curriculum, staff, estate and student number changes.
- Release of inaccurate timetables results in stakeholder dissatisfaction.

Technology

- Full functionality of timetabling information systems may be challenging to implement; possibly due to system integration and staff training issues.
- Interoperability between timetabling and other institution systems may require significant investment.
- Functionality allowing arrangement and exchange of information relating to work-placements between learning providers and placement-providing partners may not be available as part of an integrated timetabling system product.

- A single product meeting the functional requirements to manage location resources for teaching and learning and for conferencing and private hire has been identified by several consultees as not currently available.

People

- Achieving change in relation to the timetabling process itself, and the nature of timetables produced for staff and students can be challenging due to cultural factors and historical expectations.
- There may not be a 'champion' to ensure that the timetabling process is seen as a strategic tool, and considered alongside other strategic considerations.

The above is a highly synthesised summary of the common issues, and individual institutions are likely to experience a number of specific challenges.

1.7 Building blocks of successful practice

Consultees have commented on the importance of a number of 'building blocks' which are the foundation for successful management of timetabling and resource scheduling processes. These building blocks combine an appropriately rich use of the institution's timetabling information system functionality, with coordination of information and processes across the institution – and are not necessarily related to either a central or distributed approach to management of timetabling and resource scheduling. Building blocks relate to a range of factors including:

- Existence and communication of appropriate **policy** influencing process design and managing stakeholder (specifically staff and student) expectations in relation to the timetable.
- The structure of the **processes** adopted and how these interface with other significant administrative processes operating at the institution.
- Implementation and effective use of enabling **technology**.
- Deployment of appropriately skilled **people** within, and to oversee the timetabling process, and networks to support their work.

The extent to which individual institutions within both the HE and FE sector consider their current practice against these suggestions is situation dependent, and the relative merit of developing practice in these areas would need to be considered in the context of each institution's priorities and current circumstances. The following is a concise summary of the key building blocks identified:

- A strong policy¹ encompassing the timetabling and resource scheduling process, communicating the nature of the process and who is responsible for this, and stating how the institution approaches the scheduling of learning activities in order to accommodate staff preferences, efficient use of resources, and enhance the student experience. This should be coupled with recognition of the extent to which timetabling is impacted by other institution processes and the value of considering timetabling and resource scheduling within the institutions strategic agenda setting.
- Consideration of the extent to which information outputs of processes significantly impacting timetabling can be made available at a point allowing accurate planning of the timetable. Use of timetable information and input from timetabling experts could also be incorporated into these processes.
- Where existing functionality of timetabling information systems is not used, institutions should review the benefits associated with implementing this

¹ Example elements of such a policy are included within section 8.1

functionality weighed against the need to change current practice and assign resources to achieving such changes. Additional functionality could be developed in the areas of integrated placement management, and conferencing.

- Establish a senior leader to 'champion' timetabling on an ongoing basis, and ensure that the impact on timetabling and resource scheduling processes is considered during the strategic agenda setting process. A sector wide forum to support timetabling and resource scheduling related personnel was also identified as potentially very useful.

In order to consider the application of these building blocks, and more specific context defined improvements, individual institutions will first need to review their existing approach. This study offers a useful profile of current practice, challenges, use of technology, and innovation throughout the HE and FE sectors, which can be used as a benchmark summary and act as a 'menu' of approaches and possible use of policy, technology, process, and people 'levers' to develop current practice.

JISC has a potential future role in both the dissemination of this report and development of any other relevant resources for use by institutions. An example of such a resource would be a good practice guide containing detailed case study material profiling a range of approaches to timetabling and documenting the processes supporting particular innovations.

2.0 Methodology

The objectives of this study were to:

- Describe the common processes involved in timetabling and resource scheduling for learning opportunities.
- Outline the extent to which these processes are supported by technology.
- Identify where in current processes common problems arise.
- Identify how re-engineered processes could be effectively supported by technology.

These objectives were met through the delivery of four distinct project stages.

Stage 1: Initiation: A project-initiation meeting was arranged with JISC to frame and agree the project scope; clarifying any points within Oakleigh's proposal and identifying any potential areas where the proposed approach should be flexed.

Stage 2: Information gathering and materials development: The purpose of this stage was to develop the lines of enquiry to be used throughout the study with reference to existing published reports and Oakleigh collateral. The detailed research tools required at stage 3 were also developed.

Key stakeholders including sectoral and representative bodies from the FE and HE sectors, and individual institutions from these sectors were contacted at this early stage in the project and invited to participate at stage 3.

Stage 3A Interviews with key stakeholders: We invited input through structured consultative interviews with representative bodies including the AUA, AOC, ARC, SROC and AUDE. The purpose of these interviews was to:

- Identify relevant initiatives involving these bodies pertinent to this study.
- Refine the initial series of 'straw-man' scenarios for use in the next consultation phase with individual learning providers.

We also interviewed representatives of two of the major suppliers of timetabling information systems within the UK in order to assess how suppliers presently view the market for new solutions in relation to timetabling information systems and gauge the principal drivers influencing suppliers' plans for development of their offering in this area. This analysis allowed the study to be informed by the 'supply side' as well as the 'demand side' (i.e. learning providers).

Stage 3B Regional consultative workshops: Those engaged with timetabling and resource scheduling processes at the institution level were invited to a series of 8 regional consultative workshops providing a forum to:

- Present and discuss the emerging scenarios, process issues and opportunities for improvement.
- Identify further process variances, issues, and opportunities for improvement.

In total 95 individuals participated in these workshops, representing 59 institutions from across the UK. Attendees reflected a broad range of management responsibility in relation to the processes, including both strategic development and transaction based activity.

Stage 4: Analysis and reporting: Outputs from previous stages of delivery were collated and analysed in order to develop a final report accessible to the JISC executive and other organisations with an interest in timetabling and resource scheduling.

3.0 Introduction and context

3.1 Organisational models and core processes

Consultees have identified the overarching theme in defining organisational structure as the extent to which timetabling is a centralised process within the institution. However the interpretation of ‘centralised’ or ‘distributed’ timetabling differs throughout the sector. In order to accommodate these differing perceptions it is helpful to disaggregate the processes involved in development of the timetable to:

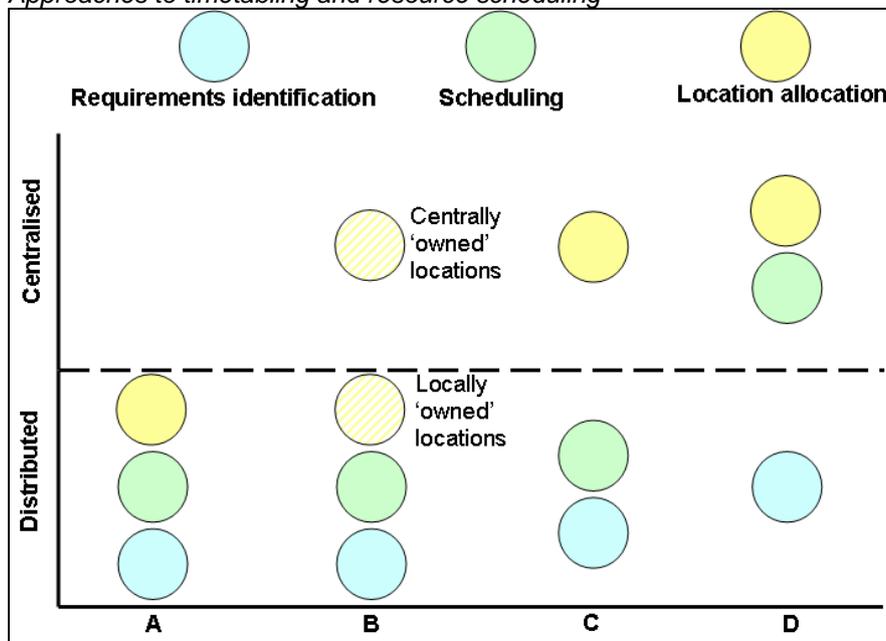
- **Requirements identification:** identifying all requirements for teaching and learning activities, including room capacity, staff allocation, and consideration of any constraints impacting when and where the activity can be scheduled.
- **Scheduling:** identifying date and time of learning activity, taking account of any conflicts in staff, student and location availability.
- **Location allocation:** allocation of rooms and other resources (excluding staff allocation) to a teaching and learning activity, taking account of any conflicts in staff, student and location availability.

These areas of administration can be managed through either a central function² (centralised), or within an academic department e.g. a school or faculty (distributed). Joint arrangements are also possible.

Following these activities there will be a process of timetable refinement and publication (amending the draft timetable in order to overcome any identified issues and changes, and communication of this to staff, students and other stakeholders). This can occur at either a central or distributed level.

Consultees identified that the most common combinations of these activity areas result in four approaches to timetabling and resource scheduling presented in the following diagram:

Figure 1 : Approaches to timetabling and resource scheduling



² It is also possible that some ‘central’ activity may take place at the faculty level – however for the purpose of presenting this simple model ‘centralised’ is taken to mean within a central administrative function of the institution.

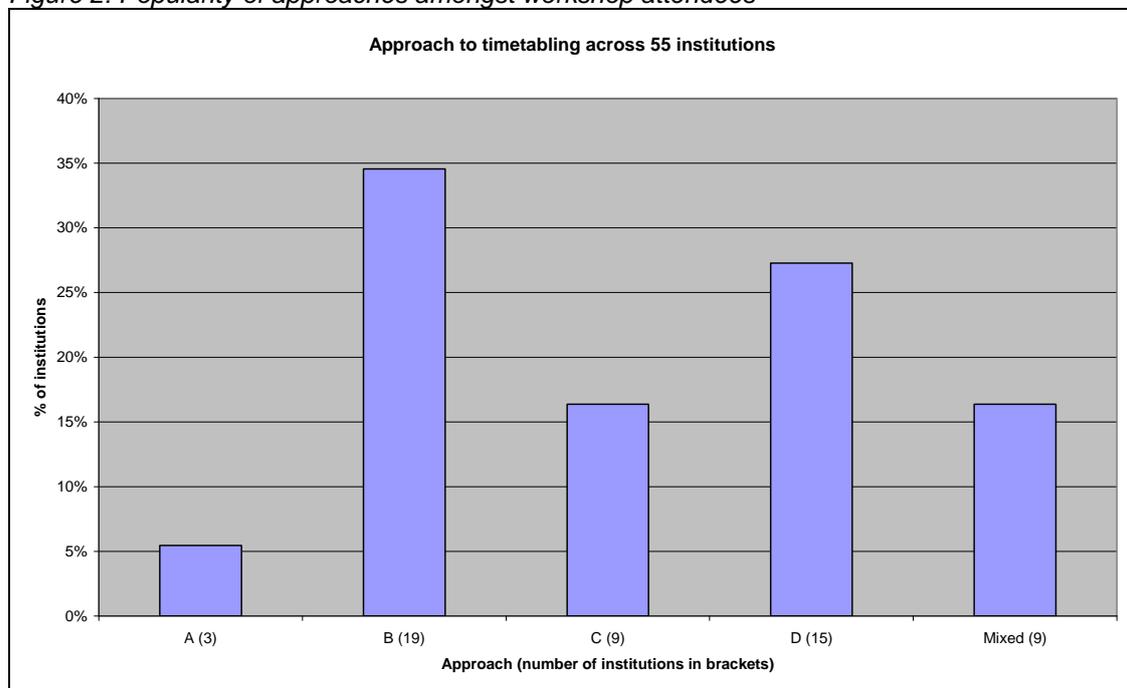
The approaches represented in figure 1 can be further described as:

- a. Distributed requirements identification, scheduling and location allocation.
- b. Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations.
- c. Distributed requirements identification and scheduling – central location allocation.
- d. Distributed requirements identification – central scheduling and location allocation.

Approach A is the most distributed model, and approach D the most centralised. Approach B involves joint management of location allocation, while this is centrally managed through approach C³.

Workshop attendees were asked to state which approach most closely resembles their institution's approach to timetabling. Of those able to comment, the following profile was reported:

Figure 2: Popularity of approaches amongst workshop attendees



The majority of participants were able to easily categorise their institution's approach as either of the four model approaches suggested, with *distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations* as the most commonly reported approach. Nine institutions reported that a mixture of these approaches was adopted at their institution⁴.

3.2 Level of resource

Consultees were less confident in making general statements about the levels of resource deployed in the delivery of the core timetabling and resource scheduling

³ Process model scenarios relating to each of these model approaches are provided in section 2 of the report annex.

⁴ A / B = 1 institution, B/C = 4 institutions, B/C/D = 1 institution, C/D = 1 institution, B/D = 2 institutions.

processes. However certain resource patterns have been linked to the four models identified above.

Figure 3: Resource deployment

Academic Unit Level	Central Function Level
A. Distributed requirements identification, scheduling and location allocation	
Distributed requirements identification, scheduling and location allocation may be carried out by academic staff (with administrative support as appropriate). Alternatively, there may be a timetabling officer and team associated with each academic department.	Staff within the estates management function may have a linked role in the assessment of space utilisation.
B. Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations	
Distributed scheduling and requirements identification, and allocation of locally 'owned' locations may be managed by academic staff (with administrative support as appropriate), or one of more academic department 'timetablers'. These staff may be locally managed, or managed through a central function.	A central 'rooming' function is likely to have one or more staff involved in the allocation of locations for timetabling purposes, and ongoing management of ad-hoc room booking (of pooled locations) for curriculum and other purposes. This function may have a coordinating role in relation to the timetabling process.
C. Distributed requirements identification and scheduling – central location allocation	
Distributed scheduling and requirements identification may be carried out by academic staff (with administrative support as appropriate). Alternatively, there may be a timetabling officer and team associated with each academic department.	A central 'rooming' function is likely to have one or more staff involved in the allocation of resources for timetabling purposes, and ongoing management of ad-hoc room booking for curriculum and other purposes. This function may have a coordinating role in relation to the timetabling process.
D. Distributed requirements identification – central scheduling and location allocation	
Distributed requirements identification may be managed by academic staff (with administrative support as appropriate) or by distributed timetabling staff. These may be managed locally or through a central function.	A central scheduling and location allocation team is likely to consist of several staff.

All consultees were confident that levels of resource adopted throughout the sector in relation to each of these models will vary greatly.

3.3 Drivers influencing approach to timetabling and the extent to which timetabling system functionality is utilised

The drivers primarily influencing the development of the different organisational models, process and systems include the following thematic circumstances and pressures. These are not listed in any order of priority.

3.3.1 *Efficiency*

Efficient use of resources, specifically locations for teaching and learning and the use of staff time, have been reported as significant drivers for a large proportion of contributing institutions.

Utilisation of locations (space) for teaching and learning is often measured and used to assess the quality of the timetable. Measures commonly include the frequency at which a particular location is used for teaching and learning. The occupancy (extent to which the full capacity of a location is used) may also be adopted as an additional measure of space utilisation.

Staff and space are costly resources and some institutions increasingly emphasise their effective deployment as a criteria for timetabling. This driver may be coupled with a degree of centrally coordinated location allocation in order to achieve the most efficient use of space across the institution. Many institutions will investigate making the most efficient use of existing resources through efficient scheduling of activities and locations, before considering expansion of the existing estate.

Pressures associated with an efficiency focus may include increased student recruitment, and patterns of delivery that are resource intensive (require several locations simultaneously). It has also been commented that comparatively efficient use of the existing estate is expected by funding councils before capital funding for estate expansion / redevelopment is made available.

This driver may be associated with a degree of either centralised location allocation, and possibly scheduling across the institution to maximise utilisation across the estate. Auto-scheduling⁵ of activities may be adopted through use of a timetabling information system.

Environmental, security, and cost saving considerations also influence the allocation of locations for teaching and learning activities. This is most significant for 'out of hours' teaching and learning activities which may be concentrated within a particular section of the estate so that the rest can be 'locked down'. As a result the energy use and associated environmental and financial costs across the estate are minimised, security of this 'locked down' estate is also increased. 'Staggered start' times for students and teaching staff have also been identified as a way to reduce the environmental footprint through reducing the need to travel at inefficient times of the day where transport emissions are increased due to congestion.

3.3.2 *Curriculum complexity*

A significant proportion of contributors commented that the complexity of the curriculum offering and the way in which this is delivered has a major impact on the timetabling process. Complexity can be increased by:

- Provision of programmes for 'non traditional' students, such as mature students - timetables must be both manageable to the institution whilst addressing the requirements of this important student group.
- Many shared modules across the institution – timetabling processes may need to be coordinated between different academic departments.
- The delivery of the curriculum may require complex scheduling of activities (the timetable may change regularly). One workshop attendee commented that 'it is increasingly hard to define the teaching day in terms of start and end, and regular

⁵ Scheduling of activities using functionality of a timetabling information system to produce a solution based on user objectives, such as maximising efficient use of locations.

learning activity times' an illustration of this is the need to produce weekly timetables for certain programmes of study – due to the irregular pattern of scheduled teaching and learning activities.

There were a mixture of views about whether a centralised or distributed approach is most suited to managing these complications. A significant degree of central coordination may be useful in the management of timetabling relating to shared modules, or meeting a standard range of student expectations across the institution. Central scheduling of complex delivery patterns has also been reported as successful, however a number of consultees felt this was best tackled at the academic department level.

Institutions may wish to respond to opportunities for business development through provision of courses at 'short notice' in response to an identified market demand or specific opportunity. This can result in 'last minute' changes to the planned curriculum and result in redevelopment of a previously drafted timetable. The extent to which this is viewed as undesirable may vary depending on how the benefits of increased student numbers are weighed against the administrative hurdles of amending the timetable as a result. By contrast, a number of small specialist institutions may have a small number of courses with a very established and rigid structure which changes very little following any curriculum management process.

In the view of a number of workshop attendees, the more complex the curriculum offering (including the provision of a large number of shared modules), the harder it is to design a timetable which is 'student friendly' as the constraints influencing when activities may be scheduled are much greater, resulting in the production of an 'odd' timetable – for example including activities scheduled at the start and end of a particular day with a significant gap in between, or involving excessive transfer between distributed locations. This view may be coupled with the concept that 'excessive' curriculum choice may be detrimental to the student experience for certain groups of students, particularly more traditional school-leavers who may value a more defined progression route.

3.3.3 *Locus of control*

Where responsibility for both the procurement and the operation of the timetabling information system resides within an institution can be a significant factor. It has been suggested that primary user requirements are often overtly influenced by the role of the sponsor or senior manager overseeing the investment. Examples cited include; space utilisation if the director of estates; administrative efficiency and effectiveness if the registrar; and wider scale change if the Vice Chancellor.

Management structures may have developed over a long time involving control and ownership of certain processes over decades and the estate may have developed around subject area needs. A popular view is that within post-92 institutions there is likely to be less ownership of subject areas in terms of estate (less estate) and buildings will have been for more generic use. This may link to a greater focus in post-92 institutions on the most efficient use of available space.

3.3.4 *Culture*

The culture of an institution is inevitably a key force for shaping how processes are administered or performed. The preferences of academic staff are perceived to have a massive effect on the timetable in some research intensive HEIs. The availability of research active academic staff for teaching is necessarily curtailed by their need to commit time to research activities and this may be an important consideration in developing the timetable. However it is also perceived that in some HEIs this necessity

has evolved into a culture that places the preferences of individual academic staff above other considerations, such as the student experience, efficient use of resources, and other measures of a 'good' timetable. Instances of where this culture is strongest are often found in institutions with highly devolved models for timetabling teaching and learning. The views of academic staff in relation to the quality of the timetable (desirability of scheduled times and allocated locations) may also affect student opinion in the event that staff comment on these factors to students.

In addition, teaching staff in certain academic areas may well be primarily employed by a partner, such as clinicians within an NHS Trust, or solicitors within a legal practice, or may be employed part-time. Depending on contractual arrangements it may have become established that teaching availability is agreed following the identification of other commitments within partner organisations i.e. those developing the timetable need to work around externally defined availability of these staff.

3.3.5 Student recruitment and retention

Pressures surrounding student recruitment and retention may be important influences on the timetabling process, as timetabling may often both drive and act as a constraint in relation to attendance monitoring. Some institutions are putting effort into system integration in order to better deliver targeted and proportionate support to 'at risk' students, as well as monitoring the impact of changing the timetable on retention.

In addition it is possible that 'the more reliant on funding from undergraduate provision, the more serious HEIs will take timetabling' and that these institutions may be more likely to operate timetabling to the individual student level (students are able to view their own timetable). This is important as this approach to timetabling, whilst designed to enhance the student experience also serves to assist institutions improve space utilisation. It was reported that attendance monitoring is an increasing area of interest amongst HEIs in particular, both as a way of measuring attendance in order to directly support and monitor the impact of changes to the timetable on retention, and also in relation to potential retention reporting requirements for certain international students as a result of recent UK boarders legislation.

3.3.6 Physical lay out of the institution

If an institution has several campuses and activities associated with a programme of study are to be scheduled at different locations, any implications for travel between different campuses will need to be considered during the timetabling process. However, multi campus institutions are often those which have been created from previously independent organisations. Therefore it is often the case that timetabling processes may not have been standardised across the institution, potentially driving inefficiencies and poor practice.

Certain locations may be considered 'undesirable' for certain reasons, for example a room with no natural light – this is also likely to inform timetable planning, for example ensuring that a single member of teaching staff or student group doesn't have activities scheduled in such locations for longer than a defined period of time.

Some institutions may wish to develop a managed surplus of space to allow for the redevelopment of other parts of the estate, and to manage risk associated with damage to the estate (for example fire or flood damage). It has also been reported that schemes exist where sections of the estate 'owned' at a distributed level will be redeveloped in the event that coordination of the use of this space is centralised (central location allocation adopted).

3.3.7 *Non teaching activities*

Priorities of the institution may include having Wednesday (or another day of the week) afternoon free for sporting or volunteering activities. It may be hard to avoid timetabling something during this period, however some institutions may timetable activities that are repeated elsewhere in the week, allowing students to be moved to another group if they wish to participate in these extra-curricula activities.

For many institutions, income generation through private hire of facilities for meetings and conferences has become a significant source of revenue. The extent to which institutions prioritise this practice can result in tensions between the objective of securing conference or meeting bookings several months or years in advance, and confirmation of the available space as a result of the timetabling process.

3.3.8 *Enhancing the student experience*

The strategic importance of the student experience has become an increasing priority for institutions. Students may have higher expectations in relation to all aspects of the student lifecycle, including the timetabling of their teaching and learning activities and access to this information. Many institutions may wish to release timetables for programmes of study well before the start of the academic year, and may well use timetables to market programmes of study to potential students. This is particularly relevant to students from non-traditional groups who may need to fit study around other commitments, such as those with young children. Producing a 'student friendly' timetable for all programmes of study may conflict with other priorities, such as the efficient utilisation of locations for teaching and learning, and the accommodation of teaching staff contact time preferences. Institutions may often struggle in defining where the 'optimum' balances between these (and other) priorities lie.

Ensuring that relevant student needs in relation to disability and discrimination are met through the timetabling process (such as step free access to all relevant locations, appropriate audio-visual provision, and not scheduling examinations to conflict with religious festivals) has developed as standard practice for institutions.

3.3.9 *FE specific drivers*

There are also important sectoral differences between HE and FE. In FE, timetabling is important for producing evidence in relation to student enrolment and retention, and securing funding in relation to this. The timetable and registers are used to prove funding is justified and this requirement has heavily influenced the establishment of centralised processes enabling adequate external reporting. For example, in FE it is likely that timetabling functionality will be available as an integrated offering of the institutions student management information system, and that this will be integrated with register generation and attendance recording processes. In the development of the timetable, the necessity to ensure all students are timetabled for their specified contact hours is likely to pervade all other priorities. Students in receipt of the Education Maintenance Allowance (EMA) are also likely to ensure their attendance is accurately recorded, and systems will need to be in place to manage the collection of this information.

The main drivers of timetabling in FE are that funding is responsive to the success of the provider and the enrolment and retention of students, any funding changes affecting the curriculum can have a huge impact on the planning and development of the timetable. Providers also have to be responsive to the local labour market through their curriculum management processes. One consultee commented that the sector 'tends of have less cash resources and space in comparison to the HE sector'.

3.3.10 Association of influencing drivers and approach to timetabling and resource scheduling

It is possible to generalise about association of the above drivers and the extent to which these relate to an institution’s approach to timetabling. Many of the drivers are loosely associated with particular types of institution such as pre- and post-92 HEIs, or FECs. The following table represents a summary of the likely associations identified by consultees, however a popular view is represented and these associations are by no means definitive. It is also possible that multiple approaches may be operating within the same institution (i.e. different academic departments participating in any centrally managed processes to different levels).

Figure 4: Association of common approaches and potential drivers / characteristics

Potential associated drivers / characteristics	Associated institutions
A. Distributed requirements identification, scheduling and location allocation	
<ul style="list-style-type: none"> • All space ‘owned’ at a distributed level • The estate may be comparatively large and academic departments may ‘own’ certain buildings • Efficient utilisation of space across institution less significant • Distributed knowledge of staff preferences influences process • Distributed knowledge of student needs and enhancing student experience influences processes • Auto-scheduling possibly used at a distributed level in certain academic departments • Timetabling processes may differ significantly between academic departments 	<ul style="list-style-type: none"> • Least common approach in HE • Present in FE
B. Distributed requirements identification, scheduling and allocation of locally ‘owned’ locations – central allocation of ‘high demand’ pooled locations	
<ul style="list-style-type: none"> • Significant distributed ‘ownership’ of space • The estate may be comparatively large and academic departments may ‘own’ certain buildings • Efficient utilisation of certain high demand locations is significant • Distributed knowledge of staff preferences influences process • Distributed knowledge of student needs and enhancing student experience influences processes • Auto-scheduling possibly used at a distributed level in certain academic departments • Timetabling system may be used centrally and at the distributed level, use of system functionality may vary • Modes of study may be complex and challenging to schedule at a central level 	<ul style="list-style-type: none"> • Most likely observed in pre-92 institutions • Present in FE

Potential associated drivers / characteristics	Associated institutions
C. Distributed requirements identification and scheduling – central location allocation	
<ul style="list-style-type: none"> • Little distributed 'ownership' • Possibly space-constrained • Efficient space utilisation important • Distributed knowledge of staff preferences influences process • Distributed knowledge of student needs and enhancing student experience influences processes • Management information on utilisation centrally collected • Auto-scheduling possibly used at a distributed level in certain academic departments • Timetabling system possibly only used centrally for the purposes of location allocation • Modes of study may be complex and challenging to schedule at a central level 	<ul style="list-style-type: none"> • Mixture of pre and post-92 institutions • Many small / specialist institutions • Present in FE
D. Distributed requirements identification – central scheduling and location allocation	
<ul style="list-style-type: none"> • Little distributed 'ownership' of space • Likely to be space constrained • Efficient use of space is core priority • Management information on utilisation collected centrally • Monitoring of student recruitment and retention may be a strategic priority • Auto-scheduling may be adopted across the institution • Timetabling system use and associated processes are likely to be standard • Staff and student preferences (including the student experience) managed through constraints identified at the academic department level – there is likely to be a supporting timetable policy • Modes of study may drive central management of scheduling (many shared modules), complex modes of study may be scheduled centrally through close working relationships with academic departments 	<ul style="list-style-type: none"> • Most likely observed in post-92 institutions • Present in FE

It is important to note that several of these models may be operating within institutions – for example half of the academic departments may make full use of centrally pooled location allocation (approach C) while the remaining departments may have significant resources that they allocate themselves (approach B).

Where space is locally 'owned' in any of the above approaches, this may be 'borrowed' by other academic departments within the institution if space is not available from their own pool of locations, or any centrally pooled resources.

4.0 The nature of common timetabling and resource scheduling processes

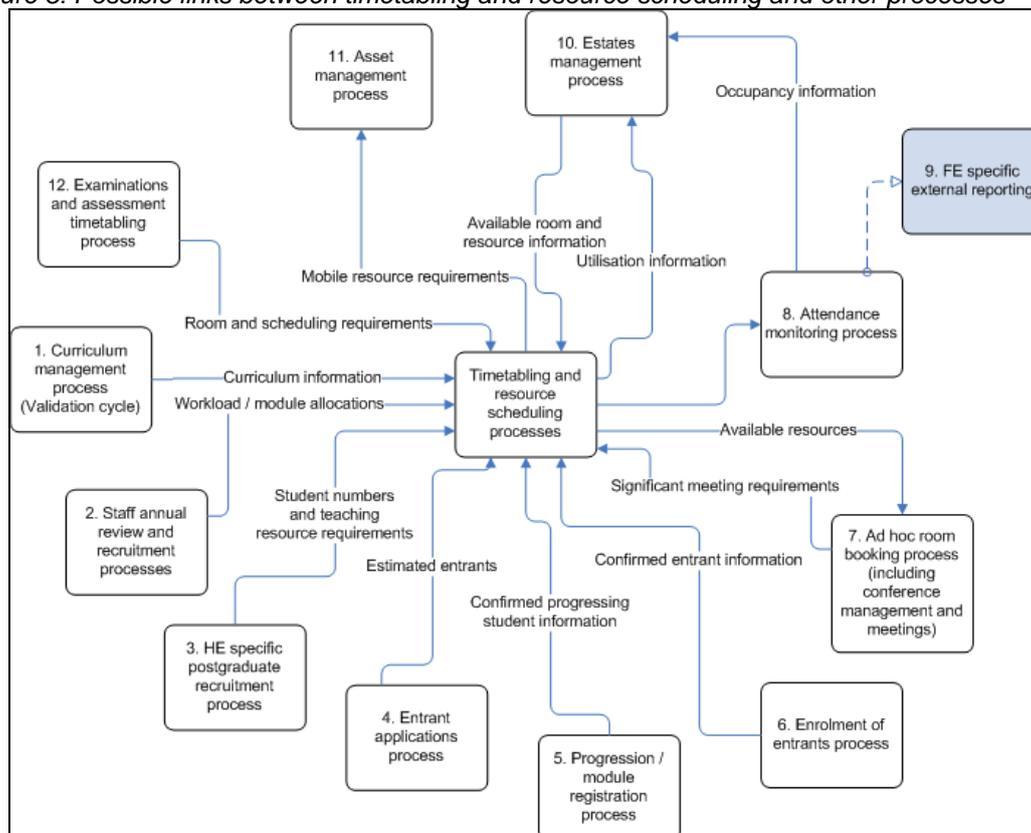
This study is primarily concerned with the process of timetabling and resource scheduling for teaching and learning. During the initial stage of consultative interviews it was the view of all consultees that ‘no two institutions will have the same approach to the delivery of their teaching and learning timetable’, and that administrative processes in this area will therefore be hard to compare between institutions.

In this section we first define the position of timetabling in relation to links with other administrative processes. Then further define the process of timetabling and resource scheduling itself.

4.1 Links between timetabling and resource scheduling and other processes

Timetabling and resource scheduling processes are very information intensive. The following diagram shows some of the potential relationships (in terms of high level information exchange) between timetabling and resource scheduling, and other institution processes. This is an idealised model of possible and potential process links, however the reality in many institutions is likely to be very complex. The purpose of this model is to highlight the most significant potential links ‘on one page’ to allow further comment. The model does not attempt to show all links between the associated process areas⁶.

Figure 5: Possible links between timetabling and resource scheduling and other processes



⁶ A number links between the satellite process areas are possible. Suggestions include: inclusion of recruitment strategies in the application process; student applications, enrolment, module choices and progression informing the examinations and assessment process; enrolment information (success of programmes) informs the curriculum management process; links between the curriculum and estates management processes.

This high level diagram is intended to show information exchange as a result of each process. It can be seen that timetabling and resource scheduling processes may be dependent on a significant proportion of other major processes within the institution. In addition, the timetabling process impacts many other significant areas of administration.

1. Curriculum management process (validation cycle)

This process involves the review of the institutions programme offering including the modification or discontinuation of existing programmes and modules, or the introduction of new programmes / modules. The process will usually involve several levels of approval and quality assurance at both a distributed and central level, and usually involve consideration of such factors as resource implications (available locations for learning activities and appropriately qualified staff do deliver these); impact on ongoing provision (such as the potential to combine module choices); and potentially the impact on the timetabling process.

Information relating to the curriculum for the coming session, including the programmes of study and associated modules and learning activities to be delivered, and possible module combinations will inform the timetabling process.

Any marketing research activity for new programmes of study may also include consideration of likely student numbers, and the needs of this group – such as likely availability for teaching and learning activities.

The relationship between timetabling processes and the curriculum management process is described in more detail at section 5.0 (some specific issues are also presented in section 1.1.1 of the report annex).

2. Staff annual review and recruitment processes

Many institutions will use a staff appraisal and workload review cycle to manage the workload allocation and associated modules with individual members of staff. The extent to which staff availability for contact time is determined through this process varies across institutions, and may be passed to timetabling staff through direct contact with individual academic staff, or be more formally managed through the line management structure.

Some institutions may use a staff workload model to document the employment status of staff, their contracted hours of availability, and the various activities required within this time. Information relating to staff association with particular learning activities and staff availability to deliver these activities is likely to inform the timetabling process.

Issues in this area for some institutions relate to a need for increased transparency in staff allocation to teaching and learning commitments, using the process as a mechanism of introducing changes to the historic timetable of staff, in order to make more efficient use of space in response to drivers associated with this priority. In addition, staff may leave the institution, and recruitment of new staff may alter the distribution of teaching workload within the academic department (some specific issues are presented in section 1.1.2 of the annex).

3. HE specific postgraduate recruitment process

The recruitment of taught postgraduate students can often have a major impact on the production of the timetable as specific information relating to this group is often only available following the enrolment of these students. Number of taught postgraduate students may be hard to estimate for the coming session and the curriculum is likely to be highly individualised involving significant post-enrolment student choice. One consultee commented that scheduling and accommodating taught postgraduate

provision can often ‘turn timetabling on it’s head’. Institutions may cope with this through the ring-fencing of certain locations to accommodate taught postgraduate activities, which can then be allocated separately from those used in production of the undergraduate teaching and learning timetable.

4. Entrant applications process

The application process through which institutions receive individual applicant information (in HE the vast majority of this is facilitated through the UCAS system) allows those concerned with planning the timetable to estimate the number of entrants likely to join each programme of study for the coming session. It is likely that number of applicants for any one year will be compared to historical information and used to estimate likely entrant numbers.

This information will then inform the timetabling process through estimated volumes of students entering each programme of study, module and therefore leaving activity. Within the FE sector, estimation of entrant numbers is likely to be based primarily on historical trend information.

Information relating to student needs may be collected at this point including any access requirements, work commitments, or absence for religious reasons.

5. Progression including module registration process

This relates to the progression of existing students to the next level of study, confirming the number of progressing students on each programme of study, module and therefore attending each associated learning activity. Where students are able to make module choices, these may be collected during the previous level of study in order to aid timetable planning for the coming session.

Issues in this area stem from fact that modules choices made during the previous session may change for a number of reasons upon or following progression, such as failure to qualify, or students deciding to change their module choices.

Information relating to student needs may be collected at this point including any access requirements, work commitments, or absence for religious reasons (some specific issues are presented in section 1.1.3 of the report annex).

6. Enrolment of entrants process

This process confirms entrant students at the first level of study and collection of any supplementary information within the student management information system. Information relating to the number of students who have enrolled, or the individual identify of enrolled students may be used within the timetable process to make any necessary adjustments to the timetable.

Information relating to student needs may be collected at this point including any access requirements, work commitments, or absence for religious reasons (some specific issues are presented in section 1.1.3 of the report annex).

7. Ad hoc room booking process

This is the process through which locations are ‘booked’ for any activity that is not considered part of the teaching and learning (or examinations and assessment) timetable process. This includes planned meetings, such as regular board or committee meetings, and ad hoc room booking. An important aspect of this is the booking of institution facilities for conference events as a source of income generation for the institution – this may be planned several years in advance; however the teaching and

learning timetabling process is likely to be annual which is a potential source of conflict. Significant meetings may be 'booked' before the timetabling process commences, however availability of locations for ad hoc meetings is likely to be determined following the development of the teaching and learning timetable. Recruitment activities such as open-days and other events may also be scheduled in particular locations prior to the development of the teaching and learning timetable.

8. Attendance monitoring

Monitoring of attendance is significant within the FE sector in relation to providing evidence in relation to student retention in order to secure funding allocations. The significance of attendance monitoring in the HE sector is increasing due to the potential to use this information in the management of student retention – for example directing support to students with poor attendance, and measuring the impact of activity scheduling on attendance levels. In addition, recent UK boarders legislation may require institutions to report on the retention of certain international students.

9. FE specific external reporting

FE providers are required to provide a number of specific reports to external funding bodies. This will include reference to both student enrolment and retention – which may be defined through reference to attendance. Management information systems used by FE providers are likely to have integrated functionality linking the student record with attendance monitoring in relation to the timetable. An example of such a report is the Individualised Learner Record (ILR) through which FE providers report on individual learners and their learning aims, an element of this includes student enrolment and retention. Recording attendance is also required in relation to the Education Maintenance Allowance (EMA).

10. Estates management process

The estates management process is used to measure the utilisation of space as a function of the frequency individual locations are used out of the total time available. In addition the extent to which the full capacity of the location is used (occupancy) may also be measured. Utilisation surveys are commonly used to assess efficiency, and may involve fines for academic departments where locations have been previously requested for teaching and learning activities, but are in fact not used. During our consultation activities it has been reported that this practice can be very successful, however behaviour has remained unchanged in some institutions.

The process is used to make decisions around the need to increase or reduce the capacity of the estate, and also how to redevelop and maintain particular locations. As such, information relating to available locations and the specification of these informs the timetabling process (some specific issues are presented at section 1.1.4 of the report annex).

11. Asset management process

The timetabling process is likely to result in the identification of mobile resource requirements in relation to certain teaching and learning activities. This information may be used by an asset management function within the institution to provide specific equipment at a particular time and location for the duration of a learning activity. Information from the timetabling process may also be used to reconfigure the layout of particular locations, such as furniture layout or implementation of partition walls.

12. Examinations and assessment process

The examinations and assessment timetabling process results in the production of the examinations and assessment timetable. This is usually managed separately from the timetabling process for teaching and learning by those with overall responsibility for examinations and assessments at the institution. It is likely that locations suitable for holding examinations will be 'booked' before the development of the teaching and learning timetable to ensure that these locations are available during the institutions examination periods.

4.2 Definition of timetabling and resource scheduling for teaching and learning

In order to rationalise and describe the processes involved, we have:

- **In this section**, defined the timetabling process, identified the sub-processes involved for all institutions, and considered how these are related⁷.
- **In the report annex** described each of the sub-processes in detail, and adapted the simple model of related sub-processes to accommodate the four main approaches to timetabling (identified at section 3.1).

Objective:

The process must produce a scheduled (positioned in time) and resourced (staff and location allocated) representation of teaching and learning activities allowing the delivery of all programmes of study operating at the institution.

Actors:

Timetabling officers (central / devolved remit), academic staff, students, management information systems

Overview:

The process involves the development of timetables (for students, staff, programmes of study, modules and locations) following collation of all required information. Timetables are verified and made available to all relevant stakeholders. Ultimately the timetable (all timetabled activity) must satisfy a number of constraints (must be satisfied in order to achieve a 'workable' solution) and criteria (desirable characteristics of the timetable based on the institution's objectives, allowing production of a 'good' timetable).

Constraints include:

- Location element – rooms must be large enough and have essential resources.
- Availability element – rooms must be unoccupied; resources must be available; staff may only teach one of their commitments at any one time, and other commitments may not occur concurrently; students may only attend one commitment at any one time, and other commitments may not occur concurrently.

If these constraints are satisfied then students and staff will be able to attend all required teaching and learning events for each programme of study. Events will be adequately resourced.

The extent to which criteria influencing the timetable are considered is determined by the individual approach of each institution and the relative importance associated with each criterion. It has been reported that a compromise between these competing priorities

⁷ Thinking in this area was initially informed by reference to: B. McCollum, University Timetabling: Bridging the Gap between Research and Practice, 2006

where some or all of these criteria are only partially satisfied is commonly achieved. For this reason the extent to which a timetable can be considered 'good' is dependent on an individual institution's view as to the importance of these criteria.

Criteria include:

- Student focus – the timetable takes account of likely student needs, and where required individual needs are accommodated.
- Workload distribution – staff and student workload (contact time) is balanced throughout a time period (e.g. a week).
- Transfer time – there must be sufficient time for staff and students to comfortably move between event locations.
- Research time – academic staff may have protected research time (non-contact) within the timetable.
- Staff availability – the availability (contact-time) preferences of academic staff may be accommodated.
- Consistency – events relating to a particular teaching and learning component are located in the same venue, and the member of staff teaching sessions remains consistent.
- Efficient use of resources – including locations, supporting resources, and staff contact time.

Institutions will commonly evaluate the timetable in relation to these and other criteria as a means for improvement.

Information systems:

A timetabling information system is commonly used by institutions throughout the timetabling process. The level of functionality available varies with the sophistication of the system adopted; however the level to which institutions fully implement the functionality of these systems also varies. The level of user intervention in the development of the timetable will vary depending on the functionality of the system and preferences of the user.

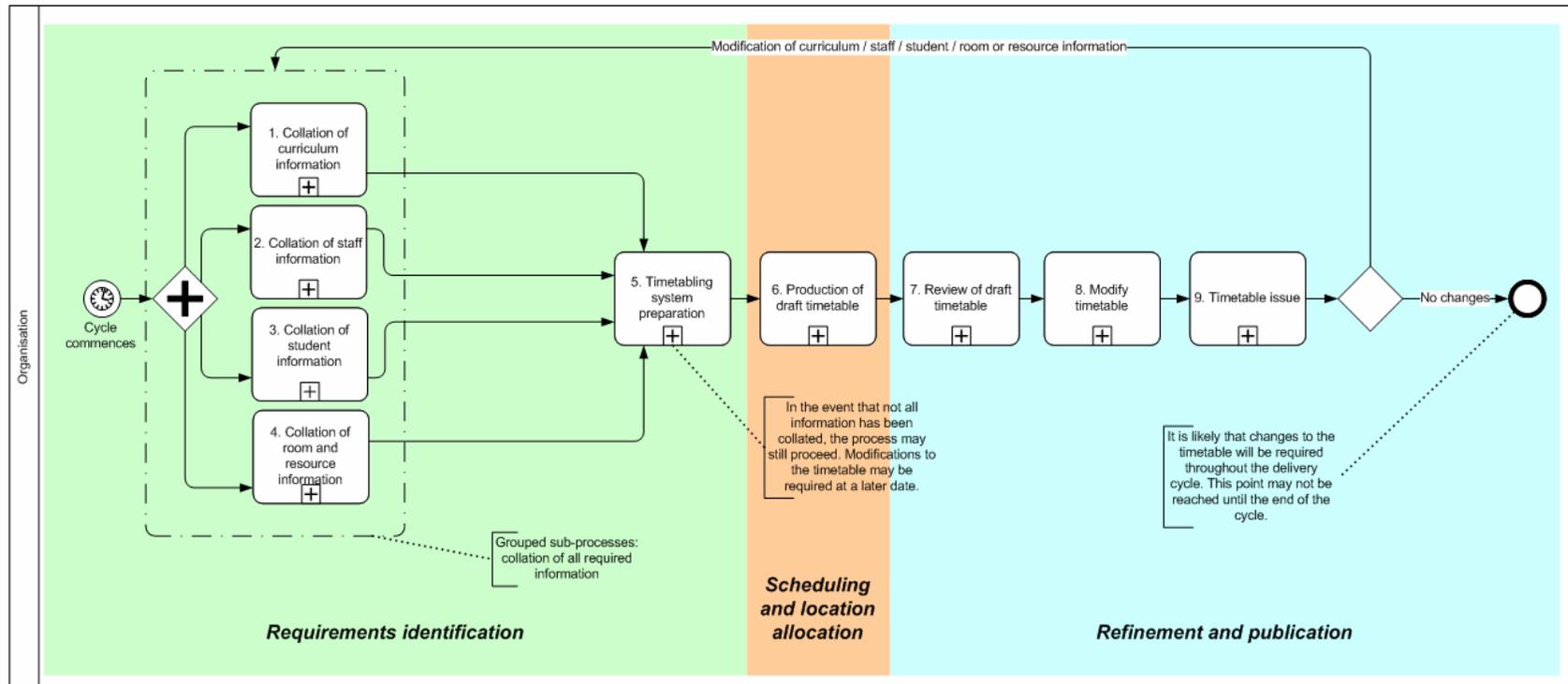
Timetabling is a very information intensive process, and information held within multiple information systems may be used including:

- Student management information system.
- Staff HR management information system.
- Estates management information system.
- Specific in-house systems holding a range of information, for example in-house systems containing programme and module information.

4.3 Sub-processes of timetabling and resource scheduling for teaching and learning and how these are related

Timetabling and resource scheduling as a process consists of a number of sub-process areas. The following figure presents the relationship between these sub-processes as a simple flow diagram. There are a number of limitations with such a model – however the purpose of this diagram is to allow organised presentation of our finding through reference to a simple diagram 'on one page'.

Figure 6: Timetabling for teaching and learning



The process of timetabling and resource scheduling commences with the collation of all information required in order to proceed with timetable development (1-4). Information is then commonly organised within a timetabling information system (5). Differing levels of functionality will then be employed in order to produce the draft timetable (6), which is then commonly reviewed by those with academic responsibility for each high level subject area (7). Any identified modifications will then be made (8), and the timetable issued through various means (9). It is likely that modifications to the timetable will be required on an ongoing basis, and the timetable will require re-issue.

Limitations with this model:

- The diagram cannot reflect the significant changes to curriculum, staff, estate, and student information that can occur throughout the timetabling process and the impact this has on production and modification of the draft and issued timetable.

- Some institutions may deliberately avoid certain language suggesting that the timetable is not dynamic, such as 'draft' and 'publication date'. This is combined with an ethos that changes to the timetable may be necessary throughout the curriculum delivery period and should be potentially expected by staff and students.
- Collation of information (1-4), particularly curriculum and staff information is likely to continue beyond initial organisation of information within the timetabling system (5). It is common practice to roll-over and subsequently amend information within the timetabling system as a starting point for planning.
- Separate processes may occur in order to produce timetables for staff, students, locations and modules.
- There may be several review and modification cycles (7 – 8) before issue of the timetable (9).
- The model assumes use of a timetabling information system (5).
- For some institutions the process may be better represented as a cyclical ongoing process.

Each of the sub-processes shown in the above model is described fully within the report annex⁸ along with a summary of reported variation, associated issues and challenges, and examples of innovation.

⁸ Annex section 1.1

5.0 The relationship between timetabling and resource scheduling, curriculum development and delivery

The scope of this study extends to consider actual and potential links between timetabling and resource scheduling, curriculum development and planning, and course delivery. We have investigated the extent to which:

- Links between these three process areas are in evidence and recognised as beneficial.
- Timetabling and resource scheduling processes have been adapted to accommodate changing modes of study.
- Specific examples of innovation are in evidence.

In this section we present our findings in relation to each of these lines of enquiry⁹.

5.1 To what extent are links between these processes in evidence / recognised as beneficial?

Consultees identified that changes to the curriculum offering and the way in which this is delivered are likely to be determined by academic staff working within an academic department of the institution. The majority of consultees suggested that few institutions fully manage impact on timetabling and resource scheduling processes when considering changes to the curriculum and the way in which this is delivered. The primary drivers for changes to the curriculum include the:

- Performance of existing programme offering and identification of modifications which may boost recruitment and retention.
- Workload of existing academic staff.
- Identification of new sources of income through delivery of new programmes.

Changes to existing offering and the introduction of new programmes of study are likely to be submitted to validation and quality management processes at both an academic unit and central institution level. The majority of consultees reported that likely resource implications were commonly considered at this point, such as the need for additional staff, and locations with specific resources, such as laboratories and portable equipment. However the extent to which these decisions are made using management information derived through the timetable, and the involvement of timetabling staff in advising likely implications on the timetabling process was identified as an area that could be developed. One consultee noted that timetabling and resource scheduling is usually 'very much at the end of every other process'.

Institutions which combine distributed requirements identification with central scheduling and location allocation may be more likely to consider timetabling implications during the curriculum management process including consideration of the relationships between different modules and programmes and how these will be affected, and how changes to delivery patterns will affect the timetable – this was reported by a small number of institutions. This collaborative approach is likely to be as a result of other drivers for a centralised approach to management of the timetabling process, such as limited locations for teaching and learning, and many shared modules. Where institutions are more 'space wealthy', changes to the curriculum and the way in which this is delivered may have less of an impact on the timetabling and resource scheduling process.

⁹ Section 1.1.1 of the report annex contains further information on collation of curriculum information within the timetabling process.

Earlier planning and confirmation of the curriculum to allow more advance planning of the timetable (and potentially earlier timetable release) may be challenging due to a focus on delivering the current curriculum, and taking advantage of opportunities for curriculum development 'at short notice'.

5.2 To what extent have timetabling and resource scheduling processes been adapted to accommodate changing modes of study?

Up to half of consultees identified that complexity of curriculum delivery is continuing to increase. Examples of complexity include scenarios where teaching and learning activities are not scheduled to a standard rhythm over time, for example one week of scheduled teaching and learning activities dispersed through independent study time, followed by one week of whole day events, such as practical training and work-placements. Further variations may then proceed throughout the academic cycle. A number of consultees suggested that such complex delivery modes are likely to be scheduled at a distributed level, as distributed requirements identification combined with central scheduling and location allocation requires transfer of a significant amount of distributed knowledge to a central function, however a small number of workshop participants reported examples of central scheduling and location allocation for these complex modes, requiring a close working relationship between the central timetabling function and the academic department concerned.

A small number of consultees concerned with production of the timetable commented on the importance of accommodating innovative pedagogic developments relating to timetabling of teaching and learning activities (such as some of the complex modes described above), however this same group commented that implications of this (such as a potential need to repeat teach certain activities, or extend the length of the teaching day or delivery period to accommodate all constraints) are not always fully considered during the planning of these changes.

In relation to complex modes of study, where programmes are delivered jointly between academic areas or modules are available to students on multiple programmes of study throughout the institution, this is a driver for distributed requirements identification combined with central scheduling and location allocation, avoiding uncoordinated separate development of the timetable within academic departments. A small number of consultees suggested that, combined with appropriate system functionality, such an approach allows consideration of the practicalities of timetabling progression pathways and considering which module combinations can be offered.

In addition there was a strong view from many consultees that activities 'which do not require a room' are unlikely to be scheduled within student timetables. This is relevant to the impact of programmes of study involving significant independent learning, such as the following modes of study:

- Distance and e-learning.
- Delivery with other partners (activities at the partner site may be provided through a separate timetable issued by the partner).
- Work-placements and work-based learning (any timetable required may be provided by the placement provider).

While a number of consultees recognised the benefits of timetabling activities in relation to these modes of study, specifically the monitoring of staff and student workload, it was also noted by a small number of consultees that students on these programmes benefit from the independence afforded through flexible study, and that there would be financial

implications associated with extending timetabling and resource scheduling processes to manage these activities.

For delivery involving other partners it was commonly reported that timetables will be made available to students with the relevant time-period marked 'study at partner institution / work-placement', any supplementary timetable information is then likely to be made available to the student by the partner institution as a separate timetable.

A small number of consultees reported that 'too much student choice' through the curriculum structure is something that has been identified as potentially detracting from the experience of certain types of students, particularly more traditional school-lever entrants who may appreciate a more defined, structured progression path. A minority of workshop attendees reported that unpopular programmes of study (maybe involving unusual shared module combinations) will continue to be made available, and need to be accommodated within the timetable, even though recruitment to these programmes is very low.

5.3 To what extent are specific examples of innovation in evidence?

Consultees were asked to comment on their experience relating to a number of specific examples of innovative practice relating to links between timetabling and resource scheduling, curriculum development and planning, and curriculum delivery. Examples of current and potential practice identified by consultees, along with benefits and limitations are described below. These suggestions and examples of reported practice were collected from interviews with sector body nominees, timetabling system suppliers, and small groups of institutions attending workshop events.

Shared calendars enabling staff and students to check the availability of, and book, rooms and resources needed for learning

Many timetabling systems allow 'clients' to view available rooms and book these. This can either involve administrator verification or can be automatically approved. Some systems will allow synchronisation with personal calendar systems allowing clients to view available resources in relation to their own availability. An example of an institution publishing staff and student timetables within the calendar of a web-access product has been reported.

A small number of workshop participants suggested that student access to such a system could be used in the booking of certain media or science laboratories and specific resources, such as psychology interview rooms. This could also be relevant in the booking of 'sections' of flexible learning space. 'Booking' space in this way may also be relevant to programmes of study where students may be 'off site' attending placements for large periods of time (e.g. a PGCE programme), and staff may wish to book appropriate space for ad hoc 'on site' activities (such as review, module option consideration, and careers advice meetings) as and when these are required.

It was identified that forward 'booking' of locations and other resources by students may have to be restricted to a particular period of time, for example two weeks in advance. In addition, the availability of locations and resources wouldn't be confirmed until the timetable had 'settled down' following enrolment.

Concerns relating to such a system include the fact that staff and students may over-book and not use space for a number of reasons (back-up, class sizes are smaller than expected), which has a negative impact on utilisation. Staff could effectively change the timetable in this way, informing students that a new location and time has been

introduced.

Other issues relate to limiting what can be seen by clients, and managing who has priority booking rights in relation to high demand resources. This can be a particular issue when meeting space is at a premium.

Curriculum development and delivery based on student-centred timetabling, focused on helping, especially non-traditional or work-based students fit study round their other commitments

Factors affecting student preferences and availability for attending teaching and learning activities often relate to their personal needs including:

- Work commitments.
- Religious commitments and observations.
- Family commitments.
- Other programme of study commitments.

Needs relating to disability also influence timetabling, for example the need for step-free access to a scheduled location.

The majority of consultees consider 'student centred' to be more subtle than individually delivered curriculum design – institutions are likely to view their distance / e-learning programmes as offering this. It is more common to consider a timetable 'student centred' if it takes account of likely student preferences where possible, however this may be necessarily defined by the popular rather than individual need. During workshops, small groups of attendees suggested the following practical manifestations of a 'student centred' timetable:

- Publishing accurate timetables in advance of the delivery period.
- Activities are well balanced throughout the teaching week.
- Avoiding imbalance of sessions within the same day (i.e. avoiding scheduling at the start and end of the day, with nothing in between).
- Effective communication of any unavoidable timetable changes to staff and students (including use of emails and text messages) e.g. activity cancellation due to staff illness.
- Offering common free time for sporting / volunteering activities across the institution (many HEIs avoid scheduling teaching and learning activities on Wednesday afternoon for this purpose).
- Offering an activity free day each week.
- Ensuring allocated locations are appropriate.
- Aiming to provide students with 'a sense of place' through allocations within a particular zone of the estate.
- Late starts for courses with more mature students, to allow for travel and childcare arrangements during the early morning.
- Multiple instances of the same class during the same day or week. This may occur in relation to part and full time delivery of the same programme / module. Students may be able to attend either session following discussion and agreement with academic department staff.
- Availability of recorded lectures / learning activities.
- An extended timetable, or teaching week allowing more teaching and learning activities to be scheduled.

The extent to which each of these examples would be appropriate across an institution, within an academic department, or for an individual programme of study or module is

dependent on the nature of the institution, and the curriculum. A small group of workshop participants suggested the following considerations during curriculum design and development of the timetable:

- Identification of programmes of study where consideration of student needs is most significant.
- Profiling of the student population – for example through the use of student union surveys.
- Collecting preference information through the interview process.

While these activities have been identified as useful sources of information on which to base decisions in this area, it would become extremely limiting if all preferences were accommodated – if not impossible. One participant noted that sometimes different student demographics can be significantly represented within the same cohort of students attending a teaching and learning activity – meeting the needs of all these students can therefore become more challenging.

A small number of workshop participants commented that the less complicated the curriculum (fewer shared modules, more regular delivery), the easier it may be to plan a 'student friendly' timetable for individual programmes of study.

If individual student information is held within the timetabling system then it should be possible to view the timetable for an individual student and accommodate any special requirements as far as possible. This is particularly relevant in relation to accessibility requirements. Publication of the timetable online, and swift notification of any timetable changes (e.g. via text message) are also seen as an important way of supporting the needs of students particularly affected by other commitments, this practice was suggested by a small number of consultees.

Consultees identified various merits of both a centralised or distributed approach to timetabling in producing a 'student centred' timetable. For example, a more centralised approach may allow institution wide commitments to be managed – such as an entitlement to one activity free day per week; however a more distributed approach may be more sensitive to student feedback and allow 'tweaking' of the timetable to accommodate individual issues e.g. moving students between activity groups.

Where a programme of study or module contains a number of identical teaching and learning activities where a student cohort is divided into smaller teaching groups (such as tutorials or certain practical sessions), identical teaching and learning activities may be scheduled on a range of dates, at a range of times. A minority of workshop participants reported timetabling information system functionality that allows students to view these scheduled sessions online and elect to attend the required number of sessions based on their preferences, the capacity of the session not being exceeded (i.e. on a first come first served basis), and any of the constraints affecting their timetable not being compromised. In this way students are given some flexibility to build elements of their timetable around other commitments. Use of individual student information within the timetabling information system has been reported as a pre-requisite for enabling this functionality.

Examples of learning from evaluation of the timetable have also been reported including formal review of processes and the timetable itself, informal review drawing on student feedback, and feedback from external examiners in relation to the quality of the examinations timetable.

Timetabling, scheduling and workload management for courses involving work placements

Where asked, all small groups of workshop participants reported that work-placements are unlikely to be shown in the student timetable in a detailed way. A small number of consultees suggested that such activity will be shown as 'work-placement', with the content of this managed through the partner providing the placement. Monitoring of attendance and workload may occur at the academic department level.

Timetabling systems are likely to include functionality where the need for a break between activities is identified.

A small number of workshop participants suggested specific programmes of study where timetabling of work-placement activities would be beneficial includes courses involving medical work-placements. The extent to which activities need to be timetabled depends on the nature of the placements, however arranging the placement and communicating the location and duration of this to students was reported as an area for development of technical support. Automating the submission of student placements to partner sites, with potential shared access to student timetable information has been reported as a meaningful goal.

One workshop participant commented that those charged with coordinating placements on the side of the placement provider (depending on contractual arrangements) may have a significant influence on when placements will be scheduled. This can have a major impact on the scheduling of activities delivered by the learning provider, and affect teaching patterns.

Timetabling and resource scheduling for flexible and learner-negotiated or designed courses

A minority of institutions reported that several teaching events may be created and students may be able to nominate which event they would like to attend. Some timetabling systems do allow students to pick which sub-groups (e.g. tutorials / seminars) they would like to attend through an online interface, once these events have been previously scheduled.

One consultee suggested that the scenario of flexible (or more specifically individualised) learning arrangements may be relevant to flexible learning arrangements when students have failed to pass particular modules, and individual re-sit arrangements may be required.

Up to half of consultees reported that institutions take the view that this type of provision is distance / e-learning and whilst timetables could theoretically be produced for these activities there are value for money issues and many students value the independence of managing their own commitments. It is economically unlikely that taught courses would be made available for an individual. Part time students may be expected to fit around their timetable which is a driver for early release of this.

One consultees suggested that programmes of study offering 'combined studies' where students are able to study any modules permitted by the timetable could be considered learner designed or negotiated. This may practically require the 'blocking' of certain subjects to take place at the same time, reducing the possible module combinations, however subjects made available through such a programme could be planned in relation to likely student preferences.

A small number of workshop participants reported that the timetable for programmes of study may be modified for the next delivery period as a result of student feedback, and

may be interpreted as designed in response to learner negotiation.

One consultee reported a scenario where an academic department is very 'space rich' allowing production of the full timetable (including scheduling and location allocation) followed by students selecting which modules, and therefore learning activities they will attend in the light of this information.

Links between timetabling, capacity planning, and management of staff and student workload.

The development of workload models for both staff and students has been identified as a useful tool by a small number of participants when considering workload and distribution of this through the delivery period. Use of an in-house automated workload model has been reported by one institution allowing balancing of staff and student workload during the scheduling of activities.

One consultee commented that the increase in distance and e-learning has an impact on workload management processes with consideration of associated workload requiring a different model to that for more traditional 'contact time' based approaches. The increased popularity of flexible staff working, such as home working also needs to be accommodated.

Timetabling systems commonly allow workload targets to be set and reported on in relation to both staff and student workload. Additional commitments can also be associated with contact time, such as planning and marking time, although functionality supporting this more detailed recording and management of workload may have become available more recently, and the extent to which it has been adopted throughout the sector is uncertain.

One consultee commented that there is a lot of potential for development in this area through greater use of management information, however some issues may arise through greater transparency of individual workload allocation. Issues may also arise where staff co-deliver modules initially and then delegate depending on the interests of the students.

Some institutions may benefit from greater analysis of impact on the timetable during the validation cycle, this could be enabled through modelling of any proposed changes through use of a timetabling information system as reported by a small number of institutions. This may require improvements to the early availability of accurate data used during the planning stages of timetabling.

One contributor reported the ongoing development of a simple in-house web-based tool designed to allow broad access to a record of 'who is doing what' in relation to the delivery of programmes of study and individual modules. It is envisaged that this tool will allow all staff concerned with the delivery of a programme / module to understand their responsibilities and identify the responsibilities of colleagues.

Use of flexible learning spaces

Up to half of consultees suggested that this is increasing in popularity as a method of improving space utilisation, and has been promoted by the funding councils. Partitions, movable equipment, multi-functional labs etc. are all increasing in popularity.

Timetabling systems commonly account for the use of the space as either a single room, or partitioned elements, preventing concurrent booking as both a single and divided space.

A small number of institutions reported that room set-up will be managed through a separate process. Facilities staff may manage room layout and AV equipment may be managed through an AV booking system.

One consultee suggested that the benefits of this approach may be limited with the overheads associated with facilities personnel to implement partitions / move furniture / other resources. It is also not possible to locate certain activities on either side of a non-sound protected partition.

6.0 The extent to which processes are supported by technology

Comments from consultees suggest that almost all institutions make use of a timetabling information system either across the institution or at a distributed level within certain academic departments¹⁰. However the extent to which the full functionality of the system is adopted varies greatly. A minority of institutions or academic departments may develop their timetable without the use of a timetabling system. Where a system is used this will commonly offer differing levels of functionality in relation to:

- Storing information relevant to the timetable.
- Production of the timetable.
- Publication of the timetable.

In addition more advanced functionality allowing management of other process areas may be available.

6.1 What is the core functionality of timetabling information systems?

Timetabling information systems are commonly used by institutions to facilitate elements of the timetabling process. A sample of the functionality identified through our consultative interviews includes the following capabilities, presented in relation to the sub-processes identified at section 4.3.

6.1.1 *Collation of information relevant to timetabling and resource scheduling (sub-processes 1-4)*

Storage of information relating to students, staff, locations and other resources and association of these elements.

6.1.2 *Preparation of the timetabling system (sub-process 5)*

Recording of curriculum structure, for example the number of lectures, seminars, tutorials and other activities associated with a module, allowing scheduling of all teaching and learning activities associated with a module.

Where individual student information is held, allocation of students to sub-groups (tutorial / seminar groups) in relation to modules.

Dynamic interface with other management information systems to access accurate up to date information (potentially student, HR, estates and other information systems).

6.1.3 *Production of the draft timetable (sub-process 6)*

Scheduling of activities associated with staff, students, location and other resources through visual positioning of teaching and learning activities within a screen-view of available schedule positions.

Functionality allowing identification of conflicts in the scheduling of activities through concurrent scheduling of staff, locations and other resources, student module options and other constraints.

Online 'client' interfaces allowing room-booking by staff and collection of room and resource requirements for central resource allocation.

¹⁰ Examples of technology use are also described throughout section 1.1 of the report annex

Auto-scheduling functionality allowing scheduling through use of conflict resolution functionality and accommodation of user-defined preferences such as availability of staff, students and resources; the need for adequate breaks between teaching; and the efficient use of resources.

6.1.4 Timetable issue (sub-process 9)

Production of timetable information suitable for publication to a range of end-users, either through paper distribution or accessible online.

6.1.5 Managing the interface with other institution processes

Production of management information relating to the utilisation of rooms, and the contact teaching hours of staff and students.

Collation of information relating to, and management of staff workload – both contact-time and other commitments.

6.1.6 Implementation

Available functionality may not be fully implemented for a number of reasons. Of those institutions represented at consultative workshops, the vast majority reported use of a timetabling information system at some level within the institution, however relatively few indicated that the available functionality of the adopted product was 'stretched' at their institution.

A product profile is provided at appendix III. The purpose of this case study is to provide richness around the functionality listed above, including the information requirements, and input from the system user.

6.2 How could information systems used in timetabling and resource scheduling be developed in order to better support processes?

In the view of the suppliers interviewed there are a number of development areas that could be investigated in order to improve the functionality offered by timetabling information systems and the way in which these are commonly used within institutions. The extent to which these suggestions relate to product development (and therefore are primarily the concern of system suppliers) or the use of timetabling information systems within institutions (which may be of interest to institutions when considering their approach to the timetabling process) is noted. Suggestions include:

6.2.1 Greater integration with other major MIS within the institution

Suppliers identified a growing interest in monitoring the attendance of students at individual teaching and learning activities. This is a specific trend within the HE sector as attendance monitoring is adopted in FE in relation to reporting requirements. Suppliers identified that functionality of timetabling systems could be developed to monitor attendance, however this would require accurate, up to date individual student information to be provided from the student MIS. FE sector institutions may be more likely to make use of functionality within their student MIS in order to develop the timetable and manage attendance monitoring.

Suppliers identified that a major benefit of recording attendance information within the timetabling system would allow more powerful utilisation monitoring, combining measurement of the frequency a location is used for teaching and learning activities with accurate information on the occupancy of the location (% of seats filled). Such monitoring would also allow identification of students with poor attendance and targeting of appropriate intervention.

Suppliers may wish to consider how their current product offering meets any functional requirements in this area, while institutions concerned with improved space utilisation, and student retention may wish to consider the benefits of developing attendance monitoring processes supported by such functionality.

6.2.2 Using the timetabling system as a source of management information

Timetabling information systems are capable of holding a great deal of information which could be very significant in relation to management decisions. In addition to the improvements in measuring attendance and efficient utilisation of space, suppliers have identified the potential to measure:

- Full economic costing of curriculum delivery in relation to the income associated with individual students and other sources, staff, location and other resource costs.
- Measurement and management of staff workload, allowing equitable allocation of staff contact time in relation to other contractual commitments.

Suppliers identified that many institutions will not currently use information held within the timetabling systems in this way.

Institutions may wish to consider the potential to use information held, or potentially held within their timetabling information system as a source of management information relating to these areas.

6.2.3 Improvements to the availability of timetabling information

The process of communicating timetabling information to both staff and students varies hugely between, and often within institutions. Many institutions will make use of a secure portal available to staff and students with a personalised interface to a number of services. A single or multiple portals may allow students access to a Virtual Learning Environment (VLE) containing study information, records management such as enrolment and programme module registration, and timetabling information. Suppliers identify the potential for greater collation of information within a single secure portal interface where staff and students could access all relevant information relating to their work, including timetable, achievement and attendance information, and study materials.

In addition effective means of communicating changes to timetabling information to students such as text messages and emails have been identified as a method of improving short notice of changes to students and staff.

Suppliers may wish to consider how their current product offering meets functional requirements in this area, while institutions concerned with coordinated communication with students and staff through the use of tools such as online portals may wish to pursue the potential of publishing timetable information in this way.

6.2.4 Improved functionality relating to development of the timetable

A number of product-specific improvements were identified by suppliers. These relate to broadening the functionality of the product offering and improving the 'usability' of the existing interface. Examples of improved functionality and user interface include:

- Notification of the implications and potential required changes when scheduling an activity within a constrained slot (how to resolve scheduling problems). This is achieved through colour-coding of the slot in question.
- Drag and drop report-building and filtering of report information.

- Development of a 'dash-board' feature allowing measurement of completion of timetable planning and drafting. A number of indicators, such as 'number of un-scheduled activities' can be used to monitor planning progress.
- Functionality relating to differentiated or adapted use of the system throughout an institution including greater control over user rights and visibility of information. And temporary 'access' of locally owned space to other academic departments, allowing scheduling of activities at certain times.
- Greater functionality in identifying student progression pathways using module credit as a measure of possible combinations, allowing decisions to be made about the practicality of scheduling certain pathways, and whether these should be offered.

Although these developments would have benefits for those using the system, they are largely product specific and therefore primarily the concern the relevant supplier.

6.2.5 Broadening the functionality of the system to manage processes related to timetabling

In addition to making greater use of timetabling systems in the generation of management information, suppliers identified the potential to produce a broader range of products relating to specific management of areas allied to timetabling, such as the management of staff workload.

One supplier is currently developing a product that is designed to allow academic managers to define all time commitments associated with a member of academic staff in relation to their various commitments including student contact time and associated preparation, marking commitments, research and study commitments. The product can be integrated with the timetabling information system in order to populate timetabled contact time and allow the academic manager to make adjustments to this, or request changes through a timetabling officer.

This is a product specific development, however institutions may wish to consider if such functionality could help improve existing processes in this area.

7.0 Common challenges and issues

During consultation with the contributors to this report, a number of issues and challenges relating to timetabling and resource scheduling have been identified. These issues can be thematically grouped in relation to policy, process, technology, and people related issues. Specific challenges identified in relation to each stage of the timetabling process are presented throughout section 1.1 of the report annex.

7.1 Policy related issues

Many of the strategic goals that institutions may wish to pursue influence the timetabling process. Responding to these priorities through the timetabling process may be challenging as a number of conflicting practical considerations can arise. Specific scenarios which have been suggested include:

- A strategy to make highly efficient use of locations through the timetabling process, combined with an institution-wide focus on increasing student recruitment, and improving the student experience through a balanced, student-focused timetable. Those charged with location allocation to teaching and learning activities may suffer from a lack of suitable locations e.g. large lecture theatres or smaller seminar style rooms, at certain times of the day – and in extreme cases throughout the whole standard delivery period. This can be caused by changes to the delivery patterns of teaching and learning activities resulting in increased space demand (for example an increase in the popularity of 'break out space' has been reported), or through an increase in student numbers. This may result in more efficient use of existing space, however students may be 'crammed in' and the quality of the student experience reduced. This issue is relevant to the estates management process through which the estate is expanded, redeveloped, or reduced.
- A conflict between certain pedagogic aspirations (e.g. not teaching every week, large lectures followed by breakout sessions all at the same time, vertical and horizontal teaching relating to the same module) and the efficient utilisation of space.
- There can be a tension between timetabling and resource scheduling processes and the need to make advanced non-teaching and learning room-bookings, particularly for private-hire / conferencing.

Depending on the institutions approach to timetabling and resource scheduling and the functionality of the timetabling information system adopted, a great deal of useful management information may be held within the system. The potential to make use of this information during other administrative and decision making processes across the institution may not be recognised. For example: measuring the efficient utilisation of space, staff workload management, attendance monitoring, implications of curriculum changes, identification of potential resource requirements as a result of curriculum modification, and full economic costing in relation to delivery.

7.2 Process related issues

The most significant issue in this area is that information allowing timetable planning is dependent on many other processes which means it is often available 'late' or is subject to significant change. As a result planning (including preparation of a timetabling information system) may need to proceed with inaccurate or incomplete data. In some cases this may be hard to avoid due to 'uncontrollable' factors, such as fluctuation in student number, or staff turnover. Specific scenarios contributing to this issue include:

- Information may be drawn from multiple information systems (including HR, student and estates MIS). This information may not be accurate for a number of reasons including: staff turnover, changes to the estate, changes to student module choices, student attrition, or that processes resulting in updates of this information have not completed.
- Information may be rolled over from the previous session in order to initiate the timetabling process. Much of the information may have changed since the previous session (curriculum, staff, student, and estate information).
- Validation of programme and module requirements (including modification of existing provision and introduction of new programmes / modules) can continue until the summer period. This delays confirmation of curriculum requirements and identification of activities to be scheduled.
- The applications process can be used to predict estimated numbers of entrants to programmes of study and therefore plan numbers of students in relation to teaching and learning activities. Issues are caused by the inaccurate estimation of student numbers based on historical trends, and the issue of late offers to potential entrants.
- Many institutions will make use of a staff HR planning process in order to identify staff teaching and learning commitments for the next academic session, often involving the association of staff with modules and teaching activities. In the event that this information is required by timetabling staff issues can arise if such a review process produces changes to staff commitments after commencement of the timetabling cycle. In addition staff turnover may require re-allocation of contact time commitments.
- Some institutions have less defined processes for the allocation of staff workload, and association of staff with particular modules and teaching and learning activities. It may be common practice for staff expectations to be based on their historical timetable. These issues are viewed as quite deep seated, but critical to address as limitations on teaching staff availability impose major constraints upon timetabling with consequent burdens upon location utilisation at certain times of the day – and very light loading at others.
- Many institutions will adopt an estates management planning cycle with the purpose of reviewing utilisation of available teaching and learning locations, and other facilities such as meeting rooms. Decisions may be made as to the need for new space, or to remove locations from the teaching and learning timetable. This strategy may be used to generate income from surplus locations, or sell portions of the institution's estate. Issues can arise where decisions relating to location availability are made after the commencement of the timetabling and resource scheduling processes.
- Information relating to the module choices of students does not become available until these have been made by students. This information is subject to change for a number of reasons including; students may be allowed to change option choices upon starting the next academic session, may leave the institution, or may not qualify to take the previously selected modules.

Coordination of the timetabling process in order to manage these challenges may also be an issue with production of the staff, student, and room timetables involving distinct, loosely connected processes. Information relating to each of these timetables may not be held in a shared management information system.

Several issues are specific to the approach adopted by an institution to management of the timetabling process (degree of centralisation). Suggested scenarios include:

- Where locations are centrally allocated, a surplus of locations may be requested by academic departments in order to ensure adequate space. These requests may not be cancelled once delivery of the curriculum has commenced. When space is 'returned to the centre' this is often beyond the stage when locations can usefully be reallocated to the teaching and learning timetable. While space charging or fining of academic departments (based on surveys of stated location use) has been reported as a successful means of deterring this scenario by some contributors, others have commented that this has limited affect.
- Several consultees commented that combining distributed requirements identification with central scheduling and location allocation, can make it challenging to be sensitive to staff requirements, student experience and pedagogic considerations. Conversely where processes are primarily managed at a distributed level, making efficient utilisation of space as a resource is challenging, as is implementing institution wide policies and processes. It should be noted that that successful practice has been reported in each of these areas, with both a centralised and distributed approach.
- Where programmes of study are delivered in partnership through different academic areas of the institution, or external partners, exchange of information, allocation of resources and scheduling can be challenging when this is not centrally coordinated. Many of the problems associated with development of the timetable for more traditional programmes of study are relevant however these are magnified. Effective cross institution / partner planning is important to addressing this, however very difficult to achieve.

Irrespective of the approach adopted, release of inaccurate timetables to staff and students as a consequence of the timetabling process, which then have to be amended, results in dissatisfaction amongst these groups.

Issues may arise around the integration of contractual continuing professional development courses within the wider teaching and learning provision of the institution. Provision may involve intense periods of teaching and learning activity throughout the year, with little activity between these. This irregular provision, and the often high expectations of students in relation to available facilities can result in scheduling and location allocation challenges. Some institutions may have specific facilities to accommodate such provision, where rooms are allocated separately to other teaching and learning activities.

7.3 Technology related issues

While a number of participants had specific suggestions for improving the usability and functionality of timetabling information systems, the majority commented that the current market offering is strong. However the huge variation across the sector and difference in approaches to timetabling and resource scheduling, means that off the shelf timetabling systems may require significant tailoring before full functionality can be implemented. Many institutions may not have the resources to tailor systems in this way.

In addition, systems may be procured in response to a particular strategic requirement, led by a related member of senior staff who is not directly involved in managing timetabling processes. The functionality of the procured system may be mismatched to the institution's requirements, and the technical abilities of staff involved in administering the process. Timetabling staff may resist changing processes in order to accommodate a

new information system, or may not have the required technical skills to implement functionality.

Specific scenarios identified by consultees as contributing to, or resulting from these issues include:

- It may not be in the interests of suppliers of either timetabling or other management information systems to limit their market through developing interoperability with particular products.
- Linking curriculum information held within the student MIS to inform the timetabling information systems can cause update issues where activities are present within the timetabling system that are not credit bearing (these may not be present within the student MIS). Updating information must be managed in such a way that this information is not lost.
- Links between timetabling information systems and conference management products have been identified as a particularly challenging area. This is heightened due to the different planning cycles relating to the booking of conferences (up to several years in advance) and timetabling (usually an annual cycle). A number of consultees commented that a single product supporting needs in both these areas of management is not currently available.
- Functionality supporting cross-partner placements of students is limited, for example the placement of nursing students within NHS partner sites. This has been identified as a very time consuming activity for administrators.

7.4 People related issues

Issues relating to people are primarily cultural and arise as a consequence of historical practice and the challenges of implementing changes to a process that has a significant impact on the practical working patterns of staff and students. For example, not accommodating staff preferences may lead to staff attrition, or reduced research delivery capability. Where staff have become accustomed to the same schedule 'year in year out' there may be resistance to change; booking rooms in order to effectively change the timetable and maintain the same working patterns has been reported as a consequence of this issue. This may be linked to a perception amongst some staff that space is a 'free' resource, and that management of this in order to produce efficiency is not considered.

Those charged with production of the timetable, or implementation of change in this area may face significant opposition to changing historical patterns of working, which may prevent agreed timetabling priorities from being implemented.

At some institutions, there is an absence of a 'champion' for timetabling within the senior management team, who is able to communicate the significance of various strategic considerations on the practicality of delivering the timetable.

8.0 Building blocks of successful practice

Consultees have commented on the importance of a number of 'building blocks' which are the foundation for successful management of timetabling and resource scheduling processes. These building blocks combine an appropriately rich use of the institution's timetabling information system functionality, with coordination of information and processes across the institution – and are not necessarily related to either a central or distributed approach to management of timetabling and resource scheduling. Building blocks relate to a range of factors including:

- Existence and communication of appropriate **policy** influencing process design and managing stakeholder (specifically staff and student) expectations in relation to the timetable.
- The structure of the **processes** adopted and how these interface with other significant administrative processes operating at the institution.
- Implementation and effective use of enabling **technology**.
- Deployment of appropriately skilled **people** within, and to oversee the timetabling process, and networks to support their work.

In this section the main building blocks identified are presented in relation to the above areas. The extent to which individual institutions within both the HE and FE sector consider their current practice against these suggestions is situation dependent, and the relative merit of developing practice in these areas would need to be considered in the context of each institution's priorities and current circumstances.

8.1 Policy building blocks

A number of participants in consultative activities have reported that an institution-wide understanding of the timetabling process is beneficial in:

- Managing the expectations of staff and students in relation to their timetable availability, accuracy, and scheduling of teaching and learning activities.
- Aligning complementary, and potentially conflicting institution strategies relating to areas such as estates management, income generation through conference hire, curriculum development agenda, marketing campaigns designed to increase student numbers, technology development and procurement, and other strategic considerations.
- Making use of information potentially held within timetabling information systems to inform significant strategic decisions relating to any of the above areas.

Such a policy has two main areas of impact:

Communication with staff, students and other stakeholders

Such a policy would state how the timetable is determined in response to the institutions' priorities and list the commitments to staff and students in terms of expected entitlements. More specifically this could include:

- A summary of the institutions' approach to timetabling, identifying where responsibility for certain tasks is held, and the 'ownership' of rooms and resources.
- How different priorities have the potential to impact the nature of the timetable and the institutions' approach to prioritising these.
- A summary of the framework within which the timetable is developed including reference to the hours in which teaching may be scheduled, and any reasons for

<p>avoiding particular times – for example Wednesday afternoons to allowing sporting and volunteering activities.</p> <ul style="list-style-type: none">• The role of the staff HR process in agreeing staff teaching availability and how this information will be used during the development of the timetable, and other workload commitments considered (such as the need to conduct research activities, assessment of student work, or session planning).• The approach to scheduling teaching and learning activities in order to produce a satisfactory timetable for individual students, including accommodation of any specific student needs.• Any timetable 'entitlements' for all staff and students, such as a break between scheduled activities within the middle of the teaching day, or a later start time following a late finish the previous day.• The process for making ad hoc room bookings.
Communication of the strategic significance of timetabling to senior functional managers
<p>Such a document should set out the institutions approach to consideration of timetabling and resource scheduling during the institutions strategic planning and agenda-setting processes. Such a document may state:</p> <ul style="list-style-type: none">• The relationship between strategic agenda setting in any one functional area and the impact on the timetabling process.• The nature of the relationship between other major processes impacting the timetabling process (e.g. the estates and curriculum management processes) and how complementary outcomes are produced (e.g. the delivery methods adopted require more / less teaching space and this is therefore reflected in estates planning, allowing the production of a timetable to meet these requirements).• The nature of planning cycles relating to certain functional areas and how any conflicts arising due to the timetabling cycle should be resolved – for example the planning of conferences is usually several years in advance, while the timetabling process is usually annual.

The extent to which elements of timetabling policy are made available as internal or widely available documents are likely to be defined by which stakeholder group is being considered¹¹.

8.2 Process building blocks

A number of specific process changes are likely to be beneficial for individual institutions, however the following summary of potential process changes represents a consolidated view of the most significant building blocks for a good process foundation¹².

Timetabling and resource scheduling processes are dependent on a range of information relating to the curriculum, staff, students, and available locations for teaching and learning activities. The availability of timely accurate information for the coming session is one of the most significant challenges constraining the planning of the timetable. Where possible this dependence should be recognised and the deadline for

¹¹ Several institutions make elements of their timetabling policy freely available through the public internet.

¹² Section 2 of the report annex also includes a summary of potential improvements to each of the four scenario approaches (A-D) to timetabling and resource scheduling.

production of accurate information as a result of these contributing processes agreed. This action is limited by the unavoidable change in certain information, such as the number of entrant students, or staff turnover.

This is particularly relevant to the curriculum management process, which could also be modified to include the modelling of changes to the curriculum offering in order to identify impact on: space utilisation, progression pathways for students¹³, staff workload, and potentially full economic costing of delivery. The existing functionality of certain timetabling information systems may be able to support this modelling activity.

For students progressing to the next level of study, the point at which module choices for the following session are made and the extent to which these may be changed are important influencing factors. Collection of this information at a point when students may make an informed decision, and timetabling officers have a significant amount of time to plan the timetable following this should be considered. Many institutions make use of online forms to collect this information from students and there is potential to integrate this information with timetabling data. The policy around changes to these choices should also be defined.

8.3 Technology building blocks

Technology currently available through the commercial market offers a rich and extensive level of functionality, and this offering continues to develop. This is not to say that further improvements in available functionality are not possible or required, however in many cases existing functionality remains under-utilised for a number of reasons, particularly the need for accurate information to enable this functionality, and the need to invest significant resources in aligning processes contributing this information, and appropriate training of staff.

There are a number of ways in which the existing functionality of timetabling information systems, and other information system resources can be used more effectively. In addition, several examples of potential development areas have been identified.

8.3.1 Making best use of existing functionality

Institutions may wish to consider adopting a range of available functionality (as profiled at section 6 and throughout the report annex), reflecting their priorities and circumstances. The following examples may have particular benefits relating to the accuracy of data, and communication of timetabling information throughout the institution.

Information held within the timetabling information system may be refreshed through integration with sources of accurate up to date information, such as the student management information system, the HR system, and an estates management information system. The extent to which a dynamic update of information is possible or desirable will depend on the functionality of the systems in place and the institutions approach to timetabling. Many timetabling systems are capable of incorporating data from other systems, be this through a dynamic link or file upload of information.

Several timetabling information system products are capable of holding individual student information. This level of information granularity enables a much broader use of potential functionality, such as clash checking at the individual student level when scheduling activities, production of individual student timetable information, and

¹³ Possible module choice complexity and practicality.

notification of timetable changes to individual students. Benefits may be realised by institutions who have the potential to include individual student information within such systems.

Where a timetabling information system is potentially accessible throughout the institution, appropriate use of user access rights can be used to allow shared access across academic departments, with allocation of 'ownership' of resources as appropriate. Such an approach can be used to better measure resource use across the institutions and enable such practices as 'borrowing' space from other departments. Communication between academic departments and any central function is also supported.

8.3.2 *Extending functionality*

The view of the contributing suppliers is presented at section 6.2. In addition, the following areas have been identified as potentially significant for further functional development:

- *Enhanced functionality available in the management of work placements at partner sites* - Technology facilitating cross-partner placements of students as part of an integrated timetabling information system product has been highlighted, for example the placement of nursing students within NHS partner sites. This has been identified as a very time consuming activity for administrators. There is potential for the development of a shared access system to facilitate communication in this area, and manage the exchange of timetable information. Recording of training hours through the functionality of such a system could be beneficial for some institutions.
- *Enhancing integration between timetabling information systems and those used for the management of conference events* – A number of workshop participants identified that there is no single product that adequately encompasses the timetabling and conference management needs of HEIs. This may involve interface with finance management systems to manage the charging of space to external parties. Such a product may be of most use to institutions who have a significant level of 'conferencing' or external hire of meeting facilities during 'term time' or for those institutions who have a significant level of teaching and learning related activities occurring in 'vacation'.

8.4 **People building blocks**

A number of workshop participants identified that there is a need for strategic oversight of the timetabling process to be held by a member of the institution's senior team, and that this individual should have responsibility for ensuring that timetabling considerations are accommodated within the institutions strategy and agenda setting processes.

It is often the case that a senior member of staff will be charged with the oversight of significant individual projects relating to timetabling, however this should be an ongoing role as a 'champion' of timetabling processes within the institution.

In addition strategic and operational benefits may be achieved through deployment of staff within each academic department who are managed through a central function. The role of these staff would be to improve communication and work with the academic department to better align all processes impacting timetabling and resource scheduling, identifying links between strategic priorities.

A number of attendees at workshop events and other consultees commented on the value of being able to discuss common issues and challenges, examples of innovation and best practice. While a number of product related user groups exist and are very useful to those working with these systems, a sector-wide forum was identified as potentially useful.

8.5 Improving practice

In order for practice to improve at the institution level, there are a number of possible activities and further actions that could be carried out by JISC, individual institutions, and by the supplier community.

Institution level

Individual institutions may wish to consider the extent to which the building blocks described above are currently in place, through a review of their existing approach to timetabling and resource scheduling. This study offers a useful profile of current practice, challenges, use of technology, and innovation throughout the HE and FE sectors, which can be used as a benchmark summary and act as a 'menu' of approaches and possible use of policy, technology, process, and people 'levers' to develop current practice.

However the extent to which individual institutions within both the HE and FE sector consider their current practice against these suggestions is situation dependent, and the relative merit of developing practice in these areas would need to be considered in the context of each institution's priorities and current circumstances.

JISC

JISC has a further role in the dissemination of this report and communication of findings to the HE and FE sectors. A potential action is to publish this report through the JISC public internet.

JISC may also like to consider completing further work to assist institutions in considering the implementation of the building block described above. This could take the form of additional resources to assist specific development in each of these areas, offering a more contextual view of practice. An example of such a resource would be a good practice guide containing detailed case study material profiling a range of approaches to timetabling and documenting the processes supporting particular innovations. The case studies adopted should seek to show-case successful deployment of one or more of the four building blocks identified above. Examples of specific scenarios that could be featured within case studies include¹⁴:

- Use of a timetabling policy to coordinate the institution's approach to timetabling and manage stakeholder expectations (policy).
- Where possible, other processes impacting the planning and development of the timetable are aligned to support, rather than complicate this. Timetabling information or staff expertise may be used within these processes (process).
- Use of information held within other management information systems to populate the timetabling information system, where successful system interoperability is achieved; including interface with different types of systems (student-MIS, HR-system, estates-management system etc.), and the frequency at which updates take place (technology).

¹⁴ Additional examples of potential process improvements which could be profiled through the development of detailed case studies are presented within section 2 of the report annex.

- Use of individual staff and student information within the timetabling information system to produce and publish timetables at the individual level (technology / process).
- Timetables for staff, students, locations, modules and programmes of study are made available online (technology / process).
- The role of a timetabling 'champion' (people).

Where asked, none of the workshop attendees were able to identify use of shared access to a timetabling information system across partners in the context of timetabling for work-placements. The extent to which this is supported by technology, or has the potential to be could also be explored further.

Any case studies could bring together examples of effective process, policy, technology use, and personnel deployment within an institution specific context. Associated challenges and benefits with each situation could also be presented.

JISC may also wish to consider the need for, and options for the instigation of, a cross-sector forum or group to facilitate networking, professional development opportunities, and sharing of best practice between timetabling and resource scheduling professionals.

System suppliers

This report has largely been informed by the comments of those concerned with production of the timetable at an institution level, and suppliers of timetabling information systems may find the content useful in understanding the developing needs of this group, and considering any potential developments to the functionality of their products.

Suppliers may wish to consider whether they recognise the specific opportunities for product development as highlighted by a number of consultees and reported at section 8.3.2.

Appendix I – Contributing organisations

Sectoral Bodies

- Academic Registrar's Council
- Association of Colleges
- Association of University Administrators
- Association of University Directors of Estates
- Student Record Officer's Conference

Timetabling information system suppliers

- CELCAT
- Scientia

Institutions represented at consultative workshops:

Higher education institutions:

- Aberystwyth University
- Birkbeck College
- Bishop Grosseteste University College Lincoln
- Bournemouth University
- Canterbury Christ Church University
- Cardiff University
- Central School of Speech & Drama
- Coventry University
- De Montfort University, Leicester
- Durham University
- Guildhall School of Music & Drama
- Heriot-Watt University
- Keele University
- Leeds College of Music
- Leeds Met University
- Loughborough University
- Manchester Metropolitan University
- Middlesex University
- North East Wales Institute of Higher Education
- Northumbria University
- Queen's University Belfast
- Royal Veterinary College
- Sheffield Hallam University
- St Georges University of London
- Swansea University
- The Arts Institute at Bournemouth
- The Nottingham Trent University
- The University of York
- University College London
- University for the Creative Arts
- University of Abertay Dundee
- University of Bolton
- University of Bradford
- University of Brighton
- University of Central Lancashire
- University of Dundee
- University of Essex

- University of Glamorgan
- University of Hertfordshire
- University of Hull
- University of Leeds
- University of Leicester
- University of Lincoln
- University of Liverpool
- University of Oxford
- University of Plymouth
- University of Sheffield
- University of Stirling
- University of Strathclyde
- University of Ulster
- University of Wales Institute, Cardiff
- University of Wales, Newport
- University of Warwick

Providers of Further Education:

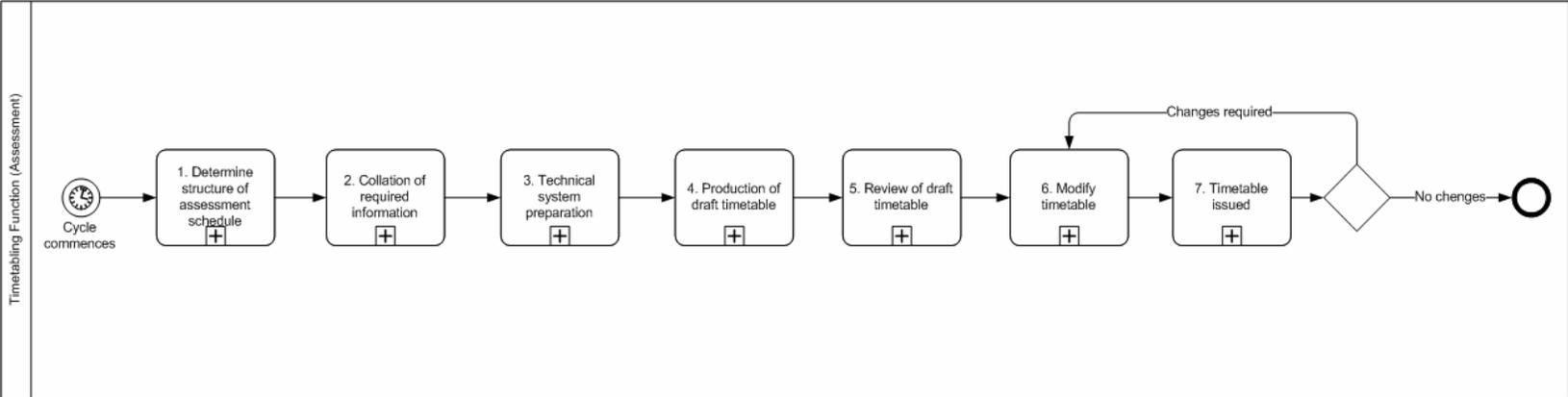
- Bridgwater College
- Kingston College
- Oaklands College
- Rotherham College of Arts and Technology
- Strode College
- Tameside College

Appendix II

Definition of timetabling and resource scheduling for examinations and assessment

The process commonly starts with the identification of the structure of the assessment schedule (the period(s) when examinations and assessments are to take place, and the time period which will be made available for these activities e.g. an AM and PM session) (1). Collation of required information will then follow (such as entrance information indicating room capacity and resource requirements, invigilation requirements etc.) (2). A timetabling information system is commonly used to organise the required information (3), the functionality of which will be used to support development of the draft timetable for examinations and assessments (4). Timetables will then commonly be reviewed by academic staff with responsibility in each high-level subject area (5) and modifications made (6). The timetable will then be issued through a range of mechanisms (7), with any post-issue modifications requiring re-issue.

Figure All.1: Timetabling for examinations and assessment



<p>Process: Timetabling for examinations and assessment</p>
<p>Objectives: The process must produce a scheduled (positioned in time) and resourced (staff and location allocated) representation of examination and assessment activities allowing the assessment of learning through all programmes of study operating at the institution. The timetable produced must satisfy various constraints. A successful product is commonly considered as spreading the assessment activities for each student as evenly as possible throughout the assessment period.</p>
<p>Actors: Assessment timetabling staff (not necessarily responsible for teaching and learning timetabling and may be working at either a central or distributed level), students, academic staff, management information systems</p>
<p>Overview In many institutions examinations and assessment timetabling will be administered by a distinct team (often central) from that of teaching and learning timetabling. Separate timetabling information systems may also be used.</p> <p>In such circumstances there will need to be an interaction to ensure that rooms to be used for assessment are removed from teaching and learning use. This is aided by the suspension of many teaching and learning activities within the assessment period and therefore the process interaction is often between the assessment timetabling process and the room-booking process (i.e. appropriate rooms are block-booked for examinations through the room booking process, which does not impact on teaching and learning resource (room) requirements).</p> <p>Special needs requirements of candidates are likely to be used by those developing the examinations timetable, with information potentially drawn through the applications and enrolment processes.</p> <p>Feedback on the quality of the examinations timetable may be provided by external examiners.</p>
<p>Information systems A specific assessment and examinations timetabling information system is likely to be used. It is possible that candidate entry and identifying information will be drawn from the institution's student management information system.</p>
<p>Dependencies The process is largely dependent on the availability of accurate information allowing timetable design, including:</p> <ul style="list-style-type: none"> • information relating to the volume and identify of individual students to attend each assessment session. • any constraints impacting the scheduling of assessment activities, such as the requirement for non-concurrent scheduling of certain activities. • any special needs requirements for individual students, such as step-free access to the assessment location, allocation of support staff during the assessment session etc.
<p>Issues and challenges</p> <ul style="list-style-type: none"> • Assessment timetabling is most challenging when this needs to occur alongside normal teaching and learning, as the constraints acting on scheduling and resource allocation are increased. • Special needs requirements information may not be available to those planning the examinations timetable when this is ideally required.

Examples of innovation

- It could be possible to timetable examinations at the same time as teaching and learning in order to produce early timetables for students. This would present an issue relating to efficient use of space as the maximum number of entrants would be need to be assumed.
- For students entitled to 1:1 support during assessment activities, consistent allocation of the same member of support staff to the same student has been reported as improving the student experience. In one institution, allocation in this way has been achieved through collation of individual student and support staff information within the examinations timetabling information system.

FE specific points

- FE providers may not have the physical resources to hold large e-assessment examinations on-site, and may need to rent assessment centre space externally. Other issues include the need to access awarding body infrastructure through the public internet, in large numbers. Invigilation staff need to be appropriately qualified to deal with technical issues, and to allocate additional time in the event that technical systems do not operate at an acceptable speed.

Appendix III

Product profile

The product profiled in this case study offers all of the functionality listed in section 6.1. The purpose of this case study is to provide richness around this functionality, including the information requirements, and input from the system user.

1 *Preparing the system*

The system can be configured to accommodate the working environment of the institution through user specification of a number of factors including:

- The length of the teaching day.
- Which days to include in the timetable.
- Duration of session.
- Duration of time in relation to reporting outputs.

The system holds information on three types of 'resources' which can be considered as constraints in the scheduling of teaching and learning activities:

- Staff.
- Locations.
- Equipment (although the vast majority of users manage equipment allocation through a separate system / process).

Each stored resource can then be associated with further information in order to aid scheduling of activities. The user is able to manage and amend this information through a screen interface of tabulated views showing the various field information, drop-down menus and free text fields.

For locations this information includes:

- The capacity of the room.
- Presence of fixed equipment (such as a data-projector).
- The location of the room (within a particular campus / building).
- The type of room (lecture theatre, seminar room etc.).
- Preferred session start time for the location (through colour coded drag-shading of the timetable grid, showing strong and negative preferences).
- When the location is not available for scheduling of activities (through drag-shading sections of the timetable grid), this could be to accommodate the examinations period, or a weekly non-timetabled event e.g. external hire on Wednesday afternoons.

For staff this includes:

- Contractual hours indicating total contact time available and permissible overtime.
- When the staff member is not available for scheduling of activities (through drag-shading sections of the timetable grid).
- Definition of staff availability preferences (through colour coded drag-shading of the timetable grid, showing strong and negative preferences).
- Activities to be taught by a staff member.

The system can also hold information in relation to the curriculum including:

- Programmes of study.
- Modules.
- Teaching and learning activities.

Programme of study can be associated with:

- All mandatory and optional modules.
- Individual students (or predicted numbers of students).

Modules can be associated with:

- Programmes of study as either mandatory or optional modules.
- Individual students (or predicted numbers of students).

'Activity templates' are used to model the number of lectures, seminars, tutorials, and other teaching and learning activities required in order to deliver each module. Use of activity templates for each module allows the user to create activities associated with the parent module and specify a number of delivery requirements including how the activities should be sequenced, and the duration between these events. It is also possible to specify when the activity cannot be scheduled and preferences around when this should be delivered. Certain information associated with the activity will be 'inherited' from the parent module including associated programme of study, and the identify of all students (or numbers of students) that need to be accommodated. In this way students can be allocated to individual tutorial groups and seminars.

The system also holds information relating to students including:

- A 'student set' which can act as a package of students to always be kept together – for example a tutorial group that should attend all seminar groups together. Most institutions only have a single student in each student set package as this allows uniquely identified student sets to represent individual students in the case that other individual student information (such as name) is not held within the system. This is particularly useful when planning the timetable for students due to enrol for the next academic session. Student sets can be used to construct the draft timetable, and associated with individual student information once this has been obtained through enrolment.
- Name, affiliated department, and programme of study, mandatory and optional modules
- When the student is not available for teaching and learning activities
- Preferences in relation to when the student is available for teaching and learning activities

Detailed information relating to staff, locations, students, and curriculum structure is stored within the system. In addition students and staff have also been associated with the curriculum structure.

In addition 'constraint profiles' can be associated with each of the main data elements held within the system (including staff, locations, and students) in order to assist scheduling of teaching and learning activities.

Examples of constraints profiles that can be applied include:

- Avoid concurrency of all associated activities (for staff and students).

- No more than [X] number of concurrent teaching and learning activities (for staff and students).
- Only schedule activities over [X] days in any week (for staff and students).
- Allow at least [X] minutes free during the centre of the day.

2 *Production of the draft timetable*

Once the system has been prepared it is possible to schedule activities. This can be achieved through automated scheduling of one or more activities, or through guided manual scheduling of individual activities.

When auto-scheduling activities the user is able to give preference to a number of criteria, such as efficient use of space, or accommodating staff availability preferences. This allows the user to experiment with a number of different scenarios.

Depending on the constraints and preference specified it is possible that some activities will remain unscheduled.

When scheduling a single activity, the user will be able to view the timetable and schedule the activity within this. The user will be presented with a number of markers indicating potential slots where the activity can be scheduled, and colour coded blocks are used to show why scheduling is not possible in an unavailable slot (e.g. a clash exists, a suitable location is not available).

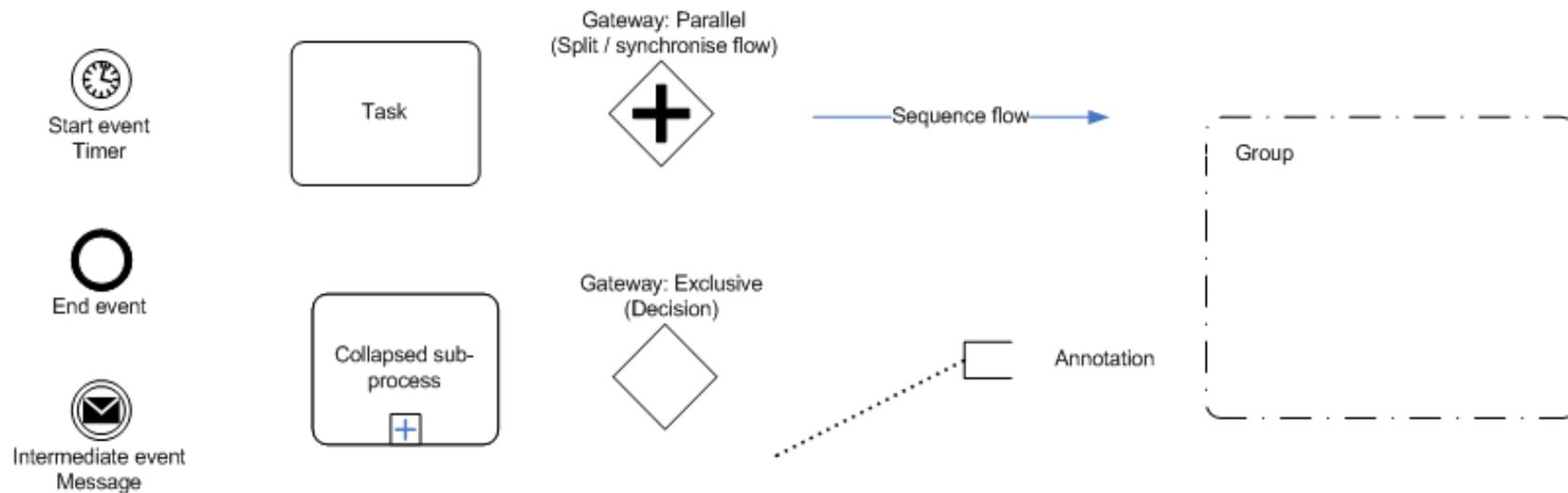
It is possible to view the individual timetable relating to staff, students, locations, and activities. This is presented as a grid view of the timetable over user-specified time periods. Colour coded blocks are used to show scheduled activities within the timetable and further information in relation to these activities can be viewed.

Annex – process scenarios

This appendix has the following structure:

1. Generic process model for the timetabling and resource scheduling process including detailed findings relating to the sub-processes comprising this model.
2. Adaptation of this generic model to four scenario approaches to timetabling and resource scheduling, supported by:
 - Process models.
 - Summary narrative descriptions.
 - Summary of potential improvements.

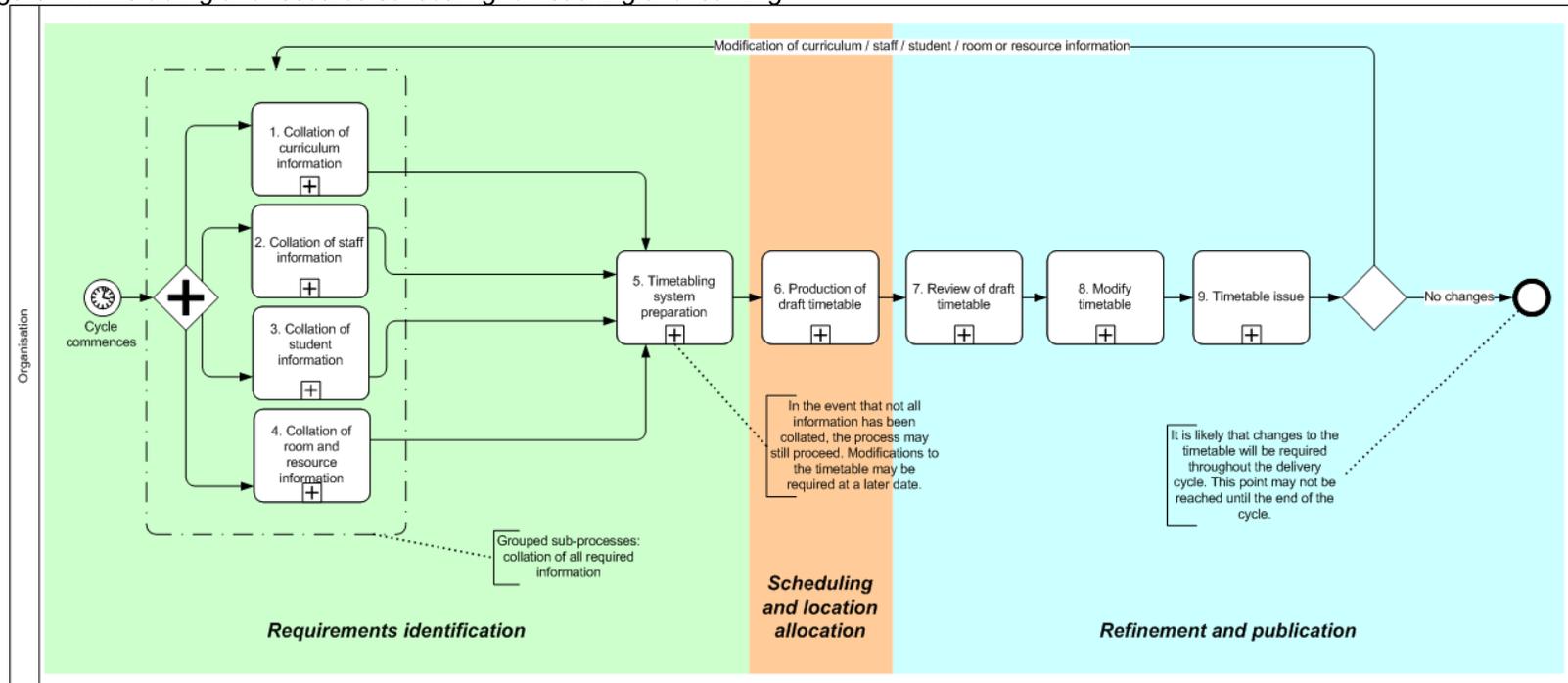
Process models are presented using proportionate application of the BPMN¹ standard, the following notation symbols have been adopted:



¹ <http://www.bpmn.org/>

1.0 Generic process model for the timetabling and resource scheduling process

Figure 1: Timetabling and resource scheduling for teaching and learning



The process of timetabling and resource scheduling commences with the collation of all information required in order to proceed with timetable development (1-4). Information is then commonly organised within a timetabling information system (5). Differing levels of functionality will then be employed in order to produce the draft timetable (6), which is then commonly reviewed by those with academic responsibility for each high level subject area (7). Any identified modifications will then be made (8), and the timetable issued through various means (9). It is likely that modifications to the timetable will be required on an ongoing basis, and the timetable will require re-issue.

Limitations with this model:

- The diagram cannot reflect the significant changes to curriculum, staff, estate, and student information that can occur throughout the timetabling process and the impact this has on production and modification of the draft and issued timetable.
- Some institutions may deliberately avoid certain language suggesting that the timetable is not dynamic, such as 'draft' and 'publication date'. This is combined with an ethos that changes to the timetable may be necessary throughout the curriculum delivery period and should be potentially expected by staff and students.
- Collation of information (1-4), particularly curriculum and staff information is likely to continue beyond initial organisation of information within the timetabling system (5). It is common practice to roll-over and subsequently amend information within the timetabling system as a starting point for planning.
- Separate processes may occur in order to produce timetables for staff, students, locations and modules.
- There may be several review and modification cycles (7 – 8) before issue of the timetable (9).
- The model assumes use of a timetabling information system (5).
- For some institutions the process may be better represented as a cyclical ongoing process.

1.1 Detailed findings relating to the sub-processes comprising this model

Each of the following tables defines the sub-process area, describes the main examples of variation identified, and the major issues and opportunities reported to date.

1.1.1 Sub-process: 1: Collation of curriculum information
<p>Objectives: The process must secure all information relating to programmes of study, components (modules) and associated teaching and learning activities (lectures, seminars, tutorials, labs etc) required to construct the timetable.</p>
<p>Description: The process will involve reference to a source of curriculum information from which required data can be obtained. This is likely to include, but is not limited to:</p> <ul style="list-style-type: none">• Programmes of study to be delivered.• Modules to be delivered and association with programmes.• Whether modules are compulsory or optional and which options may be combined.• What teaching and learning activities need to be scheduled for each module.• The frequency of learning activities.• Pedagogic considerations such as the ideal activity class size. <p>The process ends with the collation of this information in a format allowing further planning of the timetable; however changes to this</p>

1.1.1 Sub-process: 1: Collation of curriculum information

information may occur up to and beyond the start of curriculum delivery.

Examples of variation:

The main factor determining the way in which this process is managed is the source of curriculum information. This is likely to be obtained through:

- Role-over of existing information within the timetabling system – this will require subsequent amendment of any curriculum information and is most likely to occur where local requirements identification and scheduling is adopted. Where curriculum information is rolled-over this may then be shared with staff who have a roll in planning the delivery of curriculum for the coming session (such as academic staff with responsibility for an area of the curriculum). Changes to the curriculum information will then be made available to those collating this information for timetabling purposes – who will amend relevant information in the timetabling system.
- Interface with the student MIS (or other system containing programme and module information) – this is most likely where a large volume of information needs to be collated for the whole institution and is most likely to occur alongside central scheduling and location allocation. Information may be drawn from a system storing details of programme and module type, and delivery information. Updating of information within the timetabling information system may follow the completion of any curriculum management (validation) process. However changes to this information may be required closer to the delivery period.
- Web-forms allowing modification of existing (rolled over) information or submission of new information to be collated within the timetabling information system may be made available to staff within academic departments who are best placed to report changes in this area.

Information systems:

Information may be:

- Rolled-over within the timetabling information system.
- Present within an in-house module registration system.
- Obtained from the student management information system.
- Deposited within a timetabling information system.

Dependencies:

The sub-process is heavily dependent on the curriculum management process through which existing provision is reviewed, modified and discontinued, and through which new provision is validated.

1.1.1 Sub-process: 1: Collation of curriculum information

Issues and challenges:

- Validation of module and programme requirements (including modifications of existing provision and introduction of new programmes / modules) can continue until the summer period. This delays confirmation of curriculum requirements. It has been commented that this is beneficial to the institution in circumstances where a new course opportunity has become available and the institution must respond quickly to this.
- It is common for programme and module validation (including accommodation implications) to be agreed at the academic unit level. This prevents consideration of cost implications across the institution as a whole.
- Information held within the student MIS and other relevant information systems may not reflect the most recent changes to the curriculum at the point when collation of this information is desirable for planning the timetable.
- Initial information within the timetabling system is rolled-over from the previous year in many cases. This may not reflect changes that have been made in other management information systems, and the information will have to be validated.
- It may not be in the interests of suppliers of either timetabling or other management information systems to potentially limit their market through developing interoperability with particular products.
- Linking curriculum information held within the student MIS to inform the timetabling information system can cause update issues where activities are present within the timetabling system that are not credit bearing (these may not be present within the student MIS). Updating information must be managed in such a way that this information is not lost.

Examples of innovation:

- All planning cycles that impact timetabling and resource scheduling could be reviewed in order to provide information in order to inform the commencement of the timetabling and resource scheduling process. This may not be possible in all circumstances, however changes to information closer to the delivery of the curriculum could be considered in relation to the impact on timetabling processes versus the associated benefits of the change. This may require major consideration in relation to several planning processes.
- Instances of timetabling staff accommodating essentially redundant programmes of study within the timetable have been reported. Thorough review and re-validation of all existing provision with the aim of rationalisation was suggested as a means to overcome this scenario.
- Where local requirements identification is coupled with central resource allocation and scheduling, there is the potential for validation of all programme and module changes involving changes to timetabling and resource allocation to be modelled through a central timetabling function. This could be implemented as a distributed or institution wide approach.
- Information held within multiple systems could be used to populate the timetabling information system through a dynamic link. This would require commonality between data held in linked fields. There may be potential to link information between institutions in order to facilitate timetabling for joint provision.

1.1.1 Sub-process: 1: Collation of curriculum information

- Online data collection forms can be used to collect information relating to curriculum changes, and automatically collate this within a timetabling information system. This may be particularly relevant where additional information to that held within a student management information system is required by timetabling officers.

FE specific points:

- Late modification of information informing the timetabling process may be caused by changes introduced by funding bodies, and constant adjustments in relation to roll-on roll-off provision.

1.1.2 Sub-process: 2: Collation of staff information

Objectives:

The process must secure all information relating to staff relationship to the timetable, including associated teaching and learning activities, contracted contact hours, availability preferences, and any agreed non-contact time.

Description:

The process will involve reference to a source of information from which staff timetabling information can be obtained. Information will then be collated in a format allowing further planning of the timetable.

Examples of variation:

The major differences in the way this sub-process operates depend of the extent learning activities are scheduled by a central function.

- In the event that scheduling occurs centrally the richness of documented information relating to staff identify, associated teaching and learning activities, and availability will be extensive. Information may be rolled over within the timetabling information system and subsequently amended, or wholly or partly drawn from a staff HR system. Where information is rolled over, this may be reviewed by staff with responsibility for an area of academic deliver and amendments passed to timetabling staff.
- In the event that activities are scheduled locally, this may be informed by knowledge held by the scheduler. Information may be rolled over within the timetabling information system and subsequently amended, or wholly or partly drawn from a staff HR system.
- It is possible that staff information is not held within a timetabling information system, and that staff timetables and management of staff workload is managed separately from the development of the teaching and leaning timetable to be made available to learners – there will be communication between those responsible for managing these two areas to ensure that the two areas match. This scenario is most likely where there are minimal changes in the timetable year on year (who teaches what, when and where).

1.1.2 Sub-process: 2: Collation of staff information

- Web-forms allowing modification of existing (rolled over) information or submission of new information to be collated within the timetabling information system may be made available to staff within academic departments who are best placed to report changes in this area.

Information systems:

Information may be:

- Rolled-over within the timetabling information system.
- Obtained from a human resource information system.
- Deposited within a timetabling information system.

Dependencies:

The sub-process is heavily dependent on the staff annual review and recruitment processes, through which contacted contact hours, and association with programmes of study and module components will be agreed. In addition staff availability within the 'teaching week' may also be agreed.

Issues and challenges:

- Initial information within the timetabling system is likely to be rolled-over from the previous year. This may not reflect changes that have been made in other management information systems, and the information will have to be validated through communication with those for responsibility for each area of academic delivery.
- Collation of staff information is impacted by the academic staff annual review and recruitment processes, through which staff workload is agreed - often including which modules will actually be delivered. Where completion of this cycle occurs following commencement of timetabling, this can cause late modification of requirements. Late modification in this area may also be caused by the need to recruit new staff at short notice (in response to resignation / illness etc.).

Examples of innovation:

- All planning cycles in this area that impact timetabling and resource scheduling could be reviewed in order to provide information in order to inform the commencement of the timetabling and resource scheduling process. This may not be possible in all circumstances, however changes to information closer to the delivery of the curriculum could be considered in relation to the impact on timetabling processes versus the associated benefits of the change. This may require major consideration in relation to several planning processes.
- Information relating to staff availability for teaching and learning activities can be drawn from contractual arrangements, however management of staff preferences in relation to this can be coupled with the staff annual review process. Reasons for unavailability within contracted hours can be approved through a line management arrangement and reference to any agreed institution-wide policies in this area.

1.1.3 Sub-process: 3: Collation of student information

Objectives:

The process must secure all required information relating to students in order to proceed with the timetabling process. This may include individual student information for existing students, and incorporation of this information for entrants once available. Alternatively information relating to the number of students associated with modules and teaching and learning activities may be used.

Description:

The process will involve reference to a source of information from which student timetabling information can be obtained. As a minimum this will consist of numbers of students predicted or confirmed as attending each teaching and learning activity. However individual student information (including identifying information and associated teaching and learning activities) may be collated in order to make full use of timetabling system functionality during later stages of the process.

Information relating to entrants is likely to be predicted in the first instance, for example likely numbers of students required to attend each teaching and learning activity based on historical trends and current application / offers information. For existing students progressing to the next level of study, information relating to number of students to attend core teaching and learning activities can be more accurately predicted.

Information relating to numbers of students attending option related teaching and learning activities may be collected before the commencement of the timetabling process, allowing more accurate prediction of numbers also. Individual student information may also be collated in this area.

In addition, any information influencing the planning of the timetable based on student needs may also be collated at this stage. This may involve reference to access requirements.

Within the HE sector, numbers of taught postgraduates, and the specific nature of the teaching and learning activities attended by these students often varies greatly between cohorts. Popularity of taught postgraduate programmes can vary significantly, and learning is often quite individualised and may develop throughout the programme.

Examples of variation:

The main influence of the process adopted by an institution is the extent to which individual student information is collated, including:

- Information relating to the predicted or confirmed number of student associated with each module and teaching and learning activity is collated. This does not include collation of individual student information for the purposes of planning the draft timetable. It is possible that information will initially be rolled over and then verified with staff who have responsibility for the delivery of each curriculum area.

1.1.3 Sub-process: 3: Collation of student information

- Information relating to individual students is collated for use in subsequent planning of the draft timetable. For existing students this may include identifying information, core and optional associated modules. A blank individual record may be created within the timetabling system to accommodate predicted entrants; this may be updated following the enrolment process with individual student information.
- Web-forms allowing modification of existing (rolled over) information or submission of new information to be collated within the timetabling information system may be made available to staff within academic departments who are best placed to report changes in this area.

Information systems:

Information may be:

- Rolled-over within the timetabling information system.
- Obtained from a student management information system.
- Deposited within a timetabling information system.

Dependencies:

The sub-process is highly dependent on:

- Applications processes.
- Enrolment processes.
- Progression / module registrations processes.

Issues and challenges:

- Collating individual student information within many timetabling systems would allow certain benefits to be realised (e.g. online publication of individual timetables, allocation of students to tutorial groups etc.) however some institutions are not able to secure accurate information in time to make use of this functionality (e.g. enrolment information, confirmed module selection).
- Numbers of international students may be particularly hard to predict.
- Information relating to progressing student module choices can be inaccurate as:
 - Students are commonly allowed to change choices following programme initiation.
 - Pre-requisite pass grades may not be achieved.
 - Students may leave.
 - Module choices may be so complex that these need to be discussed through the first period of delivery (e.g. some nursing related programmes).
- Students may be able to apply for programmes of study, and may be accepted up to programme initiation. This makes it hard to identify student numbers. The applications process may not identify where:

1.1.3 Sub-process: 3: Collation of student information

- Planned resource (i.e. room) capacity has been exceeded.
- There has not been sufficient recruitment and delivery of the programme is not economically viable.
- Where institutions are more commonly recruiting than selecting applicants, first year student numbers need to be estimated based on:
 - Historical performance.
 - Definite / back-up acceptance of offers made.
- This is further complicated where different programmes of study share the same module. Recruitment success may also have an impact on the timetabling process following the initiation of programmes (e.g. requirement for different resources / merging of class groups etc.).

Examples of innovation:

- All planning cycles in this area that impact timetabling and resource scheduling could be reviewed in order to provide information in order to inform the commencement of the timetabling and resource scheduling process. This may not be possible in all circumstances, however changes to information closer to the delivery of the curriculum could be considered in relation to the impact on timetabling processes versus the associated benefits of the change. This may require major consideration in relation to several planning processes.
- There is potential for progressing students to select any module choices through an online portal in order to help plan the timetable, these choices may then be automatically associated with the student record and imported to the timetabling system.
- Some HEIs may have a dedicated set of teaching and learning facilities to accommodate taught-postgraduate and other programmes outside of the standard undergraduate provision (such as continuing professional development courses with irregular activity patterns i.e. the number and scheduling of activities may vary week by week). This reduces the impact of these curriculum areas on planning the undergraduate teaching and learning timetable.

1.1.4 Sub-process: 4: Collation of room and resource information

Objectives:

The process must secure all required information relating to locations. This may include capacity of the room including any alternative configurations, fixed and available portable resources.

Description:

The process will involve reference to a source of information from which location information can be obtained. This may vary from use of an estates management system to unrecorded knowledge held by staff members relating to the suitability of locations for teaching and learning.

1.1.4 Sub-process: 4: Collation of room and resource information

Examples of variation:

The nature of the process is likely to depend on the extent to which knowledge of rooms and resource throughout the entire estate is required by timetabling staff, including the following:

- In the event that locations are to be allocated locally, information within the timetabling system is likely to be rolled over and updated in response to any local estate changes, such as the building of new specialist locations or modification of existing space. It is possible that little supplementary information relating to rooms (such as capacity or alternative configurations, presence of audio-visual equipment etc.) will be held within the timetabling system, and that locally held knowledge of room suitability (possibly held within a spreadsheet) will be used to judge the allocation of rooms and other locations.
- In the event that locations are to be allocated centrally, information relating to the entire estate may need to be collated through reference to an estates management information system. Alternatively information within the timetabling system may be rolled-over and amendments identified through communication with estates management staff.
- Web-forms allowing modification of existing (rolled over) information or submission of new information to be collated within the timetabling information system may be made available to staff within academic departments who are best placed to report changes in this area.

Information systems:

Information may be:

- Rolled-over within the timetabling information system.
- Obtained from an estates management information system.
- Deposited within a timetabling information system.
- Held within local spreadsheets and other information sources.

Dependencies:

- The sub-process is dependent on the estates management process through which the utilisation of space is reviewed, and the estate re-developed, expanded and reduced.

Issues and challenges:

- Collation of room and resource information may be dependent on information held within an estates management information system. This information may not have been reviewed and updated in advance of timetabling planning activity.
- On occasion, new building and renovation work may be delayed meaning that anticipated resources are not fully available for use in teaching and learning activities as initially planned.

1.1.4 Sub-process: 4: Collation of room and resource information

- Collation of room and resource information is impacted by the estates management cycle. Information relating to utilisation of resources may be used to increase / decrease available locations. Where completion of this cycle occurs following commencement of timetabling, this can cause late modification requirements.
- Removal of rooms as teaching and learning resources in order to increase efficiency can result in the presence of unused rooms, resulting in staff resentment.

Examples of innovation:

- All planning cycles in this area that impact timetabling and resource scheduling could be reviewed in order to provide information in order to inform the commencement of the timetabling and resource scheduling process. This may not be possible in all circumstances, however changes to information closer to the delivery of the curriculum could be considered in relation to the impact on timetabling processes versus the associated benefits of the change. This may require major consideration in relation to several planning processes.
- Information relating to available locations could be drawn from any existing estates management information system that contains location information, including supplementary information such as room capacity and alternative configurations, presence of audio-visual equipment and any other relevant planning factors e.g. absence of natural light, step-free access etc.

1.1.5 Sub-process: 5: Timetabling system preparation

Objectives:

The process must result in all required information being stored in the timetabling information system, and all preparatory configuration and planning activities completed in order to proceed to production of the draft timetable.

Description:

The nature of the sub-process will depend on the institutions approach to timetabling, any timetabling system used, and the extent to which full functionality of this system is adopted. The process is likely to involve configuration of the timetabling information system in terms of time-period to be timetabled and institution specific configuration such as the length of teaching and learning activity periods, start and end times for teaching days etc.

This sub-process is heavily influenced by an institutions approach to timetabling (role of a central function in relation to academic departments) and the extent to which access to shared timetabling information systems is rolled-out across the institution.

Preparation tasks are likely to be most extensive where distributed requirements identification is combined with central scheduling and location allocation – this approach is most commonly associated with auto-scheduling.

1.1.5 Sub-process: 5: Timetabling system preparation

The timetable may be 'rolled over' from the previous session in order to start as a template for further planning and development.

Examples of variation:

The nature of the process is largely determined by the extent to which assisted manual-scheduling (where the system identifies clashes through visual guidance during manual scheduling of activities through reference to constraint rules), or auto-scheduling (where the system automatically schedules activities based on constraint rules) are to be used during production of the draft timetable i.e. the timetable is to be redeveloped rather than rolled over:

- Where assisted manual scheduling or auto-scheduling is planned, it is likely that individual student information will be used to allocate individual students to activities, and the development of 'constraint rules' (rules set up by the user during this stage to both 'clash check' scheduled activities based on location, staff and student availability, and other rules – such as the provision of a lunch hour within the middle of the day etc.) will be used to enable any relevant functionality. This scenario requires a greater level of planning and preparation.
- It is possible that the timetable and all associated information will be rolled over and then amended through reference to information systems or communication with staff responsible for areas of academic delivery. Subsequent amendments and modifications will then be made at this stage. 'Roll-over' may involve roll-over of all information including activities, scheduled time, and allocated location. It is possible that activities may have locations removed and location allocation commenced afresh at the next stage, or may be unscheduled for rescheduling afresh at the next stage – or both these scenarios.

Information systems:

A timetabling information system is likely to be used.

Dependencies:

The sub-process is dependent on the collation of all required information required to produce the timetable. Where institutions manage the timetable through collation of extensive information, this is likely to result in dependence on a broad range of other administrative processes.

Issues and challenges:

- Due to time constraints, preparation of the system may need to proceed through use of inaccurate or incomplete information. Further preparation and modification may be required once this supporting information has been provided.
- Where advance functionality is to be used (such as assisted manual scheduling, or auto-scheduling) users will need to be trained in the configuration of any rules required by the system in order to enable this functionality.
- Where provision involves partnership off-site delivery, timetabling information collation is likely to rely on paper-form transfer with the associated risks on inaccuracy.

1.1.5 Sub-process: 5: Timetabling system preparation

Examples of innovation:

- Where distributed requirements identification is coupled with central scheduling and resource allocation, consequences for late submission of required information can be made transparent. This is likely to result in the necessary allocation of any remaining (less satisfactory) activity times and locations.

1.1.6 Sub-process: 6: Production of the draft timetable

Objectives:

The process must result in a documented timetable for teaching and learning. This may consist of multiple timetables for a number of different variables including: staff, students, modules, programmes of study and locations.

Description:

The nature of the sub-process is highly dependent on the approach to timetabling adopted by an institution, however this will involve the following components:

- Scheduling: identifying date and time of teaching and learning activity.
- Location allocation: allocation of rooms to teaching and learning activities.

The process will involve production of the draft timetable including resolution of conflicts in staff, student and location availability.

Examples of variation:

This sub-process is often managed across divisional boundaries within an institution. And can be defined in relation to each of the 'high level' approaches (A-D) we have identified:

- Scenario A: Distributed requirements identification, scheduling, and location allocation.
- Scenario B: Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations.
- Scenario C: Distributed requirements identification and scheduling – central location allocation.
- Scenario D: Distributed requirements identification – central scheduling and location allocation.

In relation to each of these scenarios, the nature of the drafting process is further defined by the extent to which the timetable is 'rolled-over' or drafted afresh each year based on newly collected data. It is important to note that a 'rolled-over' timetable can mean:

- The timetable is totally rolled over (including scheduling and location of activities), then subsequently amended in response to any curriculum, staff, student, and estate changes.

1.1.6 Sub-process: 6: Production of the draft timetable

- Scheduled teaching and learning activities are rolled over, but locations are removed and re-allocated in response to any changes.
- Accommodated teaching and learning activities are rolled over, but scheduled afresh in response to any changes.
- Activities are rolled over, but these are unscheduled and locations removed. These are then rescheduled and locations allocated in response to any changes.

It is also possible that the timetable is developed 'fresh' each year based on information which is not 'rolled-over', but collated from other sources (such as other management information systems) containing updated information.

Where activities are to be rescheduled and or locations reallocated this is usually facilitated through clash checking functionality of a timetabling information system or potentially through use of 'auto-scheduling' functionality, however if the scheduler / location allocator is working at a distributed level and dealing with a relatively small number of programmes of study, a timetabling system may not be used. Tools may have been developed over time to assist this task including paper grids of available schedule positions, or use of spreadsheet records.

It should be noted that where an academic department has 'ownership' of locations within that department, these may be 'borrowed' by other academic departments. Such activity may be coordinated through direct communication between academic departments or through the work of a central coordinating function.

Information systems:

Apart from a timetabling information system, supporting applications may be used to transfer data between distributed and central functions.

Dependencies:

Drafting the timetable for teaching and learning is dependent on the completion and outputs of quite a broad range of other process areas operating within institutions. This is summarised at a high level through figure 5 of the main report.

Issues and challenges:

- Timetabling information system functionality may be utilised to differing levels of sophistication across the institution. This can lead to inconsistent processes and challenges relating to joint provision.
- The huge variation across the sector and difference in approaches to timetabling and resource scheduling, means that off the shelf timetabling systems may require significant tailoring before full functionality can be implemented. Some institutions may not have the resources to tailor systems in this way.
- At some institutions, production of the staff, student, and room timetables may involve distinct, loosely connected processes. Information relating to each of these timetables may not be held in a shared management information system.

1.1.6 Sub-process: 6: Production of the draft timetable

- Timetabling information system auto-scheduling functionality may be challenging to implement for some institutions as this requires a great deal of accurate information.
- Where distributed requirements identification scheduling and location allocation is adopted, making efficient utilisation of space as a resource across the institution is challenging.
- In certain institutions, not accommodating staff preferences may lead to staff attrition, or reduced research delivery capability. Where staff have become accustomed to delivering to the same schedule 'year in year out' there may be resistance to any changes to timetabling processes which may affect this. Staff may simply book rooms and effectively change the timetable to maintain the same working pattern.
- Where distributed requirements identification is coupled with central scheduling and location allocation, it may be difficult to ensure that sensitivity in relation to staff requirements, student experience and pedagogic considerations is maintained. There may be a value for money concern in relation to collating and updating all of the information held (through experience) locally. However some institutions have achieved this and report successful practice in overcoming these issues.
- Many of the priorities that institutions may wish to accommodate through the timetable are conflicting, for example efficient use of resources compared with being student focused and accommodating the preferences and workload of academic staff.
- There is a conflict between certain pedagogic aspirations (e.g. irregular teaching patterns to accommodate certain learning objectives, large lectures followed by breakout sessions all at the same time, vertical (long sessions on the same day) and horizontal teaching (dispersed activities throughout a period e.g. a week) relating to the same module) and the efficient utilisation of space.
- There may be issues relating to the treatment of timetabling staff, including public criticism and in extreme cases bullying. This may prevent agreed timetabling priorities from being implemented.
- Where local requirements identification and scheduling is combined with requests for centrally allocated locations, academic departments may make room bookings for the delivery of teaching and learning activities, and then not use these resources resulting in utilisation reduction. This may be for a number of reasons including:
 - Lack of clarity around anticipated student numbers.
 - Use of rooms for break-out activities where the rooms remain unused for extended periods of time.
- Resolving conflicts in the scheduling of activities can be challenging for a number of reasons, one example relates to the flexibility of the curriculum offering – for example completing levels 1 and 2 concurrently, or (within HE) combined post and undergraduate provision.
- Where locations are towards the perimeter of a campus area, these may be far less popular, reducing utilisation of these resources.

1.1.6 Sub-process: 6: Production of the draft timetable

Examples of innovation:

- Complexities associated with timetabling modules shared between academic areas could be address through use of a shared access timetabling information system.
- Institutions placing a high priority on efficient utilisation of space, and using space as an income source through private hire may want to fully integrate timetabling system information with estates management information systems, and a system allowing invoicing functionality.
- There may be potential for staff to book rooms without these having to be approved by a timetabling administrator, allowing these staff to focus on other timetabling duties. This may need to be limited to certain locations, and booking may need to be limited to a window in advance of the scheduled event e.g. two weeks.
- Centralised auto-scheduling can be used to maximise efficient utilisation of space. It may be necessary to prioritise academic staff preferences, the student experience, and pedagogic considerations in relation to this. Academic departments may be able to make modifications to the sessions / resources allocated following timetable drafting.
- Where locations are allocated centrally, there may be 'zoning' of activities in relation to curriculum areas in order to allow 'identification' with a particular building / section of a building and accommodate timetable consistency for academic staff and students.
- One workshop participant reported current consideration of a method of location allocation where each academic department of the institution would be allocated a certain number of hours within specific location types (e.g. lecture theatre, seminar room etc.), once this limit was reached then further use of this space type would be limited. Consideration of this method has come about as a result of curriculum delivery changes requiring more locations for the same programme of study / module, resulting in an 'unworkable' demand for available locations.
- Where a programme of study or module contains a number of identical teaching and learning activities where a student cohort is divided into smaller teaching groups (such as tutorials or certain practical sessions), identical teaching and learning activities may be scheduled on a range of dates, at a range of times. Timetabling information system functionality has been reported that allows students to view these scheduled sessions online and elect to attend the required number of sessions based on their preferences, the capacity of the session not being exceeded (i.e. on a first come first served basis), and any of the constraints affecting their timetable not being compromised. In this way students are given some flexibility to build elements of their timetable around other commitments. Use of individual student information within the timetabling information system has been reported as a pre-requisite for enabling this functionality.

FE specific points:

Integrating curriculum management, student information, timetabling and registration system functionality may allow individual staff to model curriculum activity, timetable this, and produce register information once students have enrolled.

1.1.7 Sub-process: 7: Review of draft timetable
<p>Objectives: The process allows staff with responsibility for the management of curriculum delivery within academic departments to review the timetable for their areas of curriculum responsibility and identify any errors, or potential improvements.</p>
<p>Description: The timetable will be made available to academic managers in an appropriate format. This is likely to be in the form of timetables for programmes of study or modules, showing the scheduling and location of associated teaching and learning activities. Any required modifications or errors will then be communicated to appropriate timetabling officers.</p>
<p>Examples of variation: The nature of the process is likely to depend on the format in which the timetable is made available to academic staff. This may be through paper communication of the material, or through access to a shared timetabling information system.</p> <p>Timetabling staff may meet with academic managers in order to review the draft timetable, and this may involve the input of distributed or central timetabling staff.</p> <p>It is possible that there may be several cycles of review and improvement. Particularly where changes to the draft timetable identified by one academic department impact the scheduling or location allocation of another department's teaching and learning activities. The timetable may be reviewed following scheduling of activities, and then again following location allocation / any subsequent modifications in either of these areas.</p> <p>It is also possible that the same individual may be responsible for drafting the timetable, reviewing this, and arranging any subsequent modifications. This may be a member of the academic or support / management staff.</p>
<p>Information systems: Timetables may be made available through use of a timetabling information system.</p>
<p>Dependencies: The process is dependent on the production of a draft timetable for review, and communication of this material to the relevant reviewer(s).</p>
<p>Issues and challenges:</p> <ul style="list-style-type: none"> • It is likely that further modifications to the timetable will be required following this exercise.

1.1.7 Sub-process: 7: Review of draft timetable

Examples of innovation:

- Functionality may be implemented that allows monitoring of staff workload in relation to the timetable, both contact time, and other associated commitments (e.g. marking / planning times). This may allow the reviewer to make or request changes to the timetable through use of an integrated product.

1.1.8 Sub-process: 8: Modification of the timetable

Objectives:

The process allows corrections and any necessary modification of the timetable as a result of identified issues with the draft timetable.

Description:

The process will be very similar in nature to that for the development of the draft timetable itself and reflects the approach to timetabling adopted by an institution, this may involve amendment of the:

- Scheduled position of a teaching and learning activity.
- Location allocated to a teaching and learning activity.
- Staff and student information associated with a teaching and learning activity.
- Resolution of any clashes as a result of the above through further modifications.

It is likely that the process will need to be repeated several times following initial review and modification of the timetable as a result of changing circumstances.

Variation:

Modifications to the timetable may involve communication across organisational boundaries within an institution as defined by the approach to production of the draft timetable:

- Scenario A: Distributed requirements identification, scheduling, and location allocation
 - Academic departments are likely to be able to modify all aspects of the timetable without communication with a central function.
- Scenario B: Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations.
 - Modifications to the scheduling and allocation of locations may be made at the distributed level, unless this involves changing the scheduled use of a centrally pooled location – in which case this may need to be negotiated with and coordinated by a central location allocating function.

1.1.8 Sub-process: 8: Modification of the timetable

- Scenario C: Distributed requirements identification and scheduling – central location allocation
 - Academic departments may be able to make changes as to the activities taking place within scheduled locations that have been allocated to them. If changes to the scheduling of locations are required, then this may need to be negotiated with and coordinated by the central timetabling function.
- Scenario D: Distributed requirements identification – central scheduling and location allocation.
 - Academic departments may be able to make changes to the activities scheduled at particular locations without requesting this from the central timetabling function. If a different location is required at a scheduled time then this may need to be negotiated and coordinated with a central function.

Information systems:

A timetabling information system is likely to be used.

Dependencies:

The process is dependent on the completion and outputs of quite a broad range of other process areas operating within institutions. This is summarised at a high level through figure 5 of the main report. Ad hoc modification of the timetable may be required for a broad range of reasons e.g. changes to staff, student, curriculum and estate information.

Issues and challenges:

- Modifications to the timetable are often extensive and may be identified as necessary up to and after the commencement of the delivery period. The extent to which these changes can be reduced, and the extent to which they are 'part of the timetabling problem' varies and is influenced by the extent to which the institution considers impact on timetabling in the design and administration of other processes impacting timetabling (such as curriculum management). However some reasons for late information are unavoidable, such as fluctuation in student numbers, staff loss, and loss of predicted locations (fire, flood etc.).
- Academic staff may request changes to the delivery of new programmes and modules in response to student feedback. This may have an impact on scheduling requirements and required resources following the commencement of curriculum delivery.
- There can be a tension between timetabling and resource scheduling processes and the need to make advanced non-teaching and learning room-bookings, particularly for private-hire / conferencing. Some negotiation and modification of the teaching and learning timetable may be required as a result.

Examples of innovation:

- Accommodating student centred timetabling may be achieved through use of functionality allowing students to identify which tutorial groups they would like to register for, once these have been timetabled.

1.1.8 Sub-process: 8: Modification of the timetable

- Some institutions may have dedicated facilities for conferencing / private hire during periods of curriculum delivery. In addition, some institutions may have specific facilities which accommodate all 'vacation' teaching and learning activity – allowing the remaining campus to be used for conferencing and private hire. In addition, certain facilities used for teaching and learning for the majority of the time, may be made available for a certain regular period during curriculum delivery for private hire – for example on Wednesday afternoons.

1.1.9 Sub-process: 9: Timetable issue

Objectives:

The process allows communication of the timetable to all necessary stakeholders. Both staff and students must be aware of how their teaching and learning activities are scheduled and the location of these events.

Description:

The timetable will be made freely available to all stakeholders. The extent to which personalised timetables are produced will vary.

It is important to note that further changes and modification of the timetable are likely after this point and that institutions will need to manage communication of this information to students.

Examples of variation:

The two main methods of publication involve publication of the timetable online, or through paper distribution. In addition, the extent to which individual student and staff timetables are made available in each format will also vary.

Online publication may involve access to timetable information for particular modules, programmes of study, or individual staff and student timetables. It is likely that individual student information will need to be held within the timetabling information system in order to allow production of individual timetables. Staff and students may be able to view these timetables through reference to an internet website, or through a virtual learning environment (VLE) or other secure portal.

Paper distribution of timetables may also be at the programme, module, or individual student level – and it is likely that individual student information will be required to produce individual student timetables. Paper versions may be published on notice boards or through distribution at initial teaching and learning events / via pigeon holes.

Where individual student timetables are produced (in either paper or online format), allocation to sub-groups of activities occurring at the same time (such as tutorial groups for all those taking a particular module / programme of study) may require students to refer to a separate series of class lists due the increased granularity of this information. Timetabling information system functionality exists whereby it is possible to allocate individual students to sub-groups, however a pre-requisite for use of such functionality is that

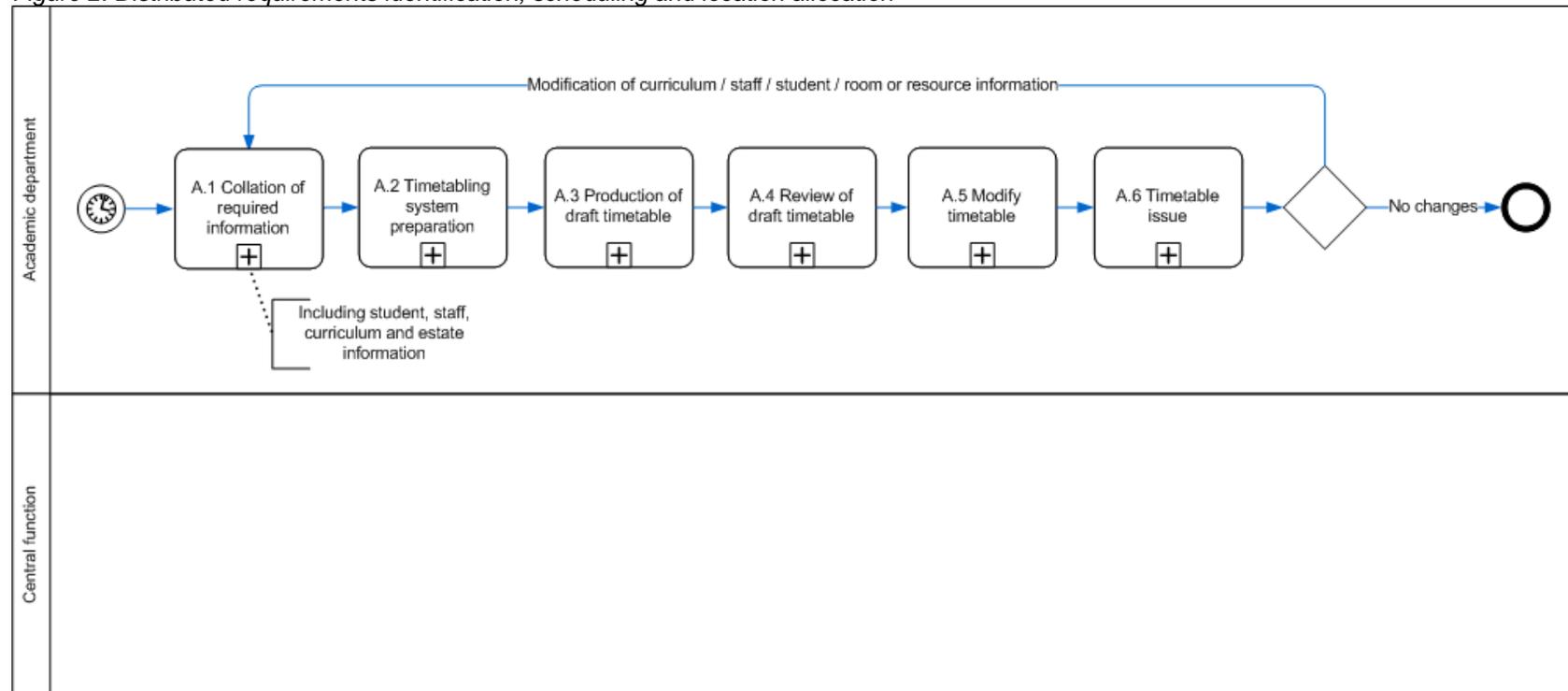
1.1.9 Sub-process: 9: Timetable issue
individual student information is held within the system.
Information systems: A timetabling information system is likely to be used.
Dependencies: The sub-process is dependent of collation and agreement of a timetable for publication.
Issues and challenges: <ul style="list-style-type: none"> • Timetable information may change following the 'publication' of the timetable to staff and students. Communication of this information to staff and students may require re-distribution of hard-copy materials, or notification of changes to an online version of the timetable. • The extent to which automatically generated timetables can be customised by institutions in order to show additional information, or present information in different formats has been raised as an issue by some contributors. • In order to allow production of individual student timetables (where such functionality is available through the institutions timetabling information system), individual student information may need to be held within the system as a prerequisite. This may require alignment of multiple significant administrative processes operating at the institution in order to collate accurate information early enough in the timetabling process.
Examples of innovation: <ul style="list-style-type: none"> • There may be potential to publish individual timetables for staff and students through existing, or new secure access portals. This information could be presented alongside all relevant teaching and learning information (module notes, attainment information, attendance history etc.) such an interface could also allow collection of module information, enrolment etc. • Timetables could be shown on screens outside rooms / within the foyer of buildings in order to communicate any changes / room availability to those entering the building. • There is potential to deploy automatic notification of timetable changes to affected students and staff through issue of emails or text messages. The media adopted could relate to the preferences of the recipient. • There is potential to manage the expectations of staff and students through the development of a transparent timetabling policy reflecting the priorities of the institution in relation to development of the timetable (efficiency, staff preferences, student focus, pedagogic considerations). • Where online publication of the timetable is used across the institution, this has been reported as prompting any changes made within academic departments (to the scheduled time or location of an activity) to be reported back to any central timetabling function. If changes are not reported in this way then inaccurate information will be published online.

2.0 Scenario approaches to timetabling and resource scheduling

Each of these scenario process models and supporting narrative reflects a possible adaptation of the generic process model described above to each of the four model approaches to timetabling and resource scheduling (A-D) identified within section 1 of the main report. The models are intended to help contextualise the information presented throughout section 1 of this document through representation of one possible process scenario reflecting each approach, rather than fully represent all variation in approach throughout the HE and FE sectors.

2.1 Scenario A: Distributed requirements identification, scheduling and location allocation

Figure 2: Distributed requirements identification, scheduling and location allocation



The timetable is essentially developed within academic departments with no central coordination activity. The process commences with the collation of all required information in order to proceed with timetable development (A.1). Information is then commonly organised within a timetabling information system (A.2). Differing levels of functionality will then be employed to develop the draft timetable (A.3), which is then commonly reviewed by those with academic responsibility for each high level subject area (A.4). Any identified modifications will then be made (A.5), and the timetable issued through various means (A.6). It is likely that modifications to the timetable will be required on an ongoing basis, and the timetable will require re-issue.

The following table indicates how each of the process areas shown relates to the generic process model, where detailed descriptive information is provided.

Figure 3: Comparison of this scenario to the generic process model

Scenario A process	Generic model process
A.1	1, 2, 3, 4
A.2	5
A.3	6
A.4	7
A.5	8
A.6	9

The following table highlights potential improvements.

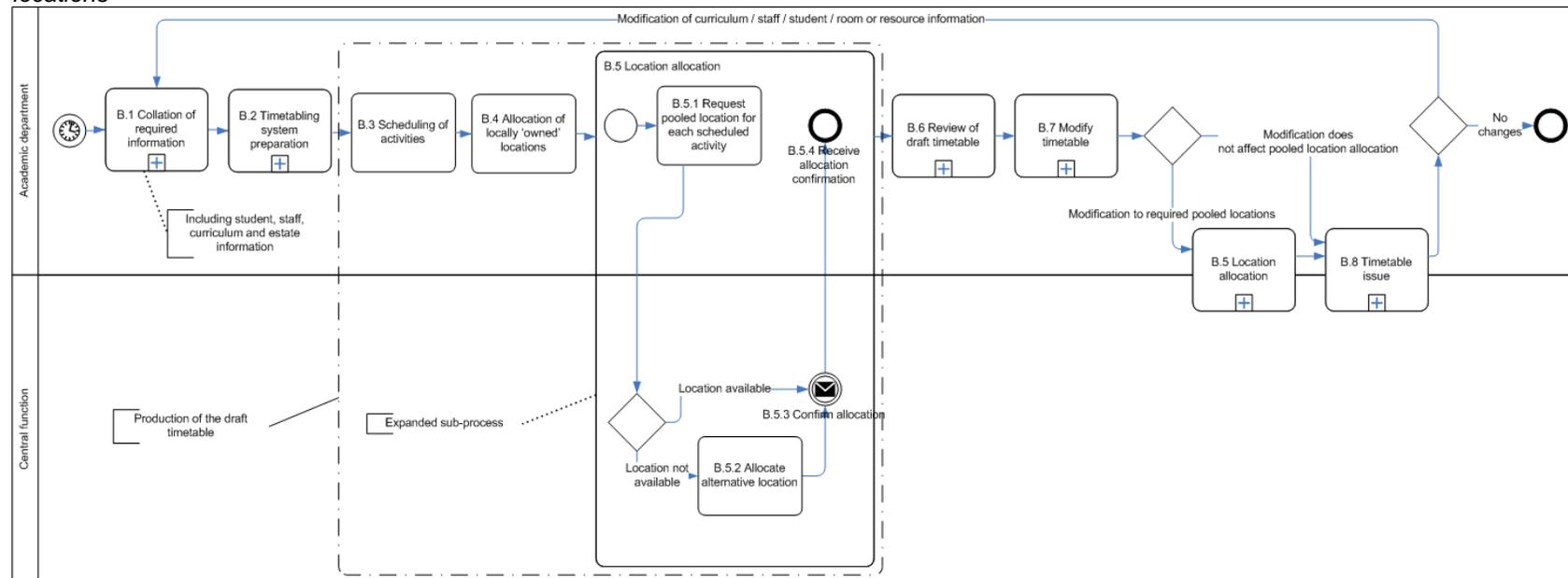
Figure 4: Scenario A – potential process improvements

Scenario A process	Potential improvements
A.1	<ul style="list-style-type: none"> Processes resulting in changes to this data are modified to provide accurate data, where possible, in advance of the timetabling process (particularly curriculum management, estates management, and staff HR processes). Where possible, information relating to progressing student module choices is secured through online forms completed by individual students. This information can then be collated within the timetabling information system. Where information is to be collected from staff outside the timetabling team, online forms are used to gather new information and automatically collate this within the timetabling information system. Rolled-over information may also be updated in this way. Accurate information may be drawn from relevant management information systems (such as the student, HR, estates management information system) to populate the timetabling information system. This is managed through file transfer or dynamic link.

Scenario A process	Potential improvements
	<ul style="list-style-type: none"> Individual student information is collated within the timetabling information system to allow consideration and management of timetabling at the individual student level.
A.2	<ul style="list-style-type: none"> Unused available functionality is reviewed and the benefits of fully utilising this functionality are weighed against any required further investments, such as the need to train staff or implement wider change.
A.3	<ul style="list-style-type: none"> Functionality allowing 'assisted manual scheduling' or auto-scheduling of teaching and learning activities can be employed to assist those developing the draft timetable. Both approaches make use of clash checking functionality to help produce a workable solution. Auto-scheduling functionality may be adopted to produce a timetable making most efficient use of locations. A timetabling policy and associated measures can be adopted to assist the institution in developing a 'good' timetable.
A.4	<ul style="list-style-type: none"> Functionality can be adopted allowing academic lead staff to view the timetable on-screen and consider the workload of staff, and the student experience in relation to programmes of study / modules. Modifications to the timetable could then be made at this point, or requested.
A.5	<ul style="list-style-type: none"> Prescheduled 'sub-groups' (such as tutorials) may be scheduled at different times and students may be able to 'sign-up' for the most convenient session online before or during the initial stage of curriculum delivery.
A.6	<ul style="list-style-type: none"> Timetables for modules, rooms and programmes of study can be made available online. In the event that individual staff and student information is held within the timetabling information system, then it may be possible to publish individual staff and student timetables in this way. Access to individualised timetables may be through a secure access portal containing other curriculum information, such as a Virtual Learning Environment (VLE). Automatic notification of any essential changes to the timetable (for example, due to staff illness) could be distributed to students through use of text messages and / or emails in line with student preferences.

2.2 Scenario B: Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations

Figure 5: Distributed requirements identification, scheduling and allocation of locally 'owned' locations – central allocation of 'high demand' pooled locations



The timetable is mainly developed within academic departments, however a central 'rooming' function is responsible for the allocation of centrally pooled 'high-demand' locations for teaching and learning. The process commences with the collation of all required information in order to proceed with timetable development (B.1). Information is then commonly organised within a timetabling information system (B.2). Production of the draft timetable then commences with scheduling of teaching and learning activities by academic department staff, differing levels of timetabling system functionality may be adopted to assist this process (B.3), locally 'owned' locations can then be allocated to these scheduled activities as appropriate (B.4). Production of the draft timetable then continues and ends with allocation of centrally 'owned' pooled locations, managed through a request and confirmation sub-process (B.5). This draft timetable is then commonly reviewed by those with academic responsibility for each high level subject area (B.6). Any identified modifications will then be made (B.7), in the event that these changes require modification to the location allocation, this sub-process will need to be repeated (B.5). Once amendments have been made the timetable is issued through

various means (B.8). It is likely that modifications to the timetable will be required on an ongoing basis, and the timetable will require re-issue.

The following table indicates how each of the process areas shown relates to the generic process model, where detailed descriptive information is provided.

Figure 6: Comparison of this scenario to the generic process model

Scenario B process	Generic model process
B.1	1, 2, 3, 4
B.2	5
B.3	6
B.4	6
B.5	6
B.6	7
B.7	8
B.8	9

The following table highlights potential improvements.

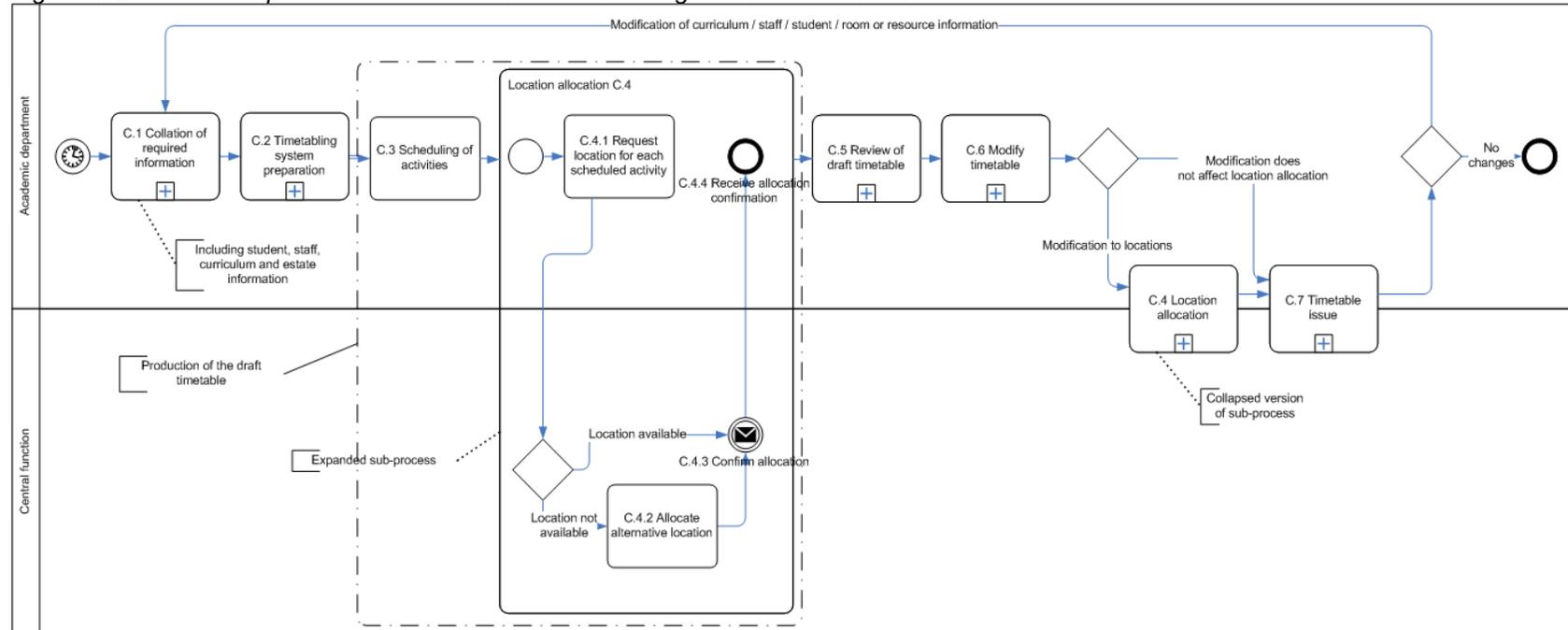
Figure 7: Scenario B – potential process improvements

Scenario B process	Potential improvements
B.1	<ul style="list-style-type: none"> Processes resulting in changes to this data are modified to provide accurate data, where possible, in advance of the timetabling process (particularly curriculum management, estates management, and staff HR processes). Where possible, information relating to progressing student module choices is secured through online forms completed by individual students. This information can then be collated within the timetabling information system. Where information is to be collected from staff outside the timetabling team, online forms are used to gather new information and automatically collate this within the timetabling information system. Rolled-over information may also be updated in this way. Accurate information may be drawn from relevant management information systems (such as the student, HR, estates management information system) to populate the timetabling information system. This is managed through file transfer or dynamic link. Individual student information is collated within the timetabling information system to allow consideration and management of timetabling at the individual student level.

Scenario B process	Potential improvements
B.2	<ul style="list-style-type: none"> Unused available functionality is reviewed and the benefits of fully utilising this functionality are weighed against any required further investments, such as the need to train staff or implement wider change.
B.3 - 4	<ul style="list-style-type: none"> Functionality allowing 'assisted manual scheduling' or auto-scheduling of teaching and learning activities can be employed to assist those developing the draft timetable. Both approaches make use of clash checking functionality to help produce a workable solution. A timetabling policy and associated measures can be adopted to assist the institution in developing a 'good' timetable.
B.5	<ul style="list-style-type: none"> Allocation of locations is managed through use of a timetabling information system where requests for specific locations are made through use of online forms. Alternatively, there is shared access to this system throughout the institutions – academic departments can schedule activities within the system and then request locations in relation to these. Requests are then confirmed by the central function.
B.6	<ul style="list-style-type: none"> Functionality can be adopted allowing academic lead staff to view the timetable on-screen and consider the workload of staff, and the student experience in relation to programmes of study / modules. Modifications to the timetable could then be made at this point, or requested.
B.7	<ul style="list-style-type: none"> Prescheduled 'sub-groups' (such as tutorials) may be scheduled at different times and students may be able to 'sign-up' for the most convenient session online before or during the initial stage of curriculum delivery.
B.8	<ul style="list-style-type: none"> Timetables for modules, rooms and programmes of study can be made available online. In the event that individual staff and student information is held within the timetabling information system, then it may be possible to publish individual staff and student timetables in this way. Access to individualised timetables may be through a secure access portal containing other curriculum information, such as a Virtual Learning Environment (VLE). Automatic notification of any essential changes to the timetable (for example, due to staff illness) could be distributed to students through use of text messages and / or emails in line with student preferences.

2.3 Scenario C: Distributed requirements identification and scheduling – central location allocation

Figure 8: Distributed requirements identification and scheduling – central location allocation



The timetable is mainly developed within academic departments, however a central ‘rooming’ function is responsible for the allocation of all locations for teaching and learning. The process commences with the collation of all required information in order to proceed with timetable development (C.1). Information is then commonly organised within a timetabling information system (C.2). Production of the draft timetable then commences with scheduling of teaching and learning activities by academic department staff, differing levels of timetabling system functionality may be adopted to assist this process (C.3). Production of the draft timetable then continues and ends with allocation of locations managed through a request and confirmation sub-process (C.4). This draft timetable is then commonly reviewed by those with academic responsibility for each high level subject area (C.5). Any identified modifications will then be made (C.6), in the event that these changes require modification to the location allocation, this sub-process will need to be repeated (C.4). Once amendments have been made the timetable is issued through various means (C.7). It is likely that modifications to the timetable will be required on an ongoing basis, and the timetable will require re-issue.

The following table indicates how each of the process areas shown relates to the generic process model, where detailed descriptive information is provided.

Figure 9: Comparison of this scenario to the generic process model

Scenario C process	Generic model process
C.1	1, 2, 3, 4
C.2	5
C.3	6
C.4	6
C.5	7
C.6	8
C.7	9

The following table highlights potential improvements.

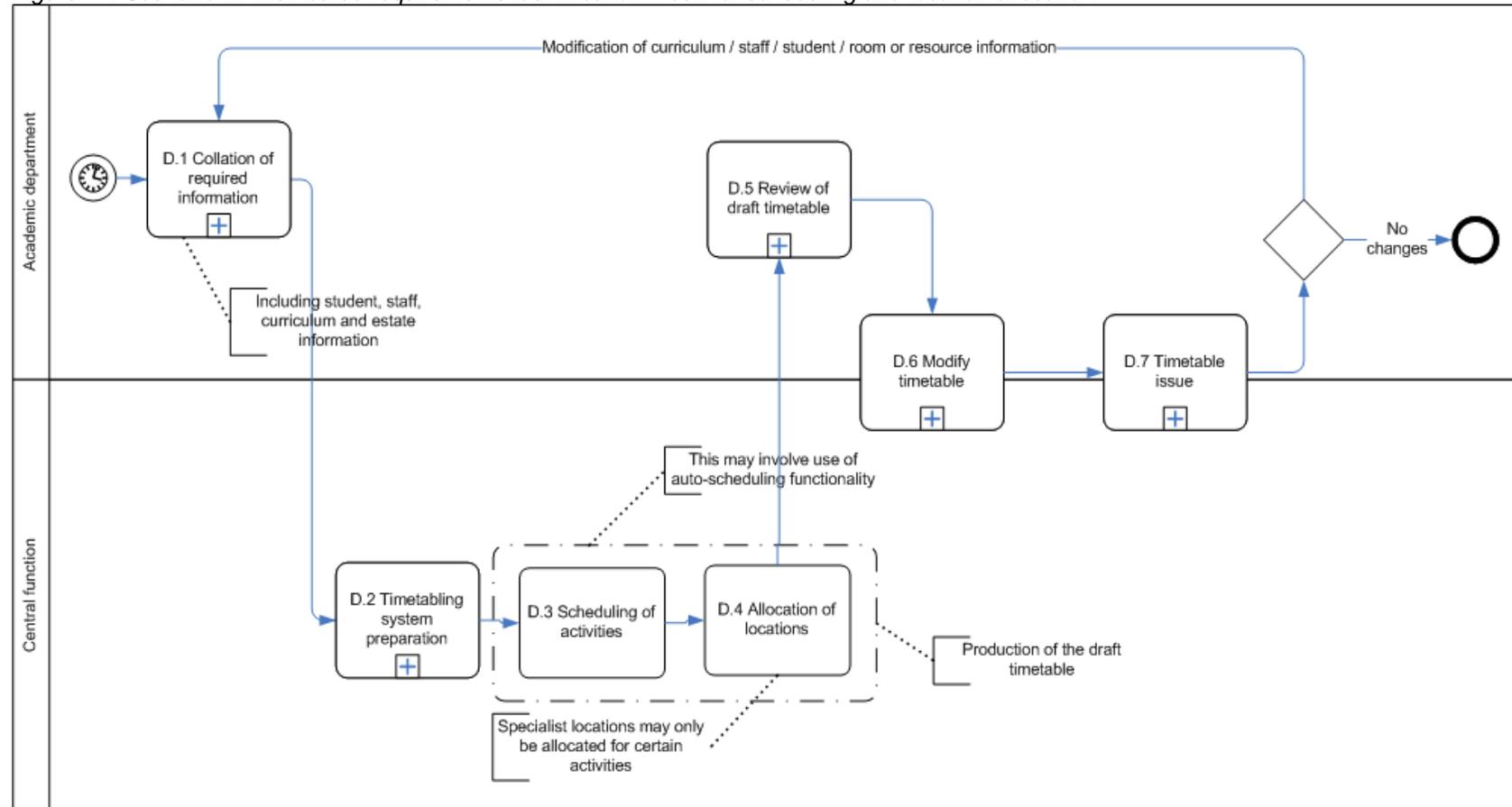
Figure 10: Scenario C – potential process improvements

Scenario C process	Potential improvements
C.1	<ul style="list-style-type: none"> Processes resulting in changes to this data are modified to provide accurate data, where possible, in advance of the timetabling process (particularly curriculum management, estates management, and staff HR processes). Where possible, information relating to progressing student module choices is secured through online forms completed by individual students. This information can then be collated within the timetabling information system. Where information is to be collected from staff outside the timetabling team, online forms are used to gather new information and automatically collate this within the timetabling information system. Rolled-over information may also be updated in this way. Accurate information may be drawn from relevant management information systems (such as the student, HR, estates management information system) to populate the timetabling information system. This is managed through file transfer or dynamic link. Individual student information is collated within the timetabling information system to allow consideration and management of timetabling at the individual student level.
C.2	<ul style="list-style-type: none"> Unused available functionality is reviewed and the benefits of fully utilising this functionality are weighed against any required further investments, such as the need to train staff or implement wider change.

Scenario C process	Potential improvements
C.3	<ul style="list-style-type: none"> • Functionality allowing 'assisted manual scheduling' or auto-scheduling of teaching and learning activities can be employed to assist those developing the draft timetable. Both approaches make use of clash checking functionality to help produce a workable solution. • A timetabling policy and associated measures can be adopted to assist the institution in developing a 'good' timetable.
C.4	<ul style="list-style-type: none"> • Allocation of locations is managed through use of a timetabling information system where requests for specific locations are made through use of online forms. Alternatively, there is shared access to this system throughout the institutions – academic departments can schedule activities within the system and then request locations in relation to these. Requests are then confirmed by the central function.
C.5	<ul style="list-style-type: none"> • Functionality can be adopted allowing academic lead staff to view the timetable on-screen and consider the workload of staff, and the student experience in relation to programmes of study / modules. Modifications to the timetable could then be made at this point, or requested.
C.6	<ul style="list-style-type: none"> • Prescheduled 'sub-groups' (such as tutorials) may be scheduled at different times and students may be able to 'sign-up' for the most convenient session online before or during the initial stage of curriculum delivery.
C.7	<ul style="list-style-type: none"> • Timetables for modules, rooms and programmes of study can be made available online. In the event that individual staff and student information is held within the timetabling information system, then it may be possible to publish individual staff and student timetables in this way. Access to individualised timetables may be through a secure access portal containing other curriculum information, such as a Virtual Learning Environment (VLE). • Automatic notification of any essential changes to the timetable (for example, due to staff illness) could be distributed to students through use of text messages and / or emails in line with student preferences.

2.4 Scenario D: Distributed requirements identification – central scheduling and location allocation

Figure 11: Scenario D: Distributed requirements identification – central scheduling and location allocation



The timetable is mainly developed within a central function of the institution, however this is based on the specifications and information provided by academic departments. The process commences with the collation of all required information in order to proceed with timetable development (D.1). Information is then commonly organised within a timetabling information system (D.2). Production of the draft timetable then commences with scheduling of teaching and learning activities (D.3), and allocation of locations

to these activities (D.4). The draft timetable is then commonly reviewed by those with academic responsibility for each high level subject area (D.5). Any identified modifications will then be made (D.6), and the timetable is issued through various means (D.7). It is likely that modifications to the timetable will be required on an ongoing basis, and the timetable will require re-issue.

Figure 12: Comparison of this scenario to the generic process model

Scenario D process	Generic model process
D.1	1, 2, 3, 4
D.2	5
D.3	6
D.4	6
D.5	7
D.6	8
D.7	9

The following table highlights potential improvements.

Figure 13: Scenario D – potential process improvements

Scenario D process	Potential improvements
D.1	<ul style="list-style-type: none"> Processes resulting in changes to this data are modified to provide accurate data, where possible, in advance of the timetabling process (particularly curriculum management, estates management, and staff HR processes). Where possible, information relating to progressing student module choices is secured through online forms completed by individual students. This information can then be collated within the timetabling information system. Where information is to be collected from staff outside the timetabling team, online forms are used to gather new information and automatically collate this within the timetabling information system. Rolled-over information may also be updated in this way. Accurate information may be drawn from relevant management information systems (such as the student, HR, estates management information system) to populate the timetabling information system. This is managed through file transfer or dynamic link. Individual student information is collated within the timetabling information system to allow consideration and management of timetabling at the individual student level.

Scenario D process	Potential improvements
D.2	<ul style="list-style-type: none"> • Unused available functionality is reviewed and the benefits of fully utilising this functionality are weighed against any required further investments, such as the need to train staff or implement wider change.
D.3-4	<ul style="list-style-type: none"> • Functionality allowing ‘assisted manual scheduling’ or auto-scheduling of teaching and learning activities can be employed to assist those developing the draft timetable. Both approaches make use of clash checking functionality to help produce a workable solution. Auto-scheduling functionality may be adopted to produce a timetable making most efficient use of locations. • A timetabling policy and associated measures can be adopted to assist the institution in developing a ‘good’ timetable.
D.5	<ul style="list-style-type: none"> • Functionality can be adopted allowing academic lead staff to view the timetable on-screen and consider the workload of staff, and the student experience in relation to programmes of study / modules. Modifications to the timetable could then be made at this point, or requested.
D.6	<ul style="list-style-type: none"> • Prescheduled ‘sub-groups’ (such as tutorials) may be scheduled at different times and students may be able to ‘sign-up’ for the most convenient session online before or during the initial stage of curriculum delivery.
D.7	<ul style="list-style-type: none"> • Timetables for modules rooms and programmes of study can be made available online. In the event that individual staff and student information is held within the timetabling information system, then it may be possible to publish individual staff and student timetables in this way. Access to individualised timetables may be through a secure access portal containing other curriculum information, such as a Virtual Learning Environment (VLE). • Automatic notification of any essential changes to the timetable (for example, due to staff illness) could be distributed to students through use of text messages and / or emails in line with student preferences.