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Post-Occupation Evaluation Study Report

Power, Electronics and Machines Centre (PEMC)

April 2023

BUILDING UNDERSTANDING

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INTRODUCTION

Building Understanding was asked to conduct a Post Occupation Evaluation study of the Power, Electronics and Machines Centre (PEMC) on behalf of the University of Nottingham. The building was completed in February 2021 with the post occupancy study conducted in Spring 2023, having been delayed by the Coronavirus pandemic. Remote interviews, conducted via Teams, were used to gather data.

PROJECT BACKGROUND

The PEMC was built on the Jubilee Campus to provide state-of-the-art facilities for research by the Power Electronics, Machines & Control research group. A budget of £8M was allocated to this project along with £1.5M external funding from the Wolfson Foundation and £4M from Propulsion Futures.

The goal was to move the PEMC research group from their existing facility in the Tower on University Park, to a purpose built, modern facility on Jubilee Campus. Here, they would be based near other new research centres, some of which are also occupied by the Faculty of Engineering.

The original design was selected following a design competition. As the project developed, and the complex electrical service needs were better understood, budget restrictions meant that some alterations had to be made to the external fabric of the building, in order to fund these internal requirements. Some needs were not fully understood until the post-tender period when additional, external funding was awarded, which brought additional challenges.

The project aimed for BREEAM Excellent, and this goal was successfully met.

PROJECT DATA

Name of facility:	Power Electronics and Machines Centre (PEMC)
Location:	Jubilee Campus
Gross area:	8,332 sq.m
Number of storeys:	Three
Users of the facility:	Power Factors Research Group – Faculty of Engineering
Room types:	Laboratories and offices
Start on site:	June 2019
Date completed:	February 2021
Period on site:	21 months
Gross construction cost:	£13.5M
Funding:	Internal capital funding plus external funding via grant
Contract type:	JCT Design & build

OBJECTIVES OF THIS POST-OCCUPATION EVALUATION

- To highlight issues and best practice associated with the project during procurement, and the construction phase.
- To bring to light any key issues associated with the operation and management of the project during all phases of the development process.
- To draw out stakeholder feedback concerning the design of the building and the experience of those who use the facility.
- To analyse all output from the interviews, focus group and the workshop to provide a summary report with recommendations.

SCOPE OF THE STUDY

STUDY PARTICIPANTS AND METHODOLOGIES

The University of Nottingham's Estates team provided Building Understanding with background to the PEMC project. Building Understanding used this information to generate questionnaires aimed at three main groups of stakeholders: the University's Estates team, consultant stakeholders who delivered the project, stakeholders and users of the finished facility.

Building Understanding gathered feedback from 12 individuals via interviews. In addition to a comment, some of the interview questions involved giving a satisfaction rating, where '1' represents 'totally dissatisfied' and '10' denotes 'totally satisfied'.

Interview methodology

In order to create an environment which matched a face-to-face interview as closely as possible, whilst achieving the efficiency of remote working, all interviews were conducted over Microsoft Teams.

Feedback, mainly by interview, was gathered from the following:

Estates Office staff

- Head of Capital Projects
- The Capital Projects Manager
- Campus Services Manager
- Assistant Senior Engineer

Consultants

Respondents represented the following stakeholders involved in the project's delivery:

- The architect
- The M&E designer – two interviews
- The cost manager
- The external project manager
- The M&E delivery contractor

Unfortunately, at the time the PoE was carried out, the main contractor was no longer trading. This means that the viewpoint of the main delivery contractor could not be obtained for the purposes of the evaluation.

Stakeholders

Feedback was gathered from technical staff involved in the project one of whom works within the completed facility.

- Senior Technical Manager PEMC, Faculty of Engineering
- Technical Services Manager, Faculty of Engineering

The workshop

The workshop objectives were to:

- Present the feedback gathered through the interviews.
- Examine to what extent the PEMC has delivered against the original vision.
- Discuss any issues raised.
- Generate recommendations for application to future University projects.

The workshop took place on 20th March 2023. There were seven attendees from the project group and stakeholders.

SAMPLE SIZES

It is important to note that quantitative feedback in this report is based on small sample sizes, particularly for user feedback. The qualitative feedback given, however, was extremely rich in detail from the interviews and workshop.

FINDINGS OF THIS POE

THE BIG PICTURE

Overall, the PEMC is a successful building with very high specification electrical capabilities, plus flexible labs and offices to support research. Despite having to make some compromises to the external aesthetic, the building is still appropriate for its location on the Jubilee Campus.

The project journey was challenging and went both over the original budget and programme. Some of this was due to the very complex service requirements of the building, plus additional external funding that was awarded for equipment in the post tender phase. A significant amount of value engineering was required, but the project group worked together well to ensure that this was a positive exercise.

There were issues with the performance of the main contractor, who has unfortunately subsequently ceased trading. This created problems during the construction phase and during the defects period. Fortunately, the M&E sub-contractor was known to the university and took a very pro-active and collaborative approach. Their performance helped greatly in the delivery of the successful PEMC.

Below are some quotes made by people involved in the evaluation:

Positives

Overall, the PEMC is a high-quality research facility which has moved the team to a facility which supports and attracts research and funding.

Respondents said:

'When you bring visitors around and show them what we can do, that brings in extra work and money. It is the 'wow' factor'.'

'There are lots of companies wanting to come in and do research and they are bursting at the seams trying to do all the projects.'

The electrical capabilities of the building are world class. The multi-voltage panel is flexible and unique.

An end user said:

'The multi voltage panel and the electrical infrastructure here, doesn't exist anywhere else in the world. It is so flexible, so unique, it is very, very good for what we need.'

Whilst the project journey was challenging the team worked well together to overcome the challenges, and deliver a good end result. The M&E sub-contractor received praise for their proactive behaviours and how this aided the delivery of the project.

One project group member said:

'Everybody just seemed to want to get to the end with the exact same goals. It was nice to be involved in it.'

Another said:

‘The M&E sub-contractor took the lead on PEMC. If it had been a less competent contractor; we might still be on site now to be honest!’

Negatives

The project journey was very difficult, and the project went over time and budget. Some of this was as a result of increased understanding of developing electrical services needs as the project progressed. A significant value engineering exercise was required, and this did mean that some of the external features from the original design were lost.

Project group members said:

‘We might have been a bit sucked into the imagery of the winning scheme in the sense that it would have been a push to try and keep it.’

‘We had to go for additional funding for this project because the stakeholder requirements changed and that then had a knock-on effect to the overall project where we needed another £2 million to complete what they were asking for.’

The main contractor struggled with delivery of the project. There was some churn of staff on-site which resulted in the loss of information and understanding. As the main contractor ceased trading during the defects period, there has been an impact on the perception of quality and in the resolution of snags and defects.

Interviewees said:

‘I think the root cause of difficulties was the turnover of staff from the main contractor side and the loss of information.’

‘There were points when the main contractor became too contractual and often in a way that did not seem to help them either.’

‘There are always snags on any new building but they have gone on for a long time now because the main contractor has gone into administration.’

In an effort to create flexibility and because of value engineering, there are limited walls and acoustic barriers in the laboratories. This means that noise is a problem. This may become worse as the amount of equipment running increases. Whilst PPE has been issued, this is not the ideal solution to the hazard, and this may need to be revisited.

One user said:

‘Initially we were looking at trying to put some walls up between the workshops, but with the crane going through, it was going to become an impossible task. So, what we decided to do was just manage noise locally.’

‘Some of the acoustic barriers got value engineered out. When we start running some of these big test plants, we are going to be having complaints.’

HOW CLOSELY THE PEMC FULFILS THE ORIGINAL VISION

Overall, the PEMC meets the original vision although there were some changes made to the external façade, due to value engineering. Whilst these did change how the PEMC looks externally, they are not felt to have significantly compromised the aesthetic.

One member of the project group said:

‘There is probably room for some improved aesthetics externally. I think there were some savings that were made on how the building ultimately looked.’

Another said:

‘It is a good-looking building and fits in with the university’s aspirations for its function.’

From an M&E services perspective, the building has delivered on some very challenging electrical supply requirements. The multi-voltage panel gives flexibility and is world-class. The users have a facility that they are happy with and which fulfils their research needs.

Ultimately, it was the right decision to prioritise the functionality of the building over some of the ‘nice to have’ external features.

One stakeholder said:

‘The end product and what that can actually do – it is just a fantastic facility. For the occupants, the visitors, the end product is the success.’

FEEDBACK FROM THE PROJECT TEAM

THE DESIGN AND CONSTRUCTION PHASE

The contract for PEMC was Design & Build. The original design for PEMC was selected following a design competition. However, as the design was developed, affordability of the original vision became an issue, and some features were removed following a value engineering exercise. The value engineering process was not felt to have been negative and it is considered that some good solutions came out of this process. The compromises made were challenging but, overall, are felt to have been successful. Whilst the building doesn't look exactly like the chosen design, it is still attractive and appropriate for its location on the Jubilee Campus. One member of the project team said:

'It would have been nice to have been able to afford the original architectural design but as much as we have lost that I don't think we have a lesser building in the end.'

Costs were a challenge, largely due to the complexity of the equipment and services required within the facility. In particular, the building had some very complex electrical infrastructure, which was challenging to understand and design because it was beyond anything that the team had previously designed and installed. In addition, whilst allowances had been made for standard equipment such as benches, specialist requirements significantly increased the costs of this type of equipment.

Additional funding had to be requested from the university once these requirements were understood. The application for additional funding was supported by the savings already identified through value engineering. The university executive board and estates team were highlighted as having been very supportive in relation to the budget challenges. One stakeholder said:

'We had to go back to the university board to request more money to change spec during the process. The support from the university executive board was brilliant, as was support from Estates.'

One of the most difficult elements of the process was the stakeholder engagement, and teasing out the specific needs of all of the groups who would be using the building. Operational stakeholders were actively engaged, although it may have been helpful for someone to be embedded in the project group to ensure that they had time to focus on the project. In addition, the project may have benefitted from a greater involvement by academics and researchers who would be using the building. Some requirements were identified quite late in the design process, and it is possible that if the detailed needs had been fully understood at the outset, then this would have assisted the design consultants and the understanding of the budget requirements.

There were challenges for the consultants on occasion, with one feeling that stakeholders wanted to be too involved in the detailed design. This was likely to be as a result of the fact that no one within the team had delivered electrical infrastructure of the complexity of that required in PEMC. It appears that some specification information was lost within communication between the stakeholders and consultants which meant the design in the tender documents did not cover all of the identified requirements. Since this project, a page-

turn exercise has been introduced prior to going out to tender, to ensure that all required information has been included.

The start of work on-site was made more difficult as it was identified that asbestos from a previous building had not been properly cleared by the demolition company. It appears that asbestos fibres had been spread across the ground as part of the removal of old equipment. The quantity of fibres found was not large but created concern for the main contractor and added additional cost to the project. The university has a new asbestos manager in post since this time, and it clear that they now have more robust processes in place for works which are now taking place.

Despite a positive tender and pre-start meeting, the main contractor struggled with the delivery of the works from the outset on-site. It is felt that the building was too large and complex for the main contractor to manage. Churn of staff at the main contractor meant that information and relationships were lost. In addition, it was felt that the main contractor was not open when it was facing struggles, and this was not helpful to the delivery process. Unfortunately, the main contractor has now ceased trading and was therefore unable to put forward a viewpoint for the evaluation.

Fortunately, the university has an established relationship with the M&E contractor appointed to carry out works on PEMC. This sub-contractor took a very pro-active approach and when things became very problematic, worked directly with the university to identify solutions. This sub-contractor no doubt played a significant role in the completion and success of the final facility. One of the project group members said:

'*I have worked with The M&E contractor on quite a few jobs and they have all been very good and very helpful through the whole process. They are an outfit that really know what they are doing and really try to help give the client what they want.'*

Works took place during the COVID pandemic which affected aspects such as site visits by consultants. However, the main contractor stopped work for only a very short period and hence the impact of the pandemic on the programme was minimised.

In hindsight, it is felt that the project may have been more successfully run as a two stage delivery because of the complexities of the services and electrical requirements. Specialist teams could have been involved earlier to increase the understanding of requirements and how they can be delivered. This option could be considered in future for projects where it is appropriate.

Recommendations

- Carry out testing and spot checks after demolition and removal of asbestos to ensure that work has been completed to a satisfactory standard.
- For future projects, consider in more detail the best way to approach the contract based on the particular detail of the building. Use a two-stage approach if this is likely to give the best outcome for the project.
- For technically complex projects, bring specialists on board at the earliest opportunity to enable their knowledge to inform the project and identify the best solutions.

- Ensure that sufficient time is given at project inception to fully understand building requirements and specification detail. This will help the design consultants and ensure affordability.
- Continue the new process of completing a pre-tender page-turn exercise to ensure that all requirements have been included in the design, and tender documents.
- Where possible embed someone from the stakeholder group in the project team, so that they have the time required to focus on the project.

FEEDBACK RELATED TO THE DESIGN AND LAYOUT

The PEMC was built following the original plans submitted by the architect, although value engineering requirements did result in some changes to the external aesthetic and some features within the building.

The goal was to build a flexible laboratory space along with modern, open plan offices plus meeting rooms. In general, this has been achieved.

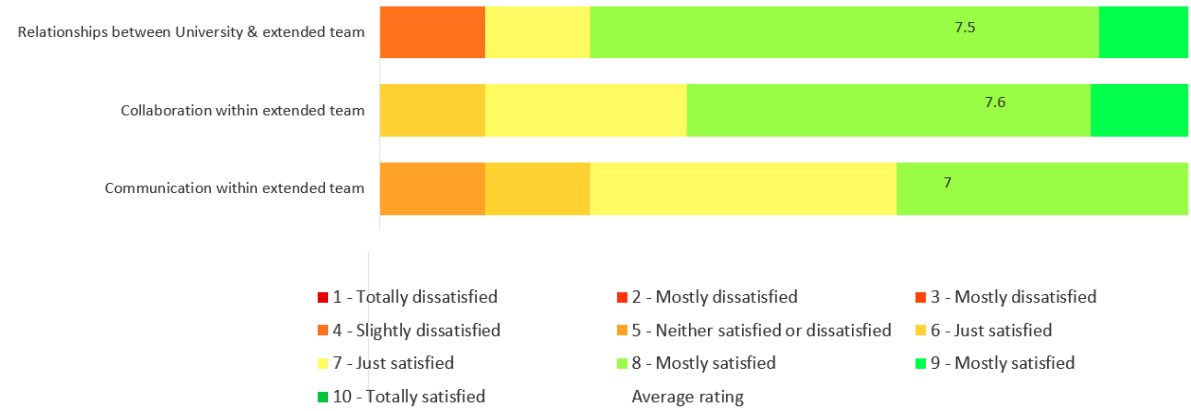
Flexibility

Respondents are mostly satisfied with flexibility. The lab space was kept open plan to increase flexibility and there is an overhead crane to assist with the movement of equipment and materials.

The multi-voltage panel provides a wide range of electrical supplies, both AC and DC. There is HV capacity and a very large overall electrical capability.

In addition, there is a ballistic test pit available for specific works.

FEEDBACK RELATING TO RELATIONSHIPS, COMMUNICATION AND COLLABORATION



During the design and construction phase, relationships within the project group were generally considered relatively good. Despite challenges within the project journey, it appears that the project group were working together to resolve them, leading to a generally positive experience.

There was considerable effort from the university estates team and the project group to engage with stakeholders and understand the complex requirements. When there were

challenges in relation to budgets, the project group appear to have worked together to resolve them.

One respondent had this to say:

'Everybody just seemed to want to get to the end with the exact same goals. It was nice to be involved in it.'

These ratings may have been affected by numerous changes of external project manager, some through unavoidable circumstances. This churn of staff was felt to have brought challenges to relationships and communication.

Collaboration

When it came to collaboration, a respectable average rating of '7.6' was given, with the majority of respondents 'satisfied'. Overall, it was felt that the project team worked together to find solutions and carry out the challenging value engineering exercise.

One consultant commented:

'We collaborated very well. From the client-side consultancy team, with the designers and project managers, it went very well. At the key stages, when it got difficult and the tenders came back in, we worked very closely to identify further ways to save money.'

Communication

A question on communication yielded slightly lower ratings with an average rating of '7'.

Gathering stakeholder information was challenging as there were a number of consultees with different requirements. Potentially, the project would have benefitted from more involvement from the academics and researchers about requirements. This group were not as forthcoming as they could have been, and this did impact the project. A more organised route of agreeing and communicating requirements would have been beneficial.

It was also felt that some requirements were identified late, with some coming after the tender process. One interviewee said:

'There were potentially some issues with communication from stakeholders from the university side and bringing things to the party late on, when they could have actually divulged it earlier.'

Some of this was due to additional funding being made available to researchers during the design and construction phase. Unfortunately, this is a challenge that is very difficult to overcome, as research teams apply for numerous funding streams and have no clear line-of-sight about which ones they are likely to be awarded.

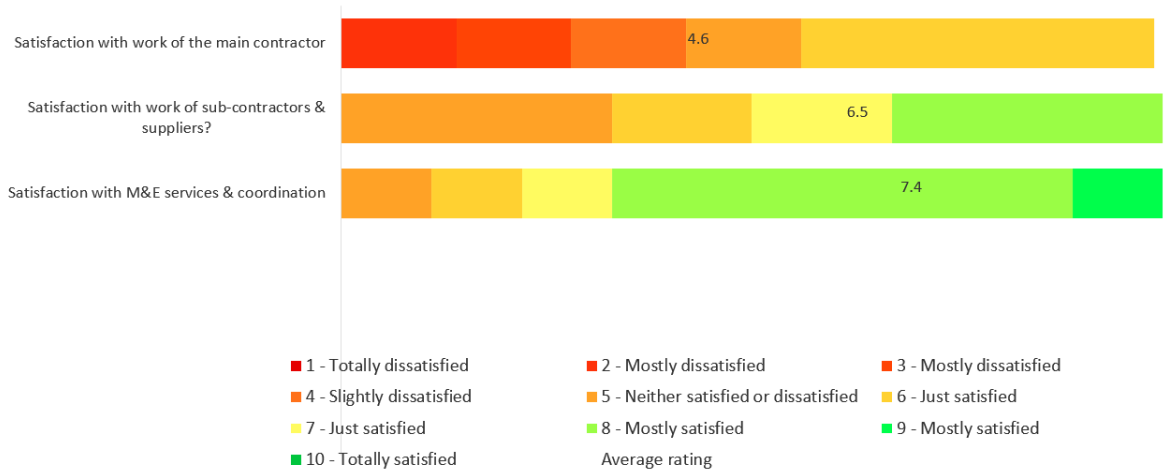
The stakeholders were unusually involved in the design process, which consultants found challenging. It was identified that some submitted specification requirements were missed from the design by the consultants at the tender stage. This caused complications with budgets and resulted in the need to request additional funding. These issues were likely to be as a result of the requirements being so specialist, meaning that the usual boundaries for involvement became blurred.

Overall, some of the communication was considered too informal and it was felt that the project group would have benefitted from some more formal communication, such as action points and trackers.

Recommendations

- Ensure that academic staff and researchers are fully engaged, at an early stage, in the design process to make certain that requirements are completely understood.
- Agree a coordinated approach to collate requirements and changes. Communicate these requirements through structured channels to guarantee information is not lost.
- Formalise communication routes where it will help to manage information and monitor progress. Create action points from meetings and use trackers to monitor requirements and changes.

FEEDBACK RELATING TO MAIN CONTRACTOR AND SUPPLY CHAIN



Main Contractor

No respondents were satisfied with the performance of the main contractor. The average rating was '4.6', which is very low.

After promising early signs, once on-site, issues began to emerge almost straight away. Overall, it appeared that the project was too large for the contractor to comfortably manage. One respondent said:

'We had a team building event at the start which was really good. When we set foot on their site though, it was all 'on a shoestring.''

There was a considerable churn of staff from the main contractor, meaning that knowledge and relationships were lost. This was felt to be the root cause of a number of the difficulties. While changes of staff are inevitable on a project of this length but potentially the handover of information could have been better.

The main contractor was felt to have taken quite a contractual approach, rather than focussing on collaboration and solutions. This was time consuming and wasn't felt to actually help the main contractor in many instances. They were not good at relaying when there were

issues, which made it difficult for the project team to understand the challenges, or to provide support and assistance.

One respondent said:

'The way the main contractor approached it was quite confrontational. We had quite a few meetings to discuss claims on both programme and cost, so it was time consuming from that front.'

Unfortunately, the main contractor has now ceased trading. This means that their viewpoint could not be gathered as part of the evaluation. It is possible that some of the issues may have been as a result of the difficulties that the contractor was facing.

Despite these issues, it was felt that the contractor selection process had been robust and that the reasons for selecting the contractor were sound. The cost difference at tender between the top two contractors was minimal and it is not known whether another contractor would have performed better, based on the complexities of the project. Going forward, the university is placing an increased in weighting towards quality and reducing the weighting on cost.

Supply Chain

The performance of the M&E sub-contractor was much more highly rated. They received an average rating of '7.4'.

This was a very electrically complex project and fortunately the university has an established relationship with the M&E contractor. When things became difficult with the main contractor, the M&E contractor worked directly with the project team to identify solutions and take a lead. They are credited with making a significant contribution to the success of the project.

One consultant said:

'The M&E contractor is willing to have a conversation and they wanted to solve the problems. I always felt when I was having a conversation with them, that their first thought was, 'we need to solve a problem' and then the impacts on the contract were secondary.'

The performance of other sub-contractors received an average rating of '6.5'. There was some good performance identified from the cladding contractor, but poorer performance in relation to the window installation. Most notably, the contractor who carried out the demolition of the old building had not removed the asbestos adequately, resulting in additional work being required.

Recommendations

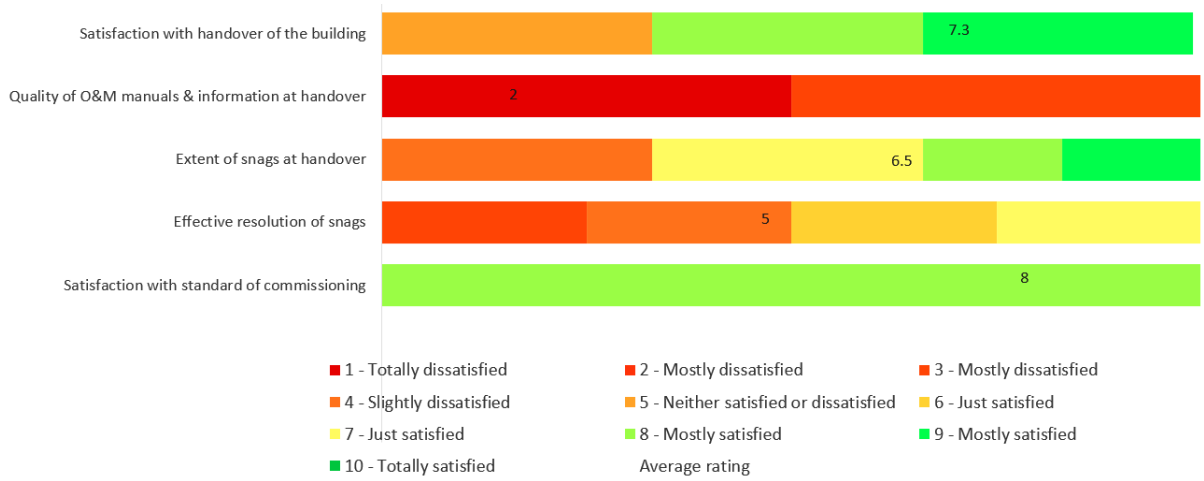
- When selecting the main contractor, ensure that the weighting between quality and cost is correct.
- For technically complex projects, consider whether a two-stage approach is beneficial to aid contractor selection.
- Where team members change, ensure that a detailed handover process takes place to avoid the loss of information.

FEEDBACK RELATING TO PROGRAMME

This question was only answered by one respondent who was mostly dissatisfied.

The project ran significantly over programme and was delivered approximately nine months later than originally planned. This was largely because of issues with the understanding of requirements and performance of contractors.

FEEDBACK RELATING TO HANDOVER AND DEFECTS



The handover of the building received a respectable average rating of '7.3'. Commissioning received a good average rating of '8'.

The handover was delayed, but when it came, was satisfactory. Training days were run by the sub-contractors, for staff and users, to provide familiarisation with the systems within the PEMC.

There were some challenges in relation to people moving in before works were complete. This may have been as a result of the over-run and also because teams were keen to start using the new facility. It was felt that both the university teams and the contractor played a part in this issue.

On stakeholder said:

'We sort of drifted into the building. There was a hard date, but things weren't finished, we were kind of floating things in. Part of that was the PEMC group's fault and some is down to the contractor.'

Average ratings were lower when it came to the extent of snags at handover, which scored '6.5', and the resolution of snags, which averaged '5'. In reality, these ratings probably reflect respondents' opinions in relation to both snags and defects. The main contractor went out of business during the defects period and this has meant that there has not been a clear route to get snags or defects resolved within the contract. Retention money is available to deal with some of the outstanding works and quotes should be collated for the outstanding works so that they can be carried out.

One respondent summarised this by saying:

'There are always snags on any new building, but they have gone on for a long time now because the main contractor has gone into administration.'

The management of defects would have been better if someone from the contractor had remained on site after the initial handover. It was suggested that this should be included in future contracts to improve the management of snags and defects.

O&M manuals received very poor ratings, with an average rating of ‘2’, although this question was only answered by a very small number of respondents. It was noted that the manuals are difficult to navigate and would be time consuming to update. One respondent did not know whether the manuals existed. During the workshop, it was identified that an additional building user guide may be needed, to provide useful information for the operational staff who will be managing the building. The format and requirement for this will vary depending on the complexity of the building and services, hence a bespoke format may need to be create on a case-by-case basis.

Recommendations

- Retain a representative from the contractor on-site in the first stages of the post tender period to assist with the swift resolution of snags and defects.
- Actively manage the move-in process to ensure that teams move in at the right time. Identify someone to lead and manage the move. Have a soft landing if this will be beneficial.
- Ensure that maintenance personnel know where to find O&M manuals and that the manuals are always accessible from the agreed location.
- Engage with end users at the point when the contractor is collating the O&M manual to ensure that all of the required information is included.
- Where appropriate, create a bespoke building user guide, to assist operational staff in the ongoing maintenance, repair and improvement of the building.
- Obtain quotes for outstanding works and use retained money to pay for these.

POST OCCUPATION – END USERS

FEEDBACK RELATING TO KEY SPACES IN THE PEMC

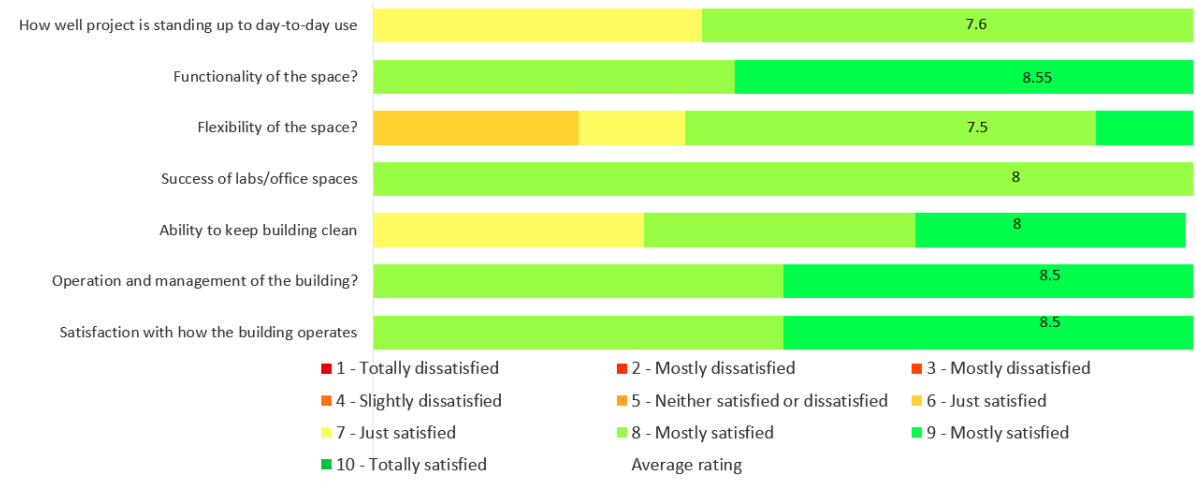
The study included only very limited feedback from end users, as there was no focus group carried out and no interviews with academic staff. However, there was some very rich qualitative feedback from staff who are involved in operations and management of the building. They had been involved throughout the process and now use the building.

Overall, there is satisfaction with the laboratory space, equipment and offices.

One interviewee said:

'You have open plan offices, but you also have segregated areas for each academic. The research facility is very flexible with the spaces as well.'

POST-OCCUPATION – FEEDBACK FROM KEY STAKEHOLDERS



Flexibility and Success of the Spaces

Some very positive ratings were received in relation to spaces and their functionality, with all respondents indicating that they are 'satisfied'. Labs and offices received an average rating of '8' and functionality of spaces was rated as '8.55'.

Flexibility was rated a little lower with an average rating of '7.5'. The factor affecting flexibility appears to relate to a wall which was changed from a block wall to a stud wall during the build. This means that things cannot be fixed to it thus reducing flexibility. The wall would have been functional in the majority of facilities but has had an impact based on the specific requirements of PEMC.

One respondent said:

'Now that they are doing work in there, they cannot attach anything to that wall. They can't drill or affix anything to it. If it had been blockwork, it would have been a lot easier. At the time, the contractors said it would be fine whereas now they say it limits what they can do.'

Recommendations

- Ensure the impacts of changes to design are fully understood before they are signed off to ensure that they do not impact on functionality or flexibility.

FEEDBACK RELATING TO OPERATIONAL ISSUES

Overall, feedback on the operation of the building is very positive, with questions relating to operation and management and how the building operates both receiving scores of '8.5'.

The multi-voltage electric panel was particularly noted as being innovative. It provides a wide range of supplies to support the research taking place and significant work took place with the supplier to design it as a bespoke item. There is some outstanding work required in relation to the switching of the multi-voltage panel. The panel was built to design, but the procedure for safely switching between voltages is complex, and hence has risk associated with it. Budget has been identified for some modifications to be completed by the panel manufacturer to simplify this process and improve safety.

A stakeholder said:

'The controls for the high voltage system here have never really been finished.'

However, one of the project group reported:

'There was some debate about how they switch from one voltage to another. It wasn't as automated as they wanted it to be.'

There is a ballistic test pit, which does not have an adequate safe ladder or steps for access and egress. Handrails are absent, creating a significant safety hazard. This was identified by both the contractor's and university's health & safety teams, but nevertheless the solution was disputed by the main contractor, until the point when they were no longer trading. This is a serious outstanding defect that needs to be resolved.

One user noted:

'We have a submerged test cell, it's a three-metre-deep pit, essentially, and the upper ladder down to it is unsafe, it has no upper guard.'

A ladder solution has been identified and a quote needs to be obtained so that this issue can be rectified. It has been suggested that the new ladder be installed at the opposite end from the current access point, so that all three sections of the interlocking lid do not need to be removed in all cases. Depending on the ladder design selected, it may be necessary to use a harness and fall-arrest system when accessing the ballistic pit. In addition, the pit should be reviewed in term of confined spaces and the appropriate safety measures put in place.

There have been issues with leaks from the roof and from roof lights. In general, this has been an inconvenience, but there was a leak over the HV panel which was much more concerning. There are leaks ongoing when there is heavy rain, possibly as a result of the building's flat roof and the quality of the roof finish. It is believed that work is ongoing via the roof warranty but this should be confirmed.

Pigeons have been able to gain access to the building through some of the doors, which is unsanitary and a wellbeing issue. A strip curtain has been installed on one of the doors and the issue appears to have been resolved.

Recommendations

- Operational team to instruct works to improve the switching mechanism on the multi-voltage panel. Write a new procedure for switching once this work is complete.
- Obtain a quote for the agreed ladder design for the ballistic pit. Install in the appropriate place, to reduce the need to remove all three sections of the interlocking lid in all cases.
- Carry out an assessment to identify whether harness and fall arrest equipment is required when accessing the ballistic pit using the new ladder. If so, provide equipment, train staff and ensure a safe procedure is in place.
- Assess the ballistic pit to identify if it is a confined space. Based on the findings, train staff and put safety procedures in place to safely manage access and emergencies.
- Resolve roof leaks via the roof warranty to avoid water ingress during heavy rain.

Cleanliness

The level of cleanliness is generally considered to be good. The average rating for the ability to keep the building clean was '8'. Any issues relating to cleanliness appear to relate to university resource rather than the fabric and design of the building.

One interviewee said:

'There was a point last year where one of the senior academics was a little bit concerned about the level of cleaning provision that we were providing, nothing to do with the building. So, I went over and had a pretty good in-depth tour of the facility and there were no obstacles as far as we are concerned.'

Day-to-day use

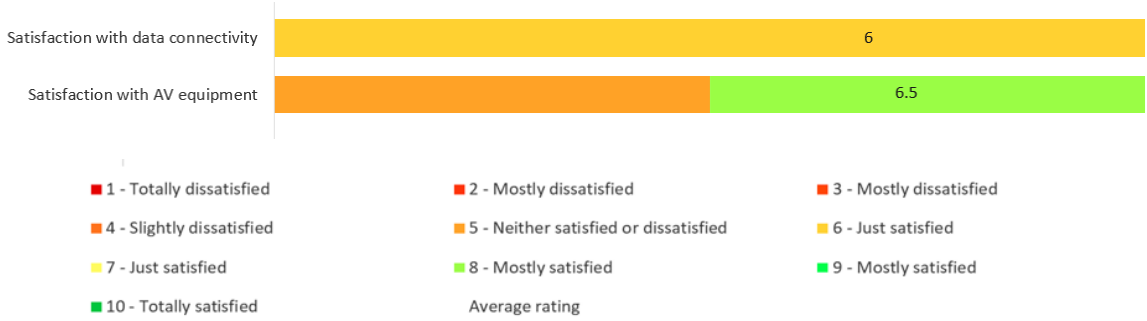
Overall, the PEMC appears to be operating well. There was an average rating of '7.6' in relation to how the building was standing up to day-to-day use.

PEMC has an unusual amount of high-risk equipment, most notably high voltage electrical equipment. Security restrictions have in place to ensure that people cannot access areas which would not be safe based on their knowledge and competence.

One respondent said:

'We have four levels of access. Level one, anybody from the university has access, Level two is the main foyer, level three is the next level for the workshops and level four is the high voltage area which only competent staff can access. Working with security, we designated all the locks and access points.'

FEEDBACK ON AV AND DATA CONNECTIVITY



Satisfaction with data connectivity was fairly low with an average rating of '6'. The problems appear to relate to Wi-Fi connectivity with some dead spots within the building. These appear to have been broadly resolved but may need some further review by the DTS team.

One user said:

'LAN is great, wireless is not great. We have had all sorts of issues with it.'

Provision of AV equipment received an average rating of 6.5. The PEMC had to provide a lot of the AV equipment because of available budget for the project. It is suggested that the facility may benefit from additional AV equipment and post pandemic it may be that needs for remote links have changed and developed.

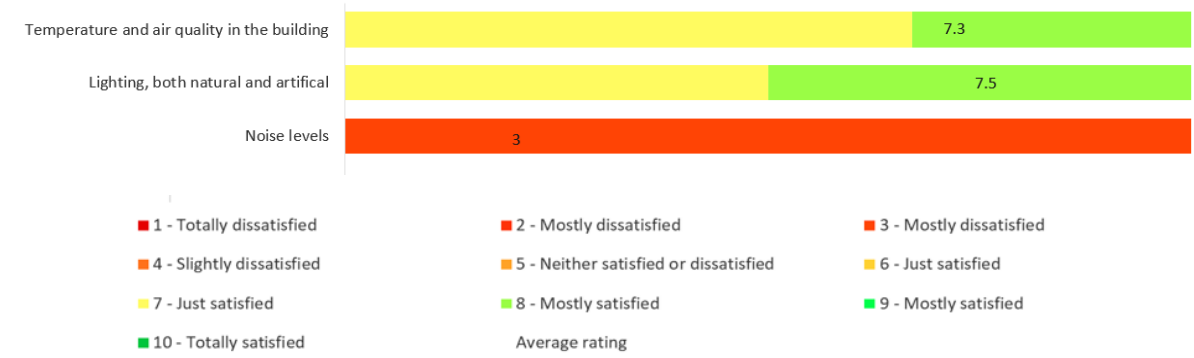
One interviewee said:

'The PEMC team had to install a load of the AV which isn't really something we should be doing. Whilst I am satisfied with it, there could be more of it.'

Recommendations

- Contact DTS to get a re-assessment of the Wi-Fi and identify if any modifications are required.
- Review the AV equipment and data connectivity periodically to see if it meets the needs of the building users. Procure new equipment if necessary to support remote working.

FEEDBACK RELATING TO THE QUALITY OF THE INTERNAL ENVIRONMENT



Heating and cooling

Temperature received an average rating of '7.3'. Users reported wide variations in the temperature and an inability to control the heating locally.

One respondent said:

'I have had quite a lot of complaints. We are either red hot or freezing cold in the rest of the building and it doesn't seem to manage itself brilliantly.'

One of the issues relates to thermostats in rooms being addressed incorrectly in the BMS. This results in the temperature in the wrong room being changed when the thermostat is adjusted. This can be rectified by ensuring that the information is corrected in the system.

An issue was raised with the boiler ventilation on the roof which did not have adequate low-level ventilation at the time of installation. It is believed that an extra vent was put in, but this needs to be confirmed for surety.

Recommendations

- BMS team to review the heating system data and correct any errors in addresses, so that the room thermostats operate correctly.
- Contact the M&E contractor to confirm that the extra low-level vent has been installed on the boiler.

Lighting

Lighting received a respectable rating of '7.5'. Artificial light is considered good with natural light less good. The value engineering exercise removed windows from some areas and this means that there are offices without natural light, which is not ideal.

Sound

Noise was the lowest rated aspect of the building with an average rating of '3'. There is some very noisy equipment in the laboratory and noise is an issue. It is likely to worsen as the use of test plants increases and this is anticipated as being an ongoing challenge as new equipment is brought in. It was, however, noted that the laboratory is industrial building therefore an amount of noise is to be expected. Acoustic guarding was included in the

specification of machinery to mitigate against noise where possible. Noise cancelling headphones have been issued to staff. However, PPE should be considered the last line of defence when managing the hazard.

Efforts to make the space flexible and the need for a crane running across the workshop meant that internal walls and acoustic barriers could not be put up. However, the open plan nature of the laboratory now means that noise travels.

One stakeholder said:

'Initially we were looking at trying to put some walls up between the workshops, but with the crane going through, it was going to become an impossible task. So, what we decided to do was just manage noise locally.'

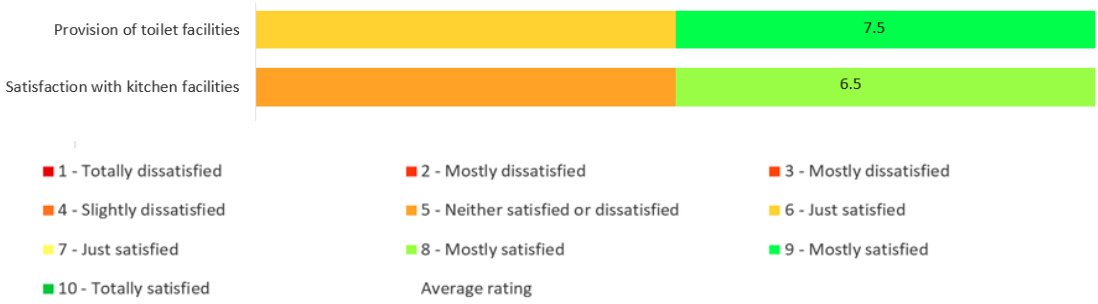
It may be beneficial to carry out a noise study and to monitor noise as new equipment is brought in. The best way to do this would be through random testing, rather than a best/worst case scenario test.

Ventilation handling on the first floor office was also identified as being quite noisy, which could be unpleasant for those working close to the noise source. It was suggested that some changes to the attenuators could improve this, and an investigation should be completed to identify improvement works to reduce noise.

Recommendations

- Carry out noise assessment at random times to identify if noise in the laboratory is at a level that requires further action.
- M&E designer to carry out a review of the ventilation in the first floor office and make recommendations of improvement works to reduce noise.

General Facilities



Toilets received an average rating of '7.5'. In general, they are functional but there is a compromise in terms of the flow rate and temperature of the hot water for handwashing, due to the instant hot water heaters.

Kitchens received an average rating of '6.5'. No significant issues were identified, but it was felt that the layouts of the kitchen could have been a bit better.

Whilst not rated, storage was identified as a problem with both general storage and provision of a bin storage area proving an issue.

Providing more storage space would have reduced the available functional space for offices and laboratories. It is often the goal that personnel reduce the amount of paperwork and equipment when moving to a new building, but people find this very difficult. The university has no strong guidance to follow to ensure that individuals reduce their personal items on-site. There are some locations that could have been storage space, had the design made them load bearing and this may have made storage easier. For future projects, plans in relation to storage should be realistic and any space opportunities utilised to reduce storage issues.

A combined bin store with the RAD building should have been built but has never been completed. A location for this has now been identified and works to install this now need to take place.

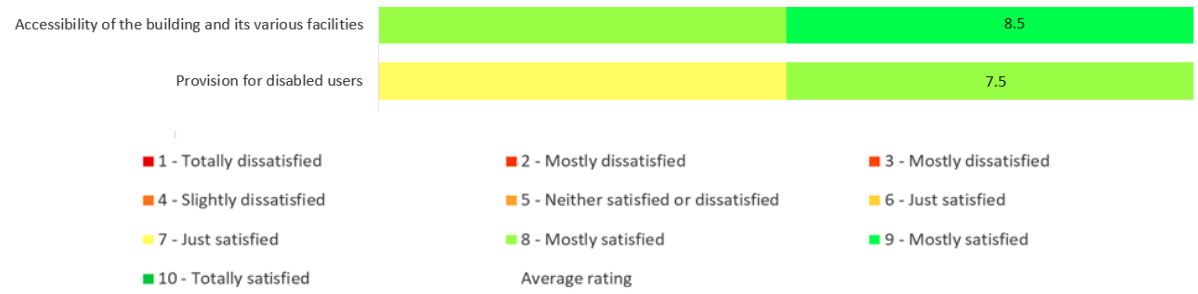
Recommendations

- For future projects, provision of storage should be fully considered, and spaces maximised for storage, wherever possible. Plans for storage should be realistic.
- The university should consider having more robust guidance about minimising personal storage, particularly in relation to teams who are moving to new facilities.
- A bin store should be installed in the agreed location, to allow for the management of waste from PEMC.

Additional elements end users would have liked to have seen:

- Bin store
- Additional storage
- Acoustic barriers
- Windows in all spaces
- Better heating control
- Additional AV equipment

FEEDBACK RELATING TO ACCESSIBILITY AND NAVIGATION



Accessibility was generally considered good and received an average rating of ‘8.5’ with all respondents satisfied. Provision for the disabled received an average rating of ‘7.5’.

General accessibility is considered good, including for those with accessibility issues. The test pit was the only exception specifically identified. Bench heights were noted to be very high, so anyone using a wheelchair would need something specifically installed for them as they would not be able to use the current equipment.

In relation to navigation, the building has high levels of security due to sensitivity and safety related to some of the research being carried out. It is not a building that students and visitors would be finding their way around alone.

FEEDBACK RELATING TO SECURITY

All respondents were satisfied with security and it received an average rating of '8'.

The Faculty of Engineering has installed CCTV cameras to monitor the building for security purposes. In addition, the building is card accessed and secure to ensure safety and ensure that people cannot access sensitive of unsafe areas.

FEEDBACK RELATING TO ENVIRONMENTAL PERFORMANCE AND SUSTAINABILITY

The building met the requirements for a BREEAM Excellent certificate. This illustrates that many sustainability goals were reached in the construction of the building.

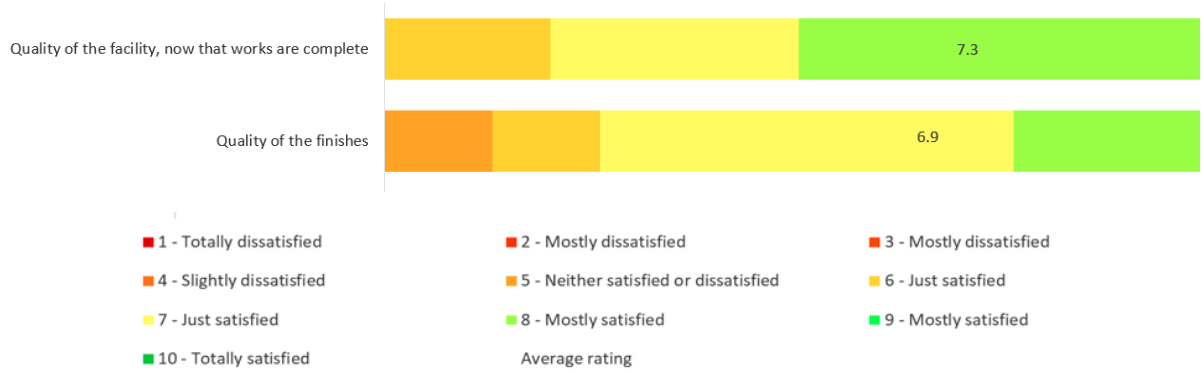
Overall, sustainability was not a core driver of the project, and the budget challenges may have made it difficult to afford some sustainable options. However, it is felt that more should have been done to improve sustainability and that it would be included if the project was being designed and delivered now.

In the initial concept it was proposed that the main floor should be naturally ventilated. This was removed, likely due to the number of cellular offices, but this was a loss to the innovation of the build.

One member of the university team said:

'It should have had some sort of sustainable element to it. It went through the control process at a time when you could quite easily get a new build through without doing much about environmental sustainability. I am sure there is something more innovative that could have been done.'

FEEDBACK RELATING TO QUALITY OF PEMC



Overall quality received average ratings of ‘7.3’. The quality of finishes was felt to be slightly lower at ‘6.9’. In general, the infrastructure and M&E was felt to be of a higher quality, but the civils work less good.

One stakeholder said:

‘A little bit more attention to detail would have been good. Overall, it is a quality building but some of the detail could have been finished off a little bit better.’

There are cracks in walls, as well as a wall which rocks when a heavy door is shut. It is felt that some walls needed movement joints, and an additional post may have been needed in the wall that rocks. Whilst some of the cracks have been filled from a cosmetic sense, the crack pathways and wall instability continue to be a concern. It would be beneficial to complete some further structural review of these features to identify if any further work is required. Budget is available until end of July 2023 for this.

There were some quality issues in relation to flooring and the flooring finish is not to a high enough standard for some of the equipment being used. This has resulted in the feet of some equipment having to be grouted in. It is accepted that some of this was as a result of the specification given by the university, but some information was lost when personnel who had been shown requirements left the project.

There are approximately six outstanding issues which need resolution. Whilst these aren’t going to be completed as part of the original contract, there is retention money to pay for this. Quotes should be obtained for the works and given to the project manager so that they can be delivered.

Recommendations

- Consultants to carry out an investigation of the cracks in the walls to identify if they are structurally significant and make recommendations for remedial works.
- Consultants to survey the wall which rocks when the heavy door is closed, identify the scale of the issue and make recommendations for remedial works.
- Ensure that the requirements for flooring finishes are fully understood to ensure that they meet the needs of equipment. Document decisions to mitigate against changes in personnel.
- Obtain quotes for the known outstanding works and discuss with the project manager so that budget can be made available. Deliver these works before the end of the retention period.

WHAT MIGHT HAVE BEEN DONE DIFFERENTLY?

With hindsight, the project delivery may have run more smoothly had a different main contractor been appointed. This is something that the university Estates team have already acknowledged and in future more reliance on quality, rather than cost, will be adopted.

The project could have been delivered in two parts, with the civil build separated from the more complex infrastructure and services installation. This may have assisted with budget and programme management, as well as allowing the best contractor to be appointed as the main contractor for each phase. In hindsight, this may have been the best option for this

project and this option should be considered depending on the specific requirements of a project.

Stakeholder engagement was very challenging within this project and there was much more involvement from stakeholders in the design than is usual. It would have been beneficial to have someone from the PEMC operational team embedded in the project group, so that they had the time to focus on the project. Academics and researchers could have been engaged to a greater extent to understand needs.

More could have been done to ensure that requirements were understood at project inception and communication could have been adapted to ensure that all requirements were fully understood pre-tender.

One member of the project group said:

'One of the lessons learnt with the university is that we now do a full two-day page turn on all documents that now go out prior. We now do a very thorough review where we sit down with the project manager and go through everything line by line to make sure nothing is missed.'

There could have been more of a focus on sustainability and the inclusion of more green energy solutions.

Suggestions identified by interviewees included:

Project team

- Increasing the weighting towards quality rather than cost when assessing bids.
- Splitting the project between civils construction and infrastructure fit out.
- Formalising communication methods to better manage the complex stakeholder engagement piece.
- Embedding someone from the PEMC operations team in the project group.
- Completing a page turn exercise to check all supplied information has been included in the tender documentation.
- Including more sustainable options.
- Maintaining a presence on-site for longer to deal with snags and defects.

End users

- Including stakeholders in the tender specification to ensure that requirements are met.
- Ensuring that the right staff are engaged at the right time and attend training and familiarisation training.
- Improving O&M manuals.
- Managing the move into the building in a more structured manner.

DOES PEMC MEET THE NEEDS OF THOSE WHO USE IT?

In general, the building does meet the needs of the users. There are newly built laboratories with world-class electrical services and infrastructure to support research. Teams are keen to move into the facility and there is a belief that PEMC is a draw for research and funding.

There are modern offices, both cellular and open plan, as well as meeting rooms with AV capabilities. The building is accessible as well as having adequate security and restriction to keep users and visitors safe.

Whilst there are some outstanding defects and issues with noise, overall, users are happy with the operation of the facility.

OVERALL OUTCOME

Good overall satisfaction ratings were awarded by the people who participated in the evaluation. 75% of respondents indicated that they were satisfied and the average rating for overall satisfaction was '8.17'.

One university stakeholder highlighted that their involvement had resulted in significant personal development. They would be keen to be involved in future projects and continue to utilise the skills and knowledge that they have developed.

Despite a challenging project journey, the end product is good and this has led the project group to be pleased with the final outcome.

One respondent said:

'People soon forget about the painful journey on the way. I think the look and feel of the space is good, how the spaces are used, and it looks very impressive.'

Another said:

'I think we have built a solid, proportionately appropriate building for the output. There is no embellishment; every bit of space is working hard. I would say that it is good overall.'

Conclusion

The project journey for PEMC was, at times, very challenging. It was difficult to deliver everything that was desired for the budget available and significant value engineering was required. Some of the electrical infrastructure requirements were extremely complex and it was a challenge for the project group, despite their expertise, to understand and manage the information coming from stakeholders.

With hindsight, the main contractor did not have the experience and capability to carry out a build of this complexity. However, it is felt that the reasons that they were chosen were sound and it is not known whether another contractor would have performed significantly better in the same circumstances. The fact the main contractor is no longer trading has made it difficult to resolve outstanding snags and defects.

Despite all of these challenges, the project group appear to have worked together and maintained positive and professional relationships. The M&E sub-contractor stepped up to take a lead on delivery of the electrical infrastructure and their pro-active behaviours are identified as having made a significant impact on getting the building completed. The team are proud, overall, in what was delivered.

Most importantly, the end product is generally good. The PEMC has electrical capabilities beyond anything else at the university and at a world-class level. Business and researchers want to use the facility and overall it is a nice place to work. There are some outstanding issues to be resolved and dealing with these will improve the performance of PEMC and the satisfaction of those using it.

Aesthetically, the building doesn't have some of the statement features from the original design. However, it is still an attractive and appropriate building for its location.

One member of the project group summarised it as

'It is a good facility for the university and another fantastic addition to the Jubilee campus.'

APPENDIX I: RECOMMENDATIONS

Understanding project requirements and budget

The design and build process for PEMC was particularly challenging because the requirements of users were not fully understood at project inception. Ultimately, this resulted in challenges for the project team in terms of programme delays and budget management. A better understanding of requirements and greater stakeholder engagement would have assisted in relation to understanding design detail and affordability. Better understanding of details such as flooring, and the impact of any design changes would have improved the outcome.

- Ensure that sufficient time is given at project inception to fully understand building requirements and specification detail. This will help the design consultants and ensure affordability.
- Ensure that academic staff and researchers are completely engaged, at an early stage, in the design process to ensure that requirements are fully understood.
- Where possible embed someone from the stakeholder group in the project team, so that they have the time required to focus on the project.
- Ensure the impacts of changes to design are fully understood before they are signed off to ensure that they do not impact on functionality or flexibility.
- Ensure that the requirements for flooring finishes are fully understood to ensure that they meet the needs of equipment. Document decisions to mitigate against changes in personnel.

The contract and contractor selection

This was a particularly complex building and as a result, may have benefitted from a two-stage approach to the contract. For future projects which are very complex in terms of services or systems, careful consideration should be made of the best approach to the contract structure and contractor selection.

- For future projects, consider in more detail the best way to approach the contract based on the particular detail of the building. Use a two-stage approach if this is likely to give the best outcome for the project.
- For technically complex projects, bring specialists on board at the earliest opportunity to enable their knowledge to inform the project and identify the best solutions.
- When selecting the main contractor, ensure that the weighting between quality and cost is correct.

Communication and sharing of information

There was a great deal of complex information being transferred between project group members throughout the design and build phase. Some of the systems being designed were more complex than anyone in the team had worked on before. The volume of information and changes in personnel meant some information and understanding was lost, which

caused issues in the design and post tender period. Some steps have been made to improve this and these should be continued for other projects.

- Continue the new process of completing a pre-tender page-turn exercise to ensure that all requirements have been included in the design, and tender documents.
- Agree a coordinated approach to collate requirements and changes. Communicate these requirements through structured channels to ensure information is not lost.
- Formalise communication routes where it will help to manage information and monitor progress. Create action points from meetings and use trackers to monitor requirements and changes.
- Where team members change, ensure that a detailed handover process takes place to avoid the loss of information.

Handover, snags and defects

There were some issues in relation to handover, management of the move and defects, both after the demolition of the old building and following completion of the PEMC build. The management of snags and defects was not as good as it could have been, although this was in part due to the main contractor ceasing trading during the defect period. The move could have been coordinated better to avoid teams moving in before the handover was complete.

- Carry out testing and spot checks after demolition and removal of asbestos to ensure that work has been completed to a satisfactory standard.
- Retain a representative from the contractor on-site in the first stages of the post tender period to assist with the swift resolution of snags and defects.
- Actively manage the move-in process to ensure that teams move in at the right time. Identify someone to lead and manage the move. Have a soft landing if this will be beneficial.

Outstanding defects

There are a number of outstanding defects which need to be resolved. Retained budget is available until the end of July 2023 and hence these works should be completed before that date.

- Operational team to instruct works to improve the switching mechanism on the multi-voltage panel. Write a new procedure for switching once this work is complete.
- Resolve roof leaks via the roof warranty to avoid water ingress during heavy rain.
- Consultants to carry out an investigation of the cracks in the walls to identify if they are structurally significant and make recommendations for remedial works.
- Consultants to survey the wall which rocks when the heavy door is closed, identify the scale of the issue and make recommendations for remedial works.
- Obtain quotes for the other known outstanding works and discuss with the project manager so that budget can be made available. Deliver these works before the end of the retention period.

Ballistic pit

The access ladder into the ballistic pit is not safe and work is required as a matter of priority to create a safe access. Issues identified regarding the potential need for fall-arrest equipment and a confined spaces assessment also need to be reviewed to ensure safety.

- Obtain a quote for the agreed ladder design for the ballistic pit. Install in the appropriate place, to reduce the need to remove all three sections of the interlocking lid in all cases.
- Carry out an assessment to identify whether harness and fall arrest equipment is required when accessing the ballistic pit using the new ladder. If so, provide equipment, train staff and ensure a safe procedure is in place.
- Assess the ballistic pit to identify if it is a confined space. Based on the findings, train staff and put safety procedures in place to safely manage access and emergencies.

Noise

Noise was identified as an issue. Within the laboratory area there is noisy equipment and noise travels because of the lack of internal walls or acoustic screening. The need for flexibility within the space requires an open plan lay-out, so options to add additional acoustic measures are limited. However, the noise levels need to be understood and managed in the longer term. In the office on the first floor, the ventilation is currently noisy which is causing a nuisance and needs to be reviewed.

- Carry out noise assessment at random times to identify if noise in the laboratory is at a level that requires further action.
- M&E designer to carry out a review of the ventilation in the first-floor office and make recommendations of improvement works to reduce noise.

O&M manuals

O&M manuals were rated poorly with staff finding them hard to navigate or simply not knowing where to find them. The manuals need to be stored in an agreed location where they are accessible to staff, and the format of user manuals refined to make them useful to the staff who are managing building operations.

- Ensure that maintenance personnel know where to find O&M manuals and that the manuals are always accessible from the agreed location.
- Engage with end users at the point when the contractor is collating the O&M manual to ensure that all of the required information is included.
- Where appropriate, create a bespoke building user guide, to assist operational staff in the ongoing maintenance, repair and improvement of the building.

Temperature

Some issues were raised in relation to the temperature in the building and the ability to adjust the temperature in some rooms. It appears that some updates are required to the BMS to ensure thermostats are operating correctly. An issue with low level ventilation for the boiler on the roof needs to be checked.

- BMS team to review the heating system data and correct any errors in addresses, so that the room thermostats operate correctly.
- Contact the M&E contractor to confirm that the extra low-level vent has been installed on the boiler.

Bin store and general storage

The shared bin store with the RAD building was never constructed and needs to be put in place to manage the efficient disposal of waste from PEMC. Overall, users feel that there is not enough storage in the building based on what was transferred from the old building. Whilst there is always a desire to reduce stored equipment, projects should be realistic and consider every option to provide storage space, given lack of storage is a common problem post occupation. The university may need to consider a more robust policy regarding the provision of personal storage for staff.

- A bin store should be installed in the agreed location, to allow for the management of waste from PEMC.
- For future projects, provision of storage should be fully considered, and spaces maximised for storage, wherever possible. Plans for storage should be realistic.
- The university should consider having more robust guidance about minimising personal storage, particularly in relation to teams who are moving to new facilities.

Data connectivity and AV equipment

A number of minor issues were raised regarding dead spots for data connectivity and a desire for additional AV equipment. Overall, these appear to have been addressed however, this should continue to be monitored given expectations in relation to connectivity and an increase in remote working.

- Contact DTS to get a re-assessment of the Wi-Fi and identify if any modifications are required.
- Review the AV equipment and data connectivity periodically to see if it meets the needs of the building users. Procure new equipment if necessary to support remote working.