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DIGITAL SOLUTIONS ON A SHOESTRING

Hackathon Report

Greater Lincolnshire Regional Defence and Security Cluster (GLRDSC)

Event: 11 June 2024
Report: 6 August 2024

Summary

The GLRDS Cluster has identified the importance of supporting companies, particularly SMEs, within the defence and security supply chain to deliver defence capabilities to enhance national security. The cluster commissioned the use of the Institute for Manufacturing's (IfM) Shoestring Hackathon approach to explore how to improve SME productivity via digitalisation. The hackathon took place on 11 June 2024, with 19 attendees from the GLRDS Cluster.

The objectives of the hackathon were to support networking, introduce low-cost digitalisation, build digital knowledge and confidence and lay the foundations for delivering a future technical hackathon. As part of this hackathon, attendees identified potential digital solutions areas. Participants were split into groups and guided through the development of a specification for a low-cost digital solution.

Five different teams developed five specifications for solutions. The two solution specifications ranked highest by participants were:
1. **Bootstrap** – A digital solution for supporting training and training management.
2. **Anomaly Analysis** – A digital solution for identifying anomalies in operation and triggering a recording of the process dashboard.

Optional next steps for developing these solutions are outlined in more detail at the end of this report. These could include the following activities:
- A hackathon using GLRDSC members
- A hackathon using local students.
- Multiple shorter solution development and training sessions

Introduction:

This report summarises some key outputs from the Shoestring Hackathon, based on research from the Digital Manufacturing on a Shoestring programme. The report is divided into sections reflecting the hackathon's key activities. The key activities are also shown in Figure 1.

1. Digital needs awareness workshop
2. Solution areas chosen by groups
3. Key improvements and challenges expected
4. Specified solutions
5. Summary and conclusion
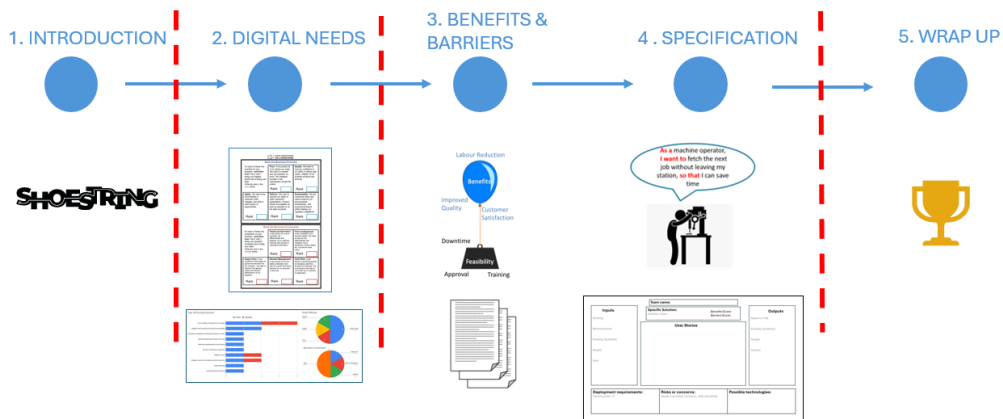
Hackathon Overview

Figure 1 - Diagram showing the hackathon and the five key sections

This report is intended for Greater Lincolnshire Defence & Security Cluster (GLDSC) leadership. It focuses on the overall outputs from the hackathon and does not identify individual participants or organisations. Where possible, the outputs are compared to outputs of research conducted by Shoestring with other secotrs. An overview of the parts of the hackathon are shown below.

Hackathon Aims

The aims of the hackathon were determined through discussions and meetings with members of the GLDSC.

- Networking: Facilitate collaboration and innovation between companies
- Digitalisation: Identify and prioritise potential low-cost digital solutions areas.
- Upskilling: Build digital knowledge and confidence in the companies attending
- Foundations: to lay the foundations for delivering a future technical-focused hackathon.

These aims are reviewed and discussed further in the report's final section.

Hackathon Participants

The participants from the hackathon were from a range of businesses, including manufacturers, consultants, system security experts and members of the RAF. Participants were asked to approach the hackathon from one of four perspectives:

- Their company
- A specific client or customer
- A specific partner
- Another organisation they work with

Part 1: Digital Needs Awareness

This section of the hackathon focused on identifying key business priorities and constraints among participants and key digital solution areas they would like to focus on. The two pie charts below (Figure 2 and 3) show the number one priority and constraint of businesses participating in the hackathon.

Business Priority

Figure 2 – Most important business priorities selected
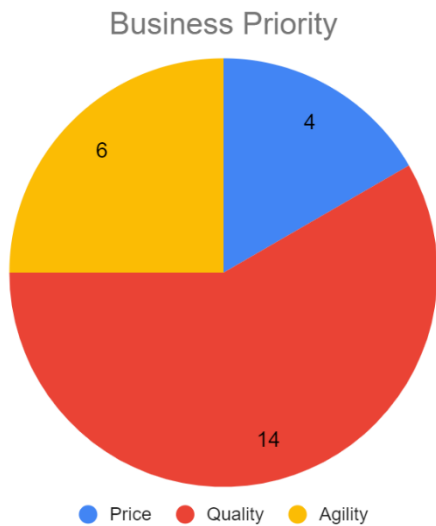
It was clear that quality is a key priority for attendees. This is likely because of the drive for high-quality equipment and work in the defence industry.

Quality has been featured in workshops with other sectors, but not as prominently. Price and Agility are also priorities commonly seen as companies try to respond to changes in the world and deal with inflation.

Business Constraints

Figure 3 – Most important business constraints selected

Participants noted that a key constraint was people and information. This may reflect the fact that the attendees came to the workshop to learn these skills. Cash flow and supply chain were also featured, with multiple participants choosing this as their main constraint.

From these constraints and priorities, participants selected key digital solution areas. The top solutions selected as a priority are shown in the bar chart in Figure 4 below. Where areas have the same number of priority votes, votes indicating an interest in the solution area were used for secondary rankings. The top three solution areas were:

1. Job tracking
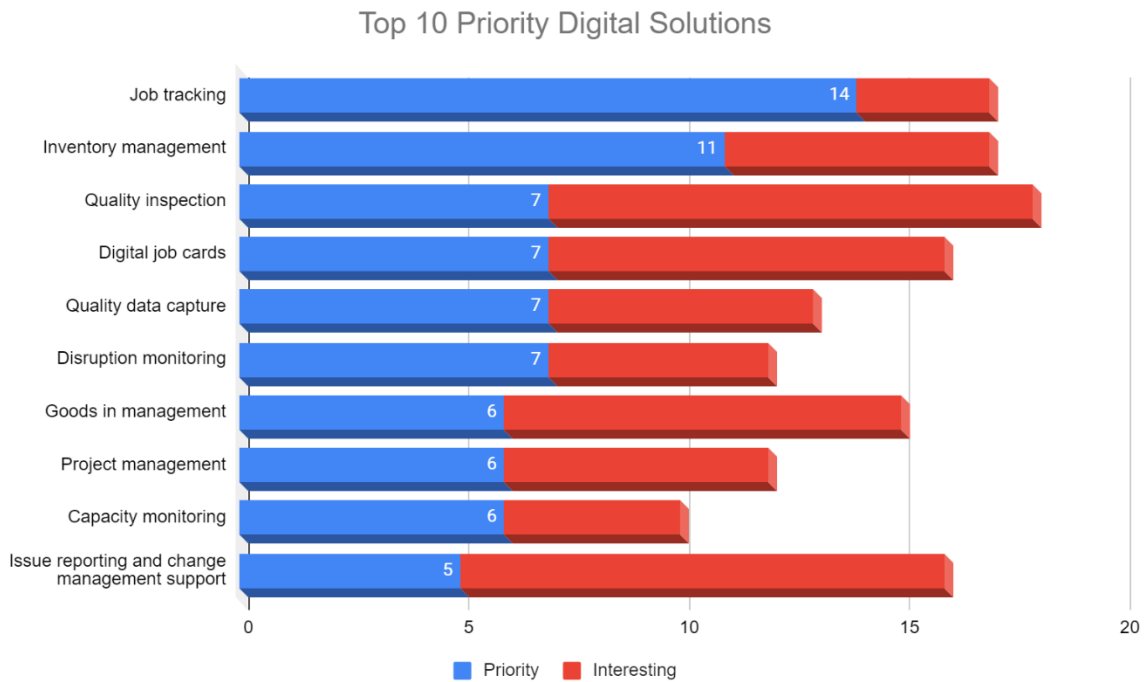2. Inventory Management
3. Quality Inspection

Figure 4 - Top ten digital solution areas selected by participants

Comparison to other sectors

Results from previous workshops and events have been compiled to show the top ten solution areas for different sectors. More information on these results can be found in Appendix A and references [1], [2], [3]. Table 1 below compares the hackathon and other sector-specific results with green highlighting where a similar solution area is seen in another sector's top ten. Many of the top ten chosen in this workshop are also seen in manufacturing sectors, which is expected given the workshop's focus and the fact that many participants are from manufacturing companies. The two new areas not seen in other sector's top ten were Quality Data Capture and Goods in Management.

Table 1 - Top ten solution areas from the hackathon and previous Shoestring research with other sectors. Green boxes highlight where a solution area appeared in the top 10 of this hackathon and other sectors.

		Top Solution areas		
Rank	This event (Defence)	Manufacturing	Construction	Logistics
1	Job tracking	Job tracking	Issue reporting and change management support	Monitoring and reporting process times
2	Inventory management	Issue reporting and change management support	Digital instructions	Costing Support
3	Quality inspection	Digital instructions	Process monitoring	Monitoring of vehicle utilisation
4	Digital job cards	Capacity monitoring	Quality inspection	Job Tracking
5	Quality data capture	Demand reporting	Scheduling Support	Identification of products to be stored close to dispatch
6	Disruption monitoring	Internal lead time monitoring	Project management support	Worker notifications system
7	Goods in management	Operations simulation	Automated completeness checking	Monitoring unloading times
8	Project management support	Disruption monitoring	Employee training management	Inventory monitoring
9	Capacity monitoring	Digital job cards	Digital job cards	Process monitoring
10	Issue reporting and change management support	Process monitoring	Scheduling visualisation	Employee training management

Part 2: Solution Areas Chosen by Groups

The top ten solution areas were the foundation for this next hackathon stage. Participants selected a solution area from the top ten as a focus for their specifications. Five groups were formed from the participants, with three to four members in each team. The five solution areas of focus that the groups chose are shown below.

Job Tracking

Digital Job Cards (Instructions)

Disruption Monitoring

Job Tracking

Issue Reporting

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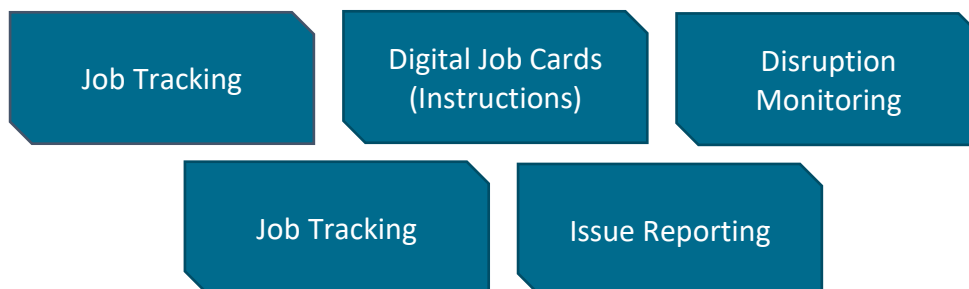
Part 3: Key Improvements and Challenges Expected

Each attendee worked individually on their chosen solution area and the specific solution they had identified. The potential benefits of their solution and challenges were identified and scored from 0 (no improvement expected) to 5 (significant benefit expected). The top three expected benefits and challenges were identified by averaging all the scores assigned by participants. Figure 5 shows the top three potential benefits, while Figure 6 shows the expected challenges.

Potential Benefits

| 1st Improve production planning efficiency | 2nd Increase process operating efficiency | 3rd Improve delivery and service performance |
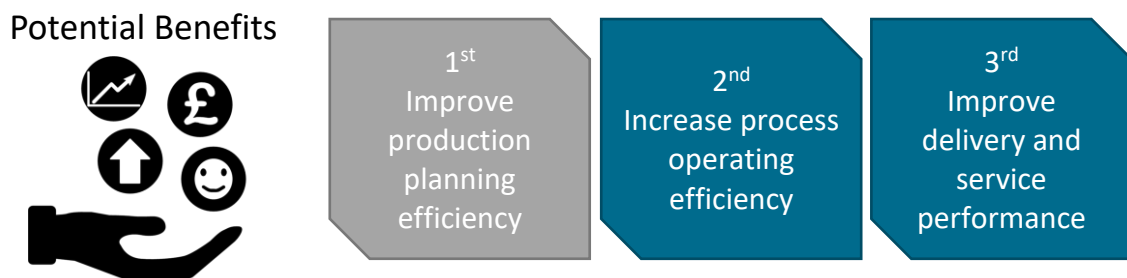
Figure 5 - Top three expected benefits from the solutions.

Expected Challenges

| 1st Integration (internal & external) | 2nd Disruptiveness of implementation | 3rd Approval and certifications |
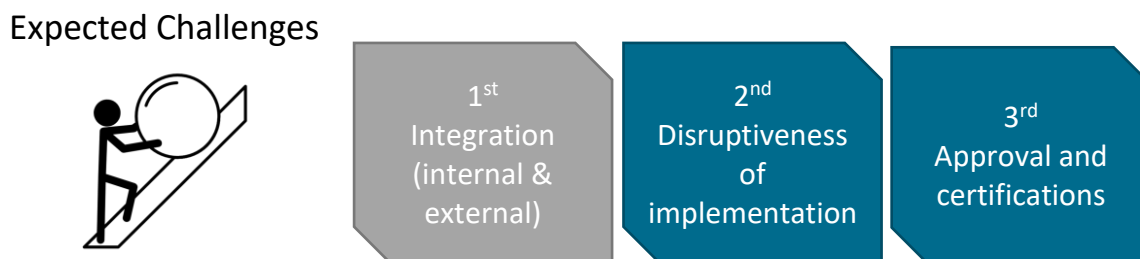
Figure 6 - Top three expected benefits from the solutions.

Tables 2 and 3 show the top five expected benefits and challenges selected in this hackathon and the results from previous workshops in the manufacturing, logistics, and construction sectors. It should be noted that these scores do not account for the fact that participants were evaluating different solutions and solution areas. Areas in green in Tables 2 and 3 highlight potential benefits and challenges highlighted in this hackathon and other sectors.

Table 2 - Top five potential benefits participants expected from their solution. The top five selections from previous Shoestring research with other sectors are also shown. Green boxes highlight where a benefit was selected in other sectors.

Rank	This event (Defence)	Manufacturing	Construction	Logistics
	Top 5 potential benefits			
1	**Improve production planning efficiency**	Reduce inventory	Increase output capacity	Improve delivery and service performance
2	**Increase process operating efficiency**	Improve delivery and service performance	Improve delivery and service performance	Increase customer satisfaction
3	**Improve delivery and service performance**	Increase worker satisfaction	Increase worker satisfaction	Improve production planning efficiency
4	**Improve speed and ability to introduce new products**	Improve production planning efficiency	Improve production planning efficiency	Increase worker satisfaction
5	**Increase customer satisfaction**	Increase customer satisfaction	Increase customer satisfaction	Increase output capacity

Table 3 - Top five potential challenges participants expected from their solution. The top five selections from previous Shoestring research with other sectors are also shown. Green boxes highlight where a challenge was selected in other sectors.

Rank	This event (Defence)	Manufacturing	Construction	Logistics
	Top 5 expected challenges			
1	**Data security**	Project resourcing	Integration (internal & external)	Project resourcing
2	**Integration (internal & external)**	Integration (internal & external)	Data availability	Cross-functional usage
3	**Approval and certifications**	Data availability	Data security	Integration (internal & external)
4	**Disruptiveness of implementation**	Current understanding of the process	Project resourcing	Current understanding of the process
5	**Data availability**	Disruptiveness of implementation	Current understanding of the process	Disruptiveness of implementation

Similarities in potential benefits expected

Participants rated *Improved production planning efficiency*, *Improved delivery service performance*, and *Increased customer satisfaction* in the top five potential benefits of the digital solution. These are all seen in the top five of the manufacturing, construction, and logistics sectors.

Differences in potential benefits expected

Key differences between participants' expected benefits in this hackathon and those of other sectors included improved speed, the ability to introduce new products, and *increased process operating efficiency*. Other sectors indicated increased work satisfaction as one of the top five potential benefits they would like to see, but this is not seen in this hackathon.

Similarities in expected challenges

Four of the top five challenges of implementing the digital solution chosen are seen in other sectors. These include *Data Security, Integration, Disruptiveness of Implementation and Data Availability.* This is to be expected because these are common factors impeding digital solution adoption in many industries.

Differences in expected challenges

Project resourcing was ranked higher in other sectors than by participants. This could indicate that participants felt the defence sector had sufficient resources to facilitate the introduction of new digital solutions. *Approval and certification* were noted as an expected challenge not seen in any other sector. Another difference to note was that *data security* was noted as a bigger challenge by participants in the hackathon than in other sectors. This likely reflects the greater need for certification and security of new products and technology in the defence sectors.

Part 4: Specified Solutions

Within each group, from the scored individual specific solutions, a final solution was chosen to specify in detail using the Shoestring process. Participants were guided through six key sections of the specification.

1. User Stories
2. Inputs
3. Outputs
4. Deployment Requirements
5. Risks and Concerns
6. Possible Technology

Specifications were compiled into posters presented to other participants on the day. The five final specifications are replicated and shown in the following pages.

Inputs

Sensing

Operator requires information regarding specific process and searches repository on their device

Measurements

Existing System(s)

Mentor needs to give mentorship regarding specific process to operator

People

Data

User Feedback on training/instruction provided, what they'd like to see

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Team name: **Bootstrap**

Specific Solution: **Digital Process**
Solution notes: ***Instructions and Mentoring***

Benefits Score: 30
Barriers Score: 6

User Stories

As an operator, I want specific instructions so that I can deliver effective output

As an operator I want to be shown how to perform unfamiliar tasks

As an operator I want to be able to access instructions remotely so that I do not need to rely on printouts or potentially unavailable systems

As a mentor I want to ensure my operators are not misinterpreting instructions

As an operator I want to ensure that I am using up to date instructions so that I can deliver effective outputs

As a mentor, I want to be able to remotely mentor my operators

As a trainer, I want to know what processes are used the most during NDW so that I can provide relevant and targeted training

Outputs

Report or File

Central repository is searchable for specific tasks for ease of use information required is easily accessible

Existing System(s)

People

Solution implemented to work with existing IT/mobile device

Actions

Implementation on the future training targets

Central repository that syncs to external/standalone mobile devices that operators use during NDW. Refo. Containing DPIs in the form of videos/step-by-step instructions and a wiki containing information that can be navigated and searched

Link output quality to instruction use to identify areas to improve

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Deployment requirements:
Infrastructure, IT

Mobile devices that can access data stored in repo and can stream live data or dashboard information for later use

Hosting environment capable of storing large amounts of data and will have connectivity to mobile devices

Risks or concerns:
Health and safety concerns, data sensiti...

Security- IP or classified info on mobile devices and connectivity to repo

Quality of instructions provided in repository

Affordability - strain on network scalability

Lots of time taken to make instructional videos, so concentrate on those

Possible technologies:

Mobile devices/standard-one – repo exists as local files on mobile devices that are JS/HTML

React?

Repository host git (locally hosted)

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Team name: Anomaly analysers

Final votes: 11

Specific Solution: Enhancing failure diagnostics

Benefits Score: 16
Barriers Score: 10

Solution notes:

Inputs

Sensing
- Light level
- Power used
- Dial – possibly using a camera or hall effect sensor

Measurements

Existing System(s)
- Test Equipment

People
- Operator (Me) – checking the system is accurate and is ready for use Camera alignment, calibration

Data

User Stories

- As a technician, I want to record failure points without depending on walking there/supervision
- As a calibrator, I want the solution to be wireless
- Carelessness and clumsy
- Lights off
- II-compatible supplies
- Maintenance efficiency
- As an operator, I want notifications that can be issued by text/email/push notification/phone call

Camera
Pi
Sensors LDR

- Light on = starts recording
  Camera records dial to review
  Camera – possibly a webcam
- Could have a week's portal which displays text to video footage and creates logs/graphs from the data

Outputs

Report or File
- Video File
  Text File-time Log

Existing System(s)
- Notification

People
- Me -technician

Actions
- Failure insight

Deployment requirements:

Infrastructure, IT
- Heat Sink
  Cooling fan
  Mouse Keyboard
  Button for activation
  Display
- Lighting for the camera
  Processor/computer –Raspberry pi
  Internet connection
  Storage for results and video
  Tripod for camera
  Wi-Fi connection
  UPS for power interruption

Risks or concerns:

Health and safety concerns, data sensitivity
- Trip Hazard
  EMF
  Privacy
- Over heating
  Possible issues with identifying the position of the DIAL (such as reflection)
  Incorrect result recorded

Possible technologies:

- Raspberry Pi
  Camera
  LDR
  Ethernet
- Team viewer – live remote monitoring

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Team name: FSC

Final votes: 6

Inputs

Sensing

User input knowledge of predicted faults
Engineer experience of faults finds

Measurements

Excel and Free text

Existing System(s)

Operator, Engineer

People

User entered

Data

Specific Solution: Fault and Solution Codification

Solution notes: Enabling Analysis of a Sensors lifespan

Benefits Score: 53
Barriers Score: 14

User Stories

Sensor Operator

Sensor Operator: I want to report faults in a way that is useful to the engineers because they ask me to provide the info they want and need. So that I'm not writing an essay

Sensor Operator: I want the fault sensor working again ASAP. So that I can do my job.

Engineer

As an Engineer I want to fix the system quickly with the spares needed available.

As an engineer, I want to know if something is ageing so I can repair/replace it at a suitable time instead of a failure when inconvenient.

As an Engineer I want to know if a complex fault has been seen before and what the solution was

Supply Manager

As a supply manager, I want to know when parts need ordering to prevent back-up of inventory

As a supply manager, I want to manage my holdings to utilize equipment before its expiry date to reduce waste

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Outputs

Report or File

Searchable Data

Standardised Data

Statistical Data Asset, Aircraft, Life span

Existing System(s)

Excel/Free Text

Aircraft Documentation System

People

Actions

Deployment requirements:

Infrastructure, IT

Noting new current infrastructure ok. Solution could need different IT requirements

Risks or concerns:

Health and safety concerns, data sensitivity

Data sensitivity due to customers' requirements

ITAR consideration

Possible technologies:

Dataverse (Microsoft Solution)

AI – For statistical Analysis

Team name: Job Tracking

Inputs

Sensing

- Barcodes
- GUI
- Operating ERP integration

Measurements

- Timestamps
- Location planning

Existing System(s)

People

People
Level 1: Operation Manager, Engineer
Level 2: Sales, procurement
Level 3: Operators

Data

Specific Solution: Barcode Scanners
Solution notes: **On the key test bench, tracking the progress of project line**

Benefits Score: *11*
Barriers Score: *14*

User Stories

1st
As an operations manager, I want to check project status and plan all locations of resources so that workflow is more efficient

2nd
As an Engineer I want to know if any parts of the process are presenting significant time delays/difficulties so that I can improve them.

As an operator, I want to know whether the previous stages on a product cycle have been carried out and that I'm working on the correct stage so that I can do my job correctly

As someone in internal sales I want to know the status of a product so that I can inform the customers with accurate lead times

As the procurement department I want to know what status a product is at so I know at what point stock requires replenishment

Outputs

Report or File

- Interactive dashboard
- Projects currently underway
- Specific status of units
- Data needs to be extractable
- Comments field required for users to log issues

Existing System(

People

Actions

Data output
- Time
- User Comments
- Percentage completion
- Schedule

- Send update notifications

Deployment requirements:
Infrastructure, IT

- Wifi/LAN/Ethernet
- Create and Store barcode/QR code
- Display/Monitor
- General I/O

Risks or concerns:
Health and safety concerns, data sensitivity

- Integration with ERP
- Cyber Security
- Personal Resistance

Possible technologies:

- Raspberry Pi
- Barcode Scanners
- Ethernet/wifi

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Inputs

Sensing

QR Scanner
- To existing documents
- Timer – start/stop

Measurements

Existing System(s)

People

Store Progress
Engineer/Operator

Data

Team name: **<no name>**

Specific Solution: **WIP Tracking**
Solution notes: *Monitoring Stages and Gates of Product*

Benefits Score: 18 average
Barriers Score: 21 average

User Stories

As the Project manager I want to monitor the product workflow to aid planning and resourcing

As the Engineers/Operators I want to use correct work instructions through information (QR codes) on Job meets/work orders

Correct material kitting at stores

Final votes: 1

Outputs

Report or File

- Traffic light system for outputs

Existing System(s)

People

- Projects Manager
- Stores
- Operator/Engineers

Actions

- PDF of work actions
- BOM

- Dashboard
- Excel with conditional formatting

Deployment requirements:
Infrastructure, IT

- Training
- Documentation updates
- Scanners

- Networking
- 1 Location

Risks or concerns:
Health and safety concerns, data sensitivity

Data Sensitivity

Possible technologies:

Raspberry Pi module to connect data

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Part 5: Summary

For each aim of the hackathon, a summary is provided highlighting how and where this was achieved.

Networking

Participants were given the opportunity to mix with other attendees, GLRDS staff and University of Cambridge researchers during the breaks and lunch. However, networking was primarily achieved by mixing groups of participants during the hackathon activities. Every team was set up of at least two different businesses, allowing them to share their experiences and challenges and exposing them to new ideas from other organisations. Some attendees left over the day due to other commitments.

Digitalisation

Teams were guided through the process of specifying a digital solution. This gave each participant and team a greater awareness of the considerations to consider when implementing digital solutions and a framework to use in their own businesses. An awareness of digital technologies was reinforced with demonstrations of existing solutions and descriptions of what these solutions are.

Upskilling

Participants gained skills in specifying a digital solution and knowledge of existing low-cost technologies companies can use. Those attendees who engaged fully with the day gained the most benefit here. Further digital and technical skills could be obtained with a future technical hackathon.

Foundations.

Specifications for five possible digital solutions were created. These could be taken further in future workshops. However, focusing on just the top two solutions may produce better results. In this case, the top two solutions that could be focused on in a future hackathon would be:

1. Bootstrap – a solution for digital instructions and mentoring
2. Anomaly Analysis – a solution that enhances failure diagnostics

Next steps

A post-event review meeting was conducted to review the feedback from participants and discuss possible next steps. Initially, this report and accompanying data will be distributed to the GLRDSC board. They will decide how best to distribute or share it with members.

A possible next step would be to proceed with the top two solution designs and run a technical hackathon to develop these solutions. It was clear from the feedback that there was an expectation of a more technical-focused hackathon rather than a conceptual one.

Participants would break into teams and work on developing a solution based on the initial specification posters. The top two solutions selected by participants were:

1. **Bootstrap** – A digital solution for supporting training and training management.
2. **Anomaly Analysis** – A digital solution for identifying anomalies in operation and triggering a recording of the process.

A technical-based hackathon could use one (or a combination of) the following formats, with teams selecting one of the solutions to work on further. This could be with or without Shoestring and IfM support.

1. **A hackathon using GLRDSC members** - A two-day event drawing on GLRDSC members who would build on the existing design and develop a working solution. This could draw on existing technical skills in the group. Teams could be formed before the event to ensure a distribution of experience and skills among groups. This would require some grouping based on evaluations of participants' skills.
2. **A hackathon using local students** – A two-day event using university students (possibly at the University of Lincoln). GLRDSC members could be added to each team to provide sector advice and expertise. Drawing on students in engineering and computer science subjects could ensure that there is a wide range of technical skills. Shoestring has organised and run these types of hackathons previously.
3. **Multiple smaller solution development and training sessions** – To help develop technical skills within GLRDSC, the hackathon could be split into a longer series of technical classes where teams meet online for several sessions designed to build technical skills. These sessions could focus on explaining and training participants to use the core open-source tools used by Shoestring. Teams could begin the development of their solution online with a final hackathon day to build and integrate the solution and present it.

Looking at the expected challenges highlighted by the participants, we see that "data security" and "approval and certifications" are key barriers that are not seen to the same extent as in other sectors. This was also highlighted in our conversations with the participants. This could hinder the technical outcome of any hackathon. These challenges could be explored further as:

1. **Facilitated workshops** – These could be facilitated by participants sharing their experiences with integrating new digital technologies, including barriers, failures, and solutions. These workshops could draw out key best practices or potential pitfalls regarding digital solution adoption from within the cluster. Sharing these findings could help improve the cluster's productivity and digital awareness.
2. **Joint future research** – Issues of security and certification have come up in many other sectors and are a key and growing problem. GLRDSC, University of Cambridge and IfM Engage could partner to set up a research program to look at this. This could seek support from government funding bodies such as Made Smarter or Innovate UK. Examples of previous similar projects include Made Smarter Connected Factories, in which we have participated.

Please feel free to contact us if you would like to discuss any of these next steps.

Written by
Dr Sam Brooks
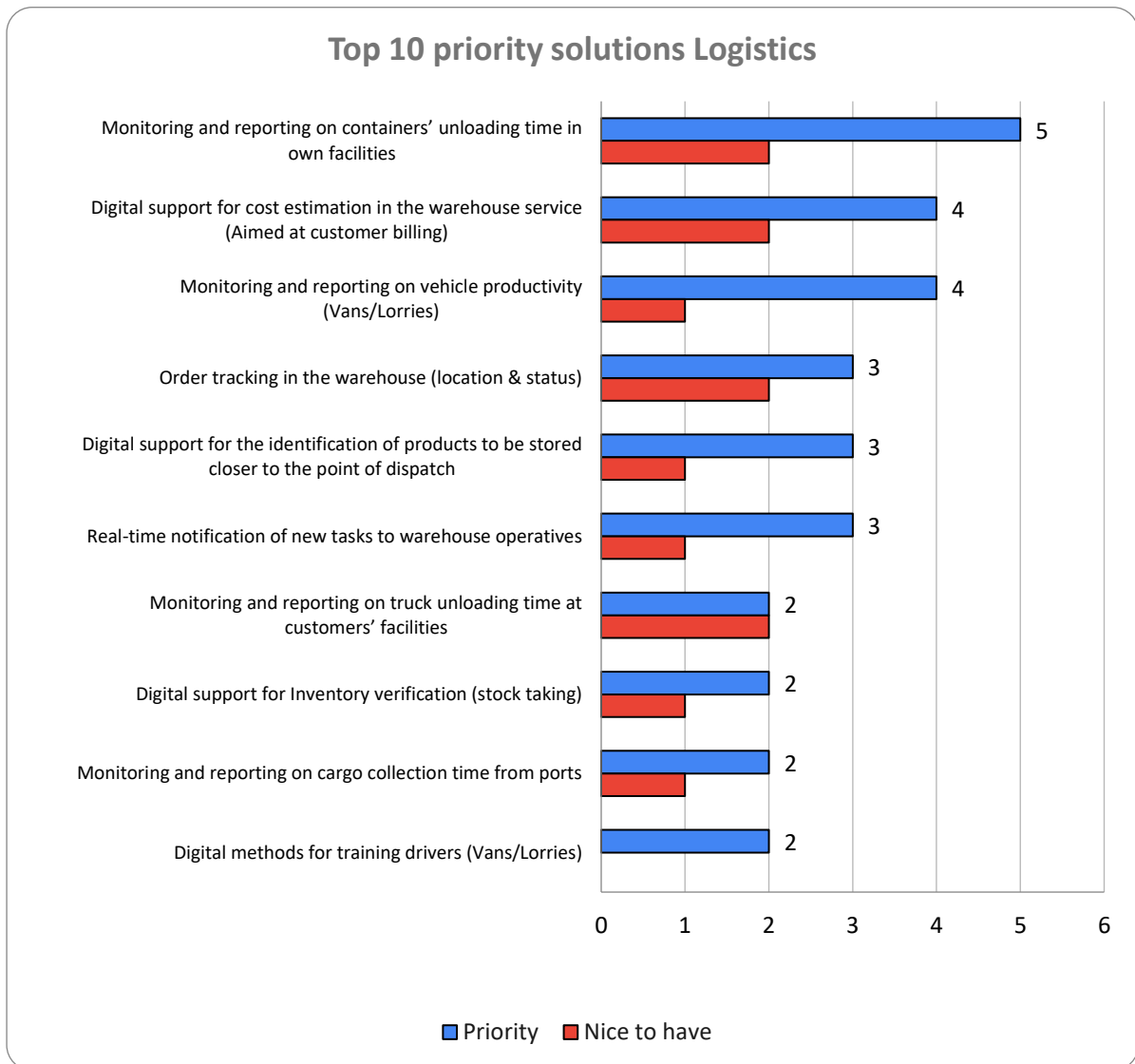*Institute for Manufacturing*

Facilitators:

- Liz Salter
- Sam Brooks
- Greg Hawkridge

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[3] G. Yilmaz, L. Salter, D. McFarlane, and B. Schönfuß, "Low-cost (Shoestring) digital solution areas for enabling digitalisation in construction SMEs," *Computers in Industry*, vol. 150, p. 103941, Sep. 2023, doi: 10.1016/j.compind.2023.103941.

Appendix A: Previous Results

Top 10 priority solutions Logistics

Solution	Priority	Nice to have
Monitoring and reporting on containers' unloading time in own facilities	5	2
Digital support for cost estimation in the warehouse service (Aimed at customer billing)	4	2
Monitoring and reporting on vehicle productivity (Vans/Lorries)	4	1
Order tracking in the warehouse (location & status)	3	2
Digital support for the identification of products to be stored closer to the point of dispatch	3	1
Real-time notification of new tasks to warehouse operatives	3	1
Monitoring and reporting on truck unloading time at customers' facilities	2	2
Digital support for Inventory verification (stock taking)	2	1
Monitoring and reporting on cargo collection time from ports	2	1
Digital methods for training drivers (Vans/Lorries)	2	

■ Priority ■ Nice to have

On-site and off-site top digital solutions Construction

Solution	Must have	Nice to have
Unified change management and issue reporting between design and construction operations	29	17
Digitised work instructions and assembly procedures	21	23
Process monitoring	19	15
Automated quality inspection	16	11
Construction scheduling	15	6
Project management system (track the status of project ie.schedule time, cost)	14	14
Automated completeness checking	13	11
Digitised employee training	8	7
Digital job cards	8	7
Display of construction schedule/work plan	8	3
4D virtual project planning (3D rendering)	7	12
Simulation of tools and processes for virtual process planning	6	8
Automated generation of basic CNC code	6	6
Internal lead time monitoring	6	6

■ Must have   ■ Nice to have

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