MPC
PERBADANAN PRODUKTIVITI MALAYSIA

PSIPN

INDUSTRY DIGITAL ROADMAP FOR ENGINEERING AND TECHNOLOGICAL SERVICES

A guide for firms to assess digital readiness and opportunities to go digital

FOREWORD

"Malaysia Productivity Corporation (MPC) through Professional Services Productivity Nexus (PSPN) is committed to boosting the professional services industry to its positive productivity growth and cementing its place as among the main contributors to Malaysia's economy. I urge the industry players to leverage this digital roadmap to increase productivity."

Dato' Abdul Latif bin Haji Abu Seman
Director General
Malaysia Productivity Corporation (MPC)

"The industry is entering the new era, characterised by smart professionals, sustainability, and industry 4.0. Technology and digitalisation are the essence of professional services in the new era. This digital roadmap serves a good guide."

Ts. Ir. Choo Kok Beng
Champion
Professional Services Productivity Nexus (PSPN)

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BACKGROUND

The Fourth Industrial Revolution (IR4.0), which aims to realise digital and networked production systems through the continuous development and adaptation of digital technologies in industrial processes, has contributed to the need for professionals to improve their skills, knowledge, and competencies. IR4.0 poses a significant challenge to businesses in locating technologically savvy personnel able to operate new systems and adapt to emerging technologies (Khan et al., 2021).

This has proven to be a significant issue for Malaysia, which is currently experiencing a shortage of skilled labour due to the dearth of appropriate job skills (Syed Yahya et al., 2021).

Engineers need a wide range of skills in order to meet current demands and adopt new technologies. When an engineer's formal education does not fully cover advanced digital technologies, he or she must rely on vendor technical support for routine maintenance (Hand, 2018). This complicates matters for engineers, whose profession is protected yet requires operational expertise to capitalise on technological advances.

Similarly, the concept of what constitutes technological professional expertise is evolving, and it is not far-fetched to imagine a scenario to in which technological professionals will increasingly cross the boundaries of information technology to create their own information systems (OECD, 2016).

In any case, this prospect necessitates a critical examination of the relationship between digitalization, work, and professions, which this study seeks to advance.

This research aims to identify the digital knowledge and/or technical skill sets required by engineering professionals and technologists in Malaysia while providing a roadmap on digital solutions based on the digital knowledge and/or technical skill sets required for the engineering and technological professional service industry in Malaysia.

ENGINEERING PROFESSIONAL SERVICES SECTOR

Engineering services sector plays an important role in the economy and contributes to technology development in Malaysia. A total of **385 engineering firms** are included from the three databases combined (see Figure 1). The "Others" category includes Malacca, Negeri Sembilan, Terengganu, Pahang, Kedah, Kelantan, Perlis, Putrajaya and Labuan. There are a total of **1,131 engineers** across all 3 statutory boards.

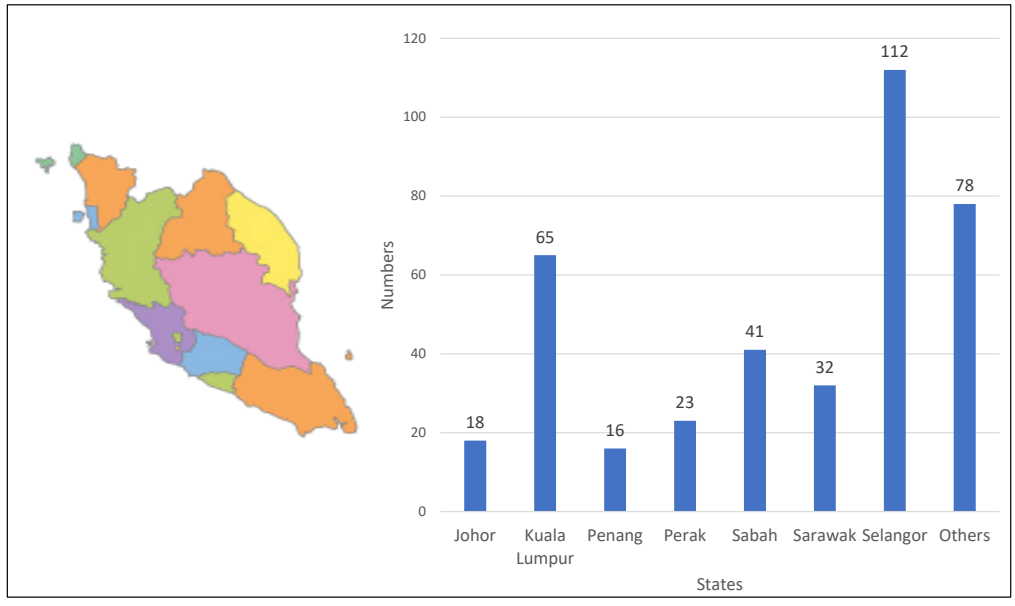


Figure 1 Engineering Firms by State in Malaysia

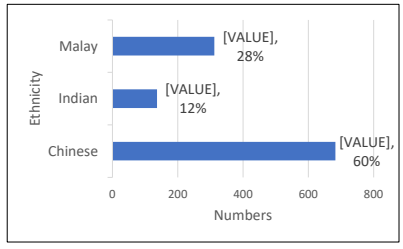


Figure 2 Engineers by Ethnicity in Malaysia

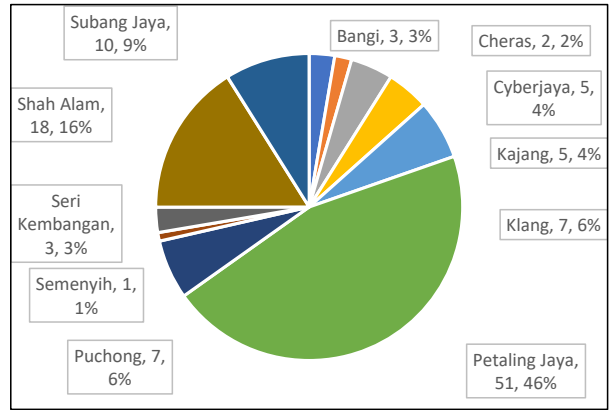
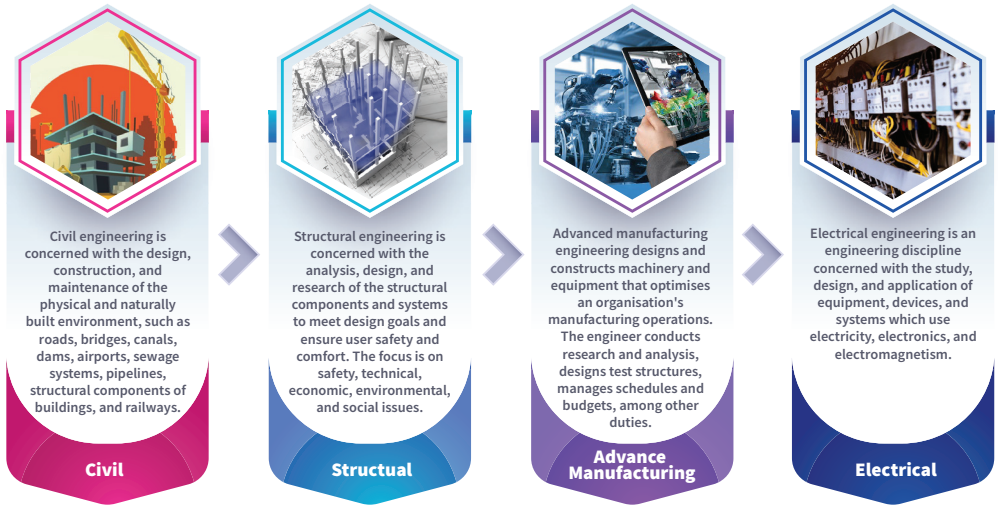


Figure 3 Engineering Firms by City in Selangor

TYPES OF ENGINEERING SERVICES



TYPES OF TECHNOLOGICAL SERVICES

MBOT listed 24 types of Technological Services in Malaysia

- Electrical & Electronic Technology
- Information & Computing Technology
- Chemical Technology
- Telecommunication & Broadcasting Technology
- Biotechnology
- Building & Construction Technology
- Resource Based Survey & Geomatics Technology
- Manufacturing & Industrial Technology
- Agro-based Technology
- Cyber Security Technology
- Transportation & Logistic Technology
- Material Science Technology
- Marine Technology
- Maritime Technology
- Atmospheric Science & Environment Technology
- Green Technology
- Oil & Gas Technology
- Automotive Technology
- Aerospace & Aviation Technology
- Food Technology
- Nano Technology
- Nuclear & Radiological Technology
- Art Design & Creative Multimedia
- Health & Medical Technology

TRENDS IMPACTING ENGINEERING AND TECHNOLOGICAL PROFESSIONS

Inadequacy of digital knowledge and skill among engineers and technologist

Formal engineering education does not adequately cover advanced digital technologies, particularly the adoption of cutting-edge technology to meet the challenges of digitalization in the engineering industry. For routine maintenance, the engineers and technologist must rely on vendor technical support (Hand, 2018).

Unqualified workforce in engineering sectors

A tech-savvy workforce is required for the implementation of any new technology in any business. An ageing workforce, particularly in the engineering field, finds it exceedingly difficult to learn and adopt new technologies. Training can also be costly and time-consuming (Glodon Co. Limited, 2022). As a result of a labour shortage brought on by the pandemic and an ageing population, the situation may deteriorate.

Increasing importance of digital transformation

Digital transformations such as artificial intelligence, blockchain, and cloud services have accelerated technological change, causing widespread concern for the future of technological professions (Dahlin, 2019). In addition to generic technological skills and knowledge, STEM (science, technology, engineering, and mathematics) is required for applying these skills to real-world problems and adapting quickly to environmental and technological change (Male et al., 2011)

TRENDS IMPACTING ENGINEERING AND TECHNOLOGICAL PROFESSIONS

Integration of data and information sharing in digital ecosystem

IR4.0 digitalisation foresees the integration of stakeholders within ecosystems, such as factories, supply chains, and customers. Such an integration necessitates the sharing of data between various local automation systems owned which may be located in different countries with their own legal systems. The sharing of data enables the optimization of productivity, raw material yield, energy consumption, and environmental impact, etc., which is the driving force behind automation (Urgese et al., 2020)

Digitalisation of inter-firms' relationships

To sustain the digital ecosystem, the digitalisation of buyer–seller relationships is a growing phenomenon among businesses. The construction of a digital infrastructure capable of supporting the inter-firm interactions required in a business network presents difficulties for engineering firms (Baraldi & Nadin, 2006). Specifically, how are digital tools constructed and introduced into business networks in order to maintain relationships, and what obstacles arise during such attempts?

Strong digital leadership needed

To continue the successful trend in digitalization, firms must continuously train engineering teams in applicable digital skills, use technology that promotes collaboration, connect projects that maximise impact, and focus digital technologies on fixing problems. The success of the digital transformation warrants strong leadership from managers and executives (Baraldi & Nadin, 2006). They must have a clear perspective, knowledge and skills on how to create value for not only their business, but also the construction projects using digital technologies

GENERIC DIGITAL KNOWLEDGE AND TECHNICAL SKILLSETS REQUIRED BY ENGINEERING AND TECHNOLOGICAL PROFESSIONS

Generic Digital Knowledge

Knowledge relating to science, technology, engineering, and math is required to tackle real-life problems.	**Communication skills are essential skills for engineers in presentation and reporting**	**Problem solving skills and teamwork skills are also important to ensure the completion of the projects**

Common digital tools and software required

Project Management - software is used to streamline the workflow of a team working on the same project	**Scheduling -** Tools for scheduling operations, including time tracking, employee communication, and work schedule management	**Documents management** - storing, managing, and tracking digital information using a computer software application	**Report generation** - provides reporting, decision making, and business intelligence capabilities
• Aha! • BigTime • GanttPRO • Flowlu • Avaza	• HoneyBook • Resource Guru • Nowsta • Bookwhen • Vectera	• Google Drive • Dropbox • Google Workspace	• Microsoft excel • Microsoft words • PowerPoint • Zoho Analytic • Whatagraph • JReport

DIGITAL KNOWLEDGE AND TECHNICAL SKILLSETS REQUIRED BY ENGINEERING AND TECHNOLOGICAL PROFESSIONS

Engineers in the oil and gas industry place a high value on project management abilities. Engineers in the construction industry and the electronic and electrical fields are concerned with digital knowledge and skills in the design and operation to effectively and efficiently manage the projects' resources.

Digital knowledge and skills are necessary for the design and operation of a system in generating data, anticipating clients' future needs, and staying abreast of technological advancements. For service consultation, digital skills are important for managing the operations of the business.

Technologists are more concerned about upskilling their digital knowledge and skills as they use the digital tools and software frequently in their day-to-day operation. Good digital knowledge and skills could make the work processes easier and more efficient and at the same time, find new solutions to industrial problems.

Technologists are required to acquire technical skills and knowledge to operate the latest and complex software, while staying up-to-date with the current trend and technology.

	Project Management	Operation	Design
Electronic and Electrical	Market intelligent analysis to identify the competitive advantages for the firm and the projects	Predicting and analysing the trend to understand the clients better	Creating models to help the clients visualise
Construction	Resource management skills and scheduling to ensure all projects are completed within the deadline and the budget allocated	• Setting goals and milestones towards achieving maximum growth • Human resources management skills	Using digital software to create architectural drawings for the company's project
Oil & Gas	Using field experience to understand and manage the project better. Onsite inspection skills are also required to monitor the workflow and the progress of the project	• Extensive knowledge of operation management tools • Human resources management skills	
Services	Competitive analysis to ensure the firm stays competitive within the industry	Computer Literacy, using technology to their benefit	Utilise their digital knowledge to provide consultation related to architecture design to clients

TYPES TOOLS AND SOFTWARE

- Generic software such as Microsoft Excel, Google Drive, and Microsoft PowerPoint are used for project management, presentation, and data storage. Cloud storage services like Google Drive and One Drive are popular storage software among engineers and technologists.

- AutoCad and Building Information Modeling (BIM) are two common tools and software in the design phase of construction projects. Plaxis and GES (Geological Evaluation system) are the software suggested for oil and gas industry specifically for modelling, simulating, and analysing in the field of geotechnical finite element analysis. Similarly, AutoCad, BIM, and 3D modelling, and designing are common among technologists.

Civil Engineering

AutoCAD Civil 3D
HEC-HMS
HEC-RAS
StormCAD
SSA
WaterCAD
EPANET
ArcGIS
Bluebeam
BIM

Chemical Engineering

Microsoft Excel
MATLAB
Simulink
Aspen HYSYS
Aspen PLUS
CHEMCAD
COMSOL
Multiphysics
ANSYS Fluent

Electrical Engineering

MATLAB
Simulink
Pspice
Multisim
ETAP
Power World
Simulator
PSCAD
PSS/E
LabVIEW
Keil uVision
BIM

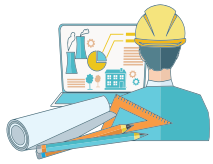
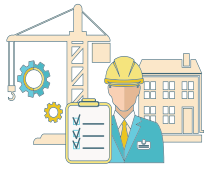
Mechanical Engineering

Fusion 360
KeyCreator
Inventor
Solid Edge
NX
SolidWorks
CATIA
ProE
Mathematica
Alibre
TurboCAD
Deluxe
AutoCAD
Mechanical
FreeCAD
SolveSpace
DesignSpark
Mechanical
BIM

DIGITAL ROADMAP

Stage 1	Stage 2	Stage 3
Getting Ready for the Digital Economy	**Growing In the Digital Economy**	**Leaping**
Uplifted Digital Capabilities, Optimised Operations	Integrated Ecosystem, Streamlined Processes	Intelligent Business, Autonomous Operations
 3D Modelling, Immersive Visualisation and Analysis	 Built Environment Digital Platform	 Blockchain for Progress Verification
 Building Information Modelling	 Computational Design	 Data and AI-driven DSS
 Coordination Tools and Collaboration Platform	 Coordinated Regulatory Approvals and Based Model Checker	 Robotics for Autonomous Project Management and Collaboration
 Project Management and Workflow Automation	 Integrated and Smart Worksite Monitoring and Inspection	

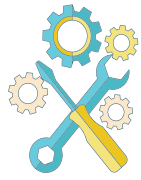
STAGE 1 : GETTING READY FOR THE DIGITAL ECONOMY

Solution Category	Description	Benefits
 3D Modelling, Immersive Visualisation and Analysis	Transform a construction idea into 3D object to have a better view and understanding of the design	• Easy to understand and validate the design • Deliver high quality product
 Building Information Modelling	• To organise and analyse data about structures • Commonly used for building design, infrastructure design and construction	• Higher accuracy when building design • Improve productivity • Project visualisation
 Coordination Tools and Collaboration Platform	• A platform for a team from different disciplines to plan and manage work together • Allows communication and exchange of information online	• Flexibility • More efficiency • Improved productivity
 Project Management and Workflow Automation	• Automate the process of managing resources for a project such as reporting, documenting, etc.	• Complete tasks more easily and quickly • Greater efficiency • Improved productivity

STAGE 2: GROWING IN THE DIGITAL ECONOMY

Solution Category	Description	Benefits
 Built Environment Digital Platform	• Enables team to communicate online to coordinate and monitor their work • Sharing information online allows project partner access to the right resources	• Reduces paperwork • Better access to wider range of information and resources • Improves productivity
 Computational Design	• Transforms the design process into computational strategies • Explore more design choices by tuning modelling parameters	• Faster and more effective • Reduces human errors • Results obtained quickly
 Coordinated Regulatory Approvals and Based Model Checker	• Validates model using rule-based checking approach during quality assurance process	• Improve design through the rule-based checking approach • Speed up submission and approval process
 Integrated and Smart Worksite Monitoring and Inspection	• Using digital tools to monitor on-site activities to prevent any safety issues and track the project progress	• Provide real-time monitoring • Improve safety and health of workers

STAGE 3: LEAPING AHEAD

Solution Category	Description	Benefits
 Blockchain for Progress Verification	A reliable method to record progress efficiently	• All transactions are encrypted across network hence increased security • Cost reduced as there is no need for middle person
 Data and AI-driven DSS	• Increase project predictability and performance by processing and analysing huge amount of data without error • Help humans make better and consistent decisions more quickly	• Improve productivity as AI is available for 24x7 • Unbiased decision as the output are based on big data analytic
 Robotics for Autonomous Project Management and Collaboration	• Automate daily tasks Help in allocating resources	• Reduce time on doing repetitive tasks so more time to spend on higher value tasks • Reduce human errors

DIGITAL ROADMAP ON TRAINING

	Stage 1 : Getting Ready for the Digital Economy	Stage 2: Growing In the Digital Economy	Stage 3: Leaping
Tech Basic Courses	• Skills for Future Digital Workplace • Introduction to Building • Information Modelling (BIM) Data and Modelling	Understanding Rule Based Expert System	Introduction to Block-chain technology Understanding Project Collaboration
Tech Advanced Courses	• Basic Building Information Modelling • Intermediate Building Information Modelling (Coordination & Documentation) • Advanced Building Information Modelling (Computational)	Integrated Digital Delivery (IDD) Project Planning and Execution	• Integrated Digital Delivery (IDD) Application and Development • Data Analytic and Machine Learning • Internet of Things

RESEARCH FINDINGS

Based on the **research findings**, several policies are **recommended**:

- Government to consider subsidising programmes for technologists to attend courses and learn new tools and software, and to upgrade their educational and professional qualifications
- Government to provide subsidies and tax incentives for purchase of equipment, digital tools, and software by engineering and technological companies
- Government to push for digitisation and enhance policy allowing e-submission as well as establishing collaborative and tender platforms for authorities' approvals and submissions
- Government to implement policies relating to cyber security to protect the interests of various stakeholders
- Relevant ministry/agency to collect data and information for analytics and planning to implement smart city concepts in the Malaysian context
- Create think-tank groups for future policy push.

The following are recommended for professional practice:

- Provide training for the engineering and technological companies' employees to increase their knowledge and technical skills related to use of digital tools and software
- Professional engineers and technologists need to attend more events and training about emerging technologies to broaden their knowledge on digital tools and software
- Integrate the digital tools, software and platforms used by various engineering and technological specialisations, and bulk purchase for professional companies' use as an annual subscription for members in professional associations/societies
- Ensure all graduate engineers and technologists are well equipped with new knowledge and skill sets and have a firm foundation of the fundamentals as part of the professional qualification requirements
- Increase the number of CPD points required by technologists to include training relating to the use of newer technologies
- Introduce a cloud library for technologists to access all previous case studies relating to engineering and technology.

Three groups of respondents interviewed face-to-face comprise those from: (a) professional bodies, regulatory and associations; (b) engineering and technological firms; and (c) individual engineers and technologists. Suitable respondents are those who have authority or expertise in the area studied. Respondents were selected from the engineering and technological professions, inclusive of the management of firms and individuals who are also engineers and technologists. Respondents from professional bodies, regulatory agencies, and associations were also selected for interview.

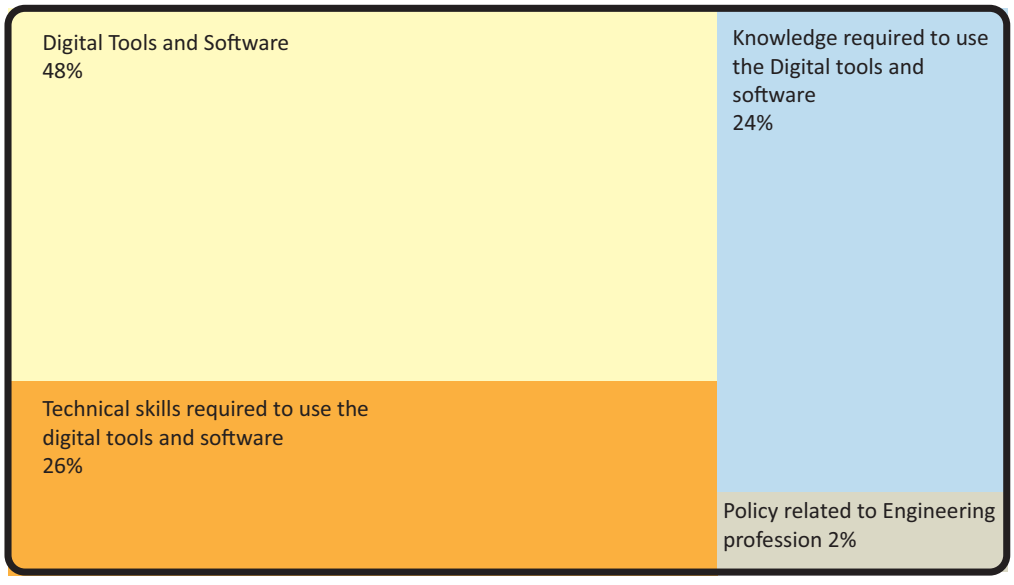


Figure 4 : Tree Map of Thematic Coding from Interview Findings of Engineering Profession

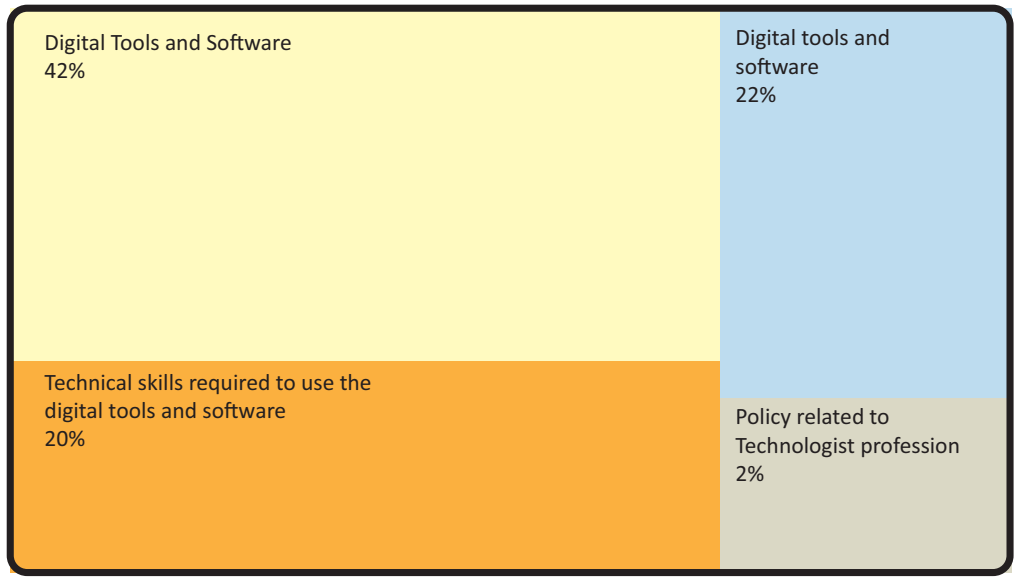


Figure 5 : Tree Map of Thematic Coding from Interview Findings of Technological Profession

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