INDUSTRY 4.0 BEHAVIORAL INSIGHTS

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The Asian Productivity Organization (APO) is an intergovernmental organization that promotes productivity as a key enabler for socioeconomic development and organizational and enterprise growth. It promotes productivity improvement tools, techniques, and methodologies; supports the National Productivity Organizations of its members; conducts research on productivity trends; and disseminates productivity information, analyses, and data. The APO was established in 1961 and comprises 21 members.

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PREFACE

The P-Insights, short for "Productivity Insights," is an extension of the Productivity Talk (P-Talk) series, which is a flagship program under the APO Secretariat's digital information initiative. Born out of both necessity and creativity under the prolonged COVID-19 pandemic, the interactive, livestreamed P-Talks bring practitioners, experts, policymakers, and ordinary citizens from all walks of life with a passion for productivity to share their experience, views, and practical tips on productivity improvement.

With speakers from every corner of the world, the P-Talks effectively convey productivity information to APO member countries and beyond. However, it was recognized that many of the P-Talk speakers had much more to offer beyond the 60-minute presentations and Q&A sessions that are the hallmarks of the series. To take full advantage of their broad knowledge and expertise, some were invited to elaborate on their P-Talks, resulting in this publication. It is hoped that the P-Insights will give readers a deeper understanding of the practices and applications of productivity as they are evolving during the pandemic and being adapted to meet different needs in the anticipated new normal.

INTRODUCTION

Technology continues to revolutionize the business world, leaving indelible impacts that span sectors. One of the most significant transformations is the way businesses operate. Automation and digital tools have streamlined processes, boosting efficiency and productivity. From cloud computing to advanced analytics, companies can now make data-driven decisions, optimizing their strategies for growth and competitiveness.

Behavioral insights play a crucial role in Industry 4.0, the era marked by the integration of digital technologies, automation, and data-driven decision-making into manufacturing and other sectors. Behavioral insights are making an impact on user experience optimization, predictive maintenance, supply chain management, employee engagement, customization and personalization, and overall productivity.

In Industry 4.0, behavioral insights provide a competitive advantage by helping companies adapt to changing market dynamics, streamline operations, and deliver better products and services. Understanding and leveraging human behavior in the context of digital transformation are essential for success in this rapidly evolving landscape. The rise of AI and machine learning is another game-changer. These technologies help businesses to predict trends, automate tasks, and provide more personalized customer experiences.

THE ECONOMIC SCENARIO

In the ever-evolving landscape of the business world, organizations must continually reinvent themselves to stay relevant. This concept has become a crucial factor in ensuring the survival and success of businesses in the 21st century. A timeline of three to seven years is often mentioned as a general guideline for organizations to consider reinventing themselves.

My personal journey into understanding the importance of reinvention began in 2016 when I visited a European country renowned for its implementation of Industry 4.0 [1]. Witnessing the transformative power of technological advances and innovative approaches to business practices was eye-opening. It highlighted the need for organizations to adapt and embrace change in order to thrive in the modern era.

The impact of technological disruption is evident when we examine the data. According to an Innosight 2017 report, it was estimated that three-quarters of S&P 500 listed corporations would be replaced in 10 years [2]. This statistic served as a stark reminder that even long-established companies can be vulnerable to extinction if they fail to adapt and reinvent themselves.

The COVID-19 pandemic brought about significant challenges for businesses of all sizes. Regardless of the size of the organization, the need for transformation is universal. In order to move forward and thrive, businesses must adapt their strategies, operations, and processes to the new realities brought about by the pandemic. One interesting phenomenon that has emerged is the potential for small companies to surpass their larger counterparts through swift, decisive action. Agility and the ability to pivot quickly in response to changing market conditions can give smaller organizations a competitive advantage. Size is no longer the sole determinant of success; instead, it is the willingness and capability to transform that truly matter.

Regardless of size or industry, organizations must recognize the necessity of reinvention to stay relevant and competitive in the business world. The rapidly

evolving landscape, coupled with the transformative impact of COVID-19, requires businesses to be proactive in their approaches. By embracing change, adopting innovative technologies, and continuously evolving, organizations can position themselves for success.

When embarking on a transformation journey, it is essential to prioritize the focus and efforts. Three key categories can help guide the approach: what can be controlled; what can be influenced; and what cannot be controlled. By understanding and categorizing these factors, organizations can make informed decisions on where to direct their energy for meaningful change.

Taking Control and Making Changes
The first step is identifying the elements within the organization which can be controlled. These factors are within your sphere of influence, allowing you to initiate and implement changes to drive transformation. By focusing on what you can control, you can actively shape your organization's future. This includes aspects such as internal processes, operations, and strategies. By leveraging your control, you can make deliberate changes that align with your transformation goals.

Letting Go of What Cannot Be Controlled
It is crucial to recognize that there are external factors beyond your control, such as politics, social dynamics, environmental circumstances, and legal issues. These variables may impact your organization, but worrying about them excessively serves no purpose. Instead, it is important to accept their presence and focus on what you can control within your organization. Redirecting your energy away from factors beyond your influence allows you to maintain a productive and proactive mindset.

The Path to Success: Focus and Effort
Ultimately, success in any transformation initiative comes down to two fundamental elements: focus and effort. By maintaining a clear focus on your goals and investing dedicated effort, you can make significant progress toward your desired outcomes. These are the elements that lie within your control and can be harnessed to propel your organization forward.

Controlling Costs for Profitability

One area that organizations can control is cost management. While market prices may be beyond your influence, you have the ability to control your organization's cost structure. In Malaysia, certain prices may be regulated by the government, imposing limitations on price control. However, by diligently managing costs, you can optimize your profit margins. Consistently monitoring and reducing costs can lead to increased profitability over time.

The Lean Concept: Managing Waste for Cost Control

To effectively control costs, the lean [3] concept offers valuable insights. This methodology focuses on waste reduction and elimination. By identifying and managing the eight types of waste, organizations can drive cost savings and improve efficiency. By streamlining processes and eliminating unnecessary steps, resources and time can be utilized more effectively.

A successful transformation journey requires a clear understanding of what can be controlled, influenced, and what lies beyond your control. Focus on what you can control, invest effort in driving change, and accept factors outside your influence. Control costs to maximize profitability and utilize the lean [3] concept to manage waste. By prioritizing these elements, organizations can set themselves on a path toward effective transformation and long-term success.

Begin by reviewing the various types of production waste that can occur within an organization by using the lean [3] concept. It is crucial to identify and address those types of waste as they can hinder efficiency, increase costs, and impact overall productivity. By understanding and mitigating waste, organizations can optimize their production processes.

Identifying and Addressing Overproduction Waste

To optimize productivity and reduce waste, it is crucial to review the various types of waste that can occur within a manufacturing setting. Begin by examining overproduction waste, which can have a significant impact on costs.

Controlling Defects for Cost Reduction

Defects are a critical aspect to control as they directly contribute to costs. Many Japanese companies have implemented programs aimed at reducing defects, often targeting a specific percentage reduction (e.g., from 30% to 10%). By diligently

addressing and minimizing defects, organizations can enhance their cost efficiency and improve overall product quality.

Mitigating Overproduction Waste
Overproduction waste arises when there are additional products manufactured beyond the planned requirements. These surplus products cannot be sold to customers, resulting in unnecessary costs and waste. Therefore, it is crucial to implement measures to control and minimize overproduction, ensuring that production aligns precisely with demand.

Eliminating Waiting Waste
Another type of waste that hampers efficiency is waiting waste. This waste can occur due to delays in receiving essential information or materials needed for production. Such delays lead to unproductive waiting time, impeding the smooth flow of operations. It is essential to identify and address these waiting issues promptly, allowing for uninterrupted production and minimizing waste caused by idle time.

Leveraging Talent and Eliminating Unused Resources
Inefficiencies can also stem from not effectively utilizing the talents and skills of employees. Human resources departments should possess profiles of employees' talents and specializations, allowing them to place individuals in suitable roles that align with their abilities. By matching talent to appropriate positions, organizations can optimize productivity and reduce waste resulting from underutilized resources.

Streamlining Transportation and Warehouse Processes
Transportation waste, particularly within the warehouse, can have a significant impact on productivity and efficiency. To minimize waste in this area, organizations can leverage technologies such as robots for product transfer, optimizing warehouse operations and reducing unnecessary transportation-related waste.

Managing Inventory and Reducing Waiting Time
Inventory waste is not limited to materials alone but also includes spare parts. Excessive inventory levels can lead to delays in waiting time, impacting production timelines and efficiency. It is essential to manage inventory carefully, striking a balance between meeting production needs and avoiding excess storage of materials or parts.

Implementing Motion Study for Waste Reduction
Motion study is a valuable method for identifying and reducing waste related to unnecessary movements. By carefully analyzing and calculating each motion involved in a process, organizations can identify areas where waste can be minimized. Through streamlining and optimizing motion, unnecessary waste can be eliminated, contributing to improved productivity and efficiency.

Avoiding Unnecessary Extra Processing
Finally, organizations must evaluate the need for any additional processes beyond the initial requirements. While extra processing may be implemented to control quality, it is important to critically assess whether it is necessary or if improvements can be made to the initial processes. Eliminating unnecessary extra processing can enhance efficiency and reduce waste.

By addressing and minimizing overproduction, defects, waiting time, underutilized talent, transportation inefficiencies, excessive inventory, unnecessary motion, and extra processing, organizations can significantly reduce waste and enhance productivity. A systematic approach to waste reduction can lead to cost savings, improved product quality, and overall operational efficiency.

The evolving economic landscape compels us to adapt and embark on the journey of digital transformation to reinvent our businesses. However, apprehension may arise among some when it comes to embracing this transformation. Yet, upon closer examination, digital transformation is not always as costly as perceived initially.
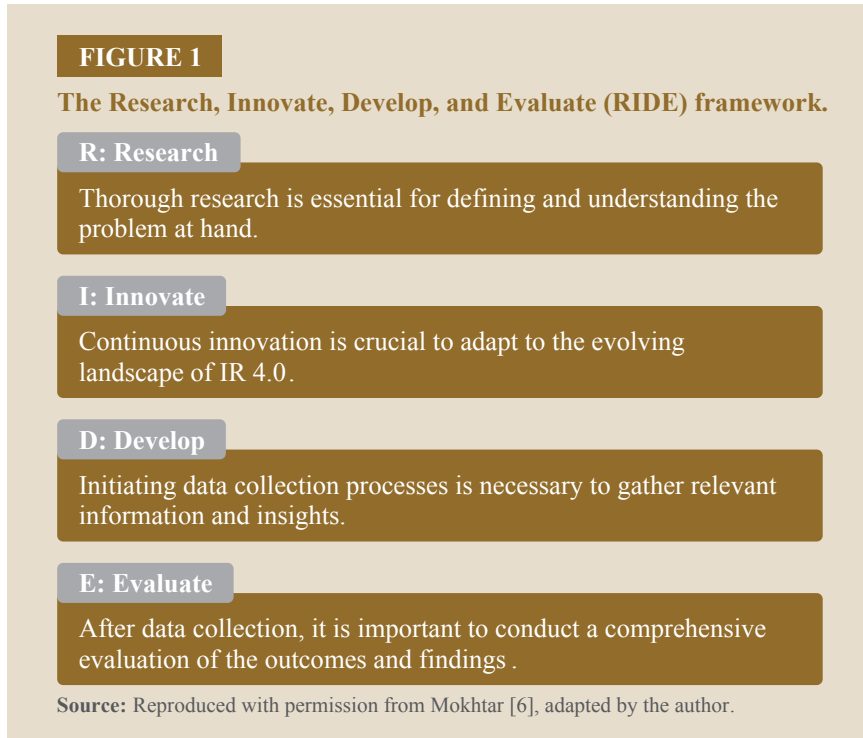
BEHAVIORAL INSIGHTS

The field of behavioral insights (BIs) [4] can be defined as an inductive approach to policymaking which integrates findings from psychology, cognitive science, and social science. By leveraging empirical evidence and tested outcomes, it aims to gain a deeper understanding of human decision-making processes and the factors that influence choices.

In Malaysia, the Malaysia Productivity Corporation (MPC) [5] has been entrusted by the government with the responsibility of overseeing BIs [4] for all agencies in the country. By visiting the MPC website and exploring the section dedicated to BIs, one can witness a multitude of ongoing activities. It is evident that the focus is on finding solutions to existing problems based on an understanding of how people actually behave, rather than how they ought to behave.

Through my own research, I have formulated the following statement regarding BIs in the context of IR 4.0: "Behavioral insights [4] in IR 4.0 represent a concerted effort to gain accurate and evidence-based comprehension of human behavior and decision-making processes." This highlights the significance of studying and understanding human behavior to effectively navigate the challenges and opportunities presented in the IR 4.0 era.

I would like to share my personal experiences in utilizing technology from IR 4.0 to observe and understand how people behave and make decisions. The application of IR 4.0 technology provides valuable insights into the hindsight, insight, and foresight of various situations. BI[4] approach within the realm of IR4.0 emphasizes the importance of evidence-based practices, practical problem-solving, and innovative thinking. It involves identifying practical issues, developing innovative solutions, and evaluating the outcomes.

Dr. Danilla Mokhtar, a renowned academic from Universiti Kebangsaan Malaysia (UKM), emphasizes the importance of RIDE[6] in this context, as shown in Figure 1.

FIGURE 1

The Research, Innovate, Develop, and Evaluate (RIDE) framework.

R: Research

Thorough research is essential for defining and understanding the problem at hand.

I: Innovate

Continuous innovation is crucial to adapt to the evolving landscape of IR 4.0.

D: Develop

Initiating data collection processes is necessary to gather relevant information and insights.

E: Evaluate

After data collection, it is important to conduct a comprehensive evaluation of the outcomes and findings .

Source: Reproduced with permission from Mokhtar [6], adapted by the author.

By adopting the RIDE framework, organizations and researchers can effectively navigate the challenges and harness the opportunities offered by IR 4.0, enabling them to make informed decisions and drive meaningful changes.

WHAT IS IR 4.0?

IR 4.0 represents a significant leap in technological advances. Japan has embarked on Society 5.0, which is particularly noteworthy for its emphasis on addressing the challenges posed by an aging society. When we refer to IR 4.0 [1], we are essentially discussing the integration of various cutting-edge technologies, such as cyberphysical systems, the IoT, cloud computing, and AI. The key distinction between IR 3.0 and IR 4.0 lies in their orientations. IR 3.0 was process-centric, whereas IR 4.0 adopts a human-centric approach. This shift empowers us to understand and control the technological advances taking place.

In IR 3.0, machines were set to run without a comprehensive understanding of their operations. However, in IR 4.0, we have the opportunity to delve into the intricate workings of these technologies. The following sections provide specific examples to illustrate the technological advances and their practical applications in greater detail. In essence, the previous industrial revolutions focused on doing things right, ensuring efficiency and effectiveness. However, IR 4.0 takes a different perspective by emphasizing the importance of doing the right things in the correct manner. This distinction marks a significant shift in approach and mindset.

Furthermore, IR 4.0 introduces a transformative element to the economy and society by integrating quality into quantity. Unlike previous eras, where quantity was prioritized, IR 4.0 leverages technology to enhance both quantity and quality, enabling improved decision-making processes. In essence, IR 4.0 can be summarized as the digitalization of data and information exchange, facilitated by advanced technologies that enable real-time connectivity and collaboration through cyberphysical systems.

IR 4.0 enables valuable insights into how people behave and make decisions, ultimately enhancing our decision-making capabilities. With the wealth of interconnected data and advanced analytical tools available, we can make more informed and precise decisions in the IR 4.0 era. This ability to harness insights and leverage technology sets IR 4.0 apart from its predecessors, offering significant potential for progress and advancement.

What is a cyberphysical system? It encompasses the integration of communication, control, and computation. Effective communication plays a vital role in the functioning of these systems. For example, I rely on a strong broadband connection for seamless communication. Similarly, reliable, high-speed internet connections are crucial. Connectivity forms the foundation of successful communication.

In today's technological landscape, terms like 4G, 5G, and even 6G are frequently mentioned. The level of connectivity available depends on location. In manufacturing settings that are confined to smaller areas, Wi-Fi can be used, providing short-range connectivity. On the other hand, industries such as agriculture, farming, or palm oil estates require long-range connectivity, which can be achieved through embedded systems.

A cyberphysical system integrates communication, control, and computation. Communication, facilitated by strong connectivity, is a crucial aspect that varies depending on the scale and requirements of different industries. Whether it is utilizing Wi-Fi in closed manufacturing environments or employing long-range embedded systems in larger-scale operations, the effective exchange of information is vital for the seamless functioning of cyberphysical systems.

Control refers to how we manage and govern various elements. One crucial component in this regard is the IoT, which plays a significant role in enabling control. IoT devices are embedded with sensors that collect valuable data. These data hold immense potential in processes. Here, the keyword to focus on is "data." Once collected, data are stored in the cloud. However, it is essential not to let these data remain idle. Merely storing data without utilizing them is ineffective. Instead, we must actively analyze the data to extract valuable insights and make informed decisions.

If data remain dormant, they become "dark data." Dark data lack utility and fail to generate any meaningful impact. Therefore, it is crucial to harness the potential of collected data through analysis to derive valuable insights. This unlocks the true power of data and paves the way for informed decision-making and impactful outcomes.

The data collected are often referred to as "raw data." However, to make sense of these data, we need to employ computational techniques to visualize and interpret them effectively. Visualization allows us to explore the data and gain valuable insights, encompassing the aspects of hindsight, insight, and foresight.

It is important to recognize that Industry 4.0 [1] technologies are not static; they are dynamic and constantly evolving. In Malaysia, we initiated our journey with Industry4wd [7] and focused on 11 key technological pillars, including AI, advanced materials, the IoT, cloud computing, and other elements. With time, new technologies and concepts such as big data analytics, additive manufacturing, and autonomous robots have emerged.

If readers are not technologists and are overwhelmed by the jargon associated with these technologies, do not be afraid. While the terminology may initially seem complex, it is not inherently difficult to grasp. With a little effort and curiosity, you can gain a basic understanding of these concepts and their applications. Embracing these technologies can empower individuals and organizations to thrive in the digital era and harness their full potential.

THE IR 4.0 MINDSET AND APPROACH

Another important aspect to consider is the mindset when embracing IR 4.0 (Figure 2). It is crucial to understand that IR 4.0 is not about replacing existing processes; instead, it is about transforming the way we approach and execute them. As mentioned earlier, it is about doing the right things the correct way. Cultivating a growth mindset is key. But what does that mean? When we venture into the realm of digital technology, we will inevitably encounter challenges and setbacks. It is important to recognize that failure is a natural part of the learning process. Embrace the notion that nobody is perfect, and it is acceptable to stumble along the way. Patience and resilience are essential qualities to navigate these challenges successfully.

FIGURE 2

The IR 4.0 mindset.

Growth mindset
I can learn anything I want to.
When I'm frustrated, I persevere.
I want to challenge myself.
When I fail, I learn.
Tell me I try hard.
If you succeed, I'm inspired.
My effort and attitude determine everything.

Fixed mindset
I'm either good at it, or I'm not.
When I'm frustrated, I give up.
I don't like to be challenged.
When I fail, I'm no good.
Tell me I'm smart.
If you succeed, I feel threatened.
My abilities determine everything.

Source: Reproduced with permission from Wilson [8].

Do not be discouraged by failures. In fact, view them as valuable learning experiences that provide deeper insights into the overall situation. Foster a positive growth mindset that embraces the possibilities offered by technology and fearlessly confronts failure. Remember, even experienced individuals face failures when embarking on new endeavors. By maintaining a growth mindset, you empower yourself to continuously learn, adapt, and improve. Embrace technology with an open mind, face challenges with courage, and recognize that failure is an opportunity for growth. Through perseverance and a positive mindset, you can overcome obstacles and thrive in the digital era.
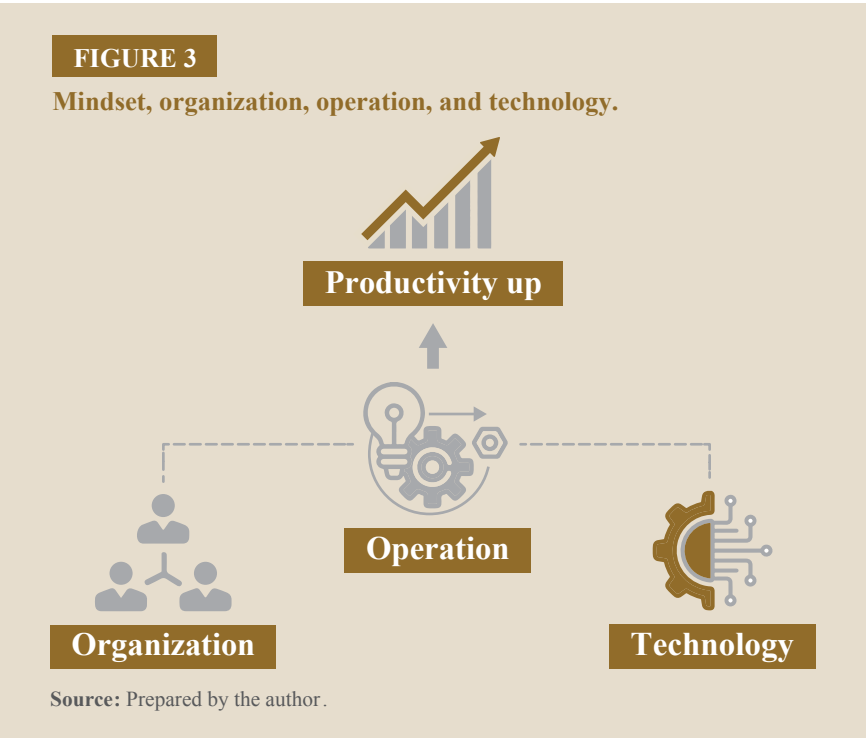
When it comes to mindset [9], it is important to consider the alignment of organization, operation, and technology. Placing technology as the sole priority can be misleading. Instead, it is crucial to ensure that processes are compatible with the chosen technology. Technology should serve as an enabler for processes, not the other way around.

Within the organization, cultivating a growth mindset among employees is paramount. There may be concerns about technology replacing human resources and rendering jobs obsolete. However, it is crucial to approach this with a balanced perspective. Technology should be seen as a tool that enhances and augments human capabilities, rather than a threat. In the organization, it is essential to establish a consensus from top to lower management, where everyone understands and embraces the potential of technology.

In addition to mindset, process evaluation is vital. Identify which processes within the organization need improvement. With many processes in place, it is important to pinpoint the top three pain points. By focusing on these areas, you can prioritize improvements and allocate resources effectively.
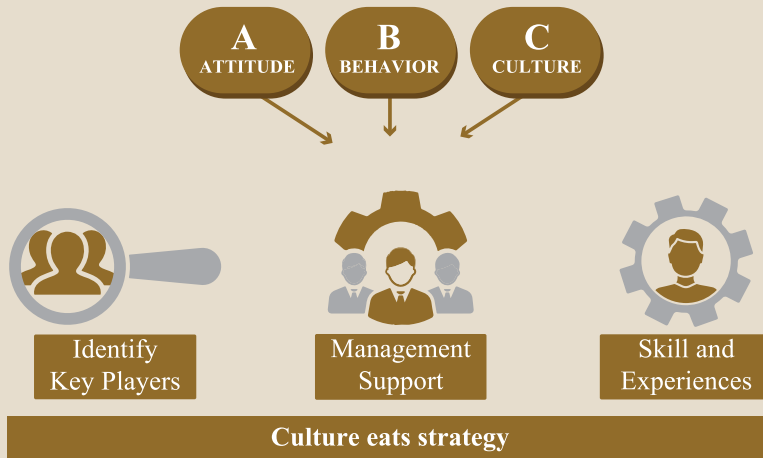
By adopting a holistic approach that encompasses mindset, organization, and process evaluation, you can navigate the challenges and leverage the opportunities presented by IR 4.0. Remember, technology should serve processes, and a growth mindset empowers employees to embrace and adapt to new advances. Then, choose the IR 4.0 technology that can improve processes, productivity, quality, and/or efficiency. Make process the priority.

Always consider the process first, then pick the technology that fits it (Figure 3).

FIGURE 3

Mindset, organization, operation, and technology.

Productivity up

Operation

Organization

Technology

Source: Prepared by the author.

Remember the importance of people in the organization (Figure 4). When it comes to building a workforce with a positive mindset toward IR 4.0, it is essential to examine three key aspects: A-Attitude, B-Behaviors, and C-Culture. Understanding and addressing these elements will contribute to a successful transition. To foster a positive mindset, identify key individuals within the organization who can drive and champion IR 4.0 initiatives. These individuals will play a crucial role in implementing programs and ensuring their success. Additionally, obtaining management support is vital for creating a conducive environment that encourages innovation and embraces technological advances.

In addition to mindset and support, skill development and experience are paramount. Malaysia has implemented several skill programs, such as the MPC's [5] MYRESKILL initiative, which provides free education on the IoT to selected companies. Leveraging these skill programs can help enhance workforce capabilities, ensuring that employees have the necessary skills and knowledge to thrive in the era of IR 4.0.

FIGURE 4

The approach: People

A ATTITUDE   **B** BEHAVIOR   **C** CULTURE

Identify Key Players   Management Support   Skill and Experiences

Culture eats strategy

Source: Prepared by the author.

By focusing on people and addressing their attitudes, behaviors, culture, and skills, organizations can effectively navigate the challenges and opportunities presented by IR 4.0. Building a workforce that embraces change, is supported by management, and is equipped with the right skills will contribute to a successful digital transformation journey.

To ensure a successful transition to IR 4.0, it is crucial to embed a culture of knowledge and understanding within the organization. The first step is to emphasize the importance of educating employees in IR 4.0. By fostering a knowledgeable community within the organization, everyone will be on the same page and able to communicate effectively, eliminate barriers, and work together to increase productivity.

Encouraging a culture of continuous learning and professional development is key. This can be achieved through various initiatives such as training programs, workshops, and knowledge-sharing sessions focused on IR 4.0 concepts and technologies. By providing employees with the necessary knowledge and resources, they are empowered to adapt and embrace the changes brought by IR 4.0.

Creating a shared language and understanding of IR 4.0 is essential for effective collaboration and teamwork. This shared knowledge will enable employees to align their efforts and work toward common goals, leveraging the benefits of IR 4.0 to enhance productivity and drive innovation. Furthermore, fostering a culture of curiosity and open-mindedness will encourage employees to explore new ideas and technologies related to IR 4.0. Encourage cross-functional collaboration and create platforms for employees to share their insights and experiences, fostering a collaborative environment that embraces the principles of IR 4.0. By prioritizing knowledge and understanding and promoting a culture of continuous learning, organizations can overcome language and frequency barriers, enabling effective collaboration and increasing productivity in the context of IR 4.0.

In the realm of operations, understanding supply chains or value stream mapping is essential. By analyzing the details of the information flow and material flow, you gain insights into your processes and identify potential pain points or areas for improvement. This step is crucial in optimizing your operations within the context of IR 4.0.

Once you have identified the problem areas, the next step is to collect data. This can be done manually or by utilizing IoT devices that capture real-time data. Data collection serves as the foundation for further analysis and decision-making. The analysis of data involves several stages. First, descriptive analytics provide an understanding of what has happened in operations. It gives insights into historical trends, patterns, and performance metrics.

The next stage is diagnostic analytics, which delve deeper into the "why" behind the observed trends and issues. They help uncover the root causes of problems and bottlenecks in processes. Building upon the previous stages, predictive analytics enable the anticipation of future outcomes and trends. By leveraging historical data and advanced modeling techniques, you can forecast potential scenarios and make informed decisions to avoid undesirable situations. Finally, prescriptive analytics allow recommended actions to be taken proactively based on advanced algorithms and optimization techniques to suggest the best course of action to optimize operations and prevent recurring issues.

By employing these analytical approaches in operations, you can leverage data-driven insights to continuously improve and optimize processes, reduce inefficiencies, and maximize productivity within the realm of IR 4.0.

It is crucial to foster innovation by establishing a integrated control center that serves as the hub for information flow. This digitalization process enables seamless sharing of data among the various stakeholders within an organization. The control center acts as a repository for all information, allowing for efficient management and monitoring of operations. With the availability of comprehensive data, managers gain the ability to extract meaningful insights and make informed decisions that drive predictability, sustainability, traceability, velocity, and agility within processes.

Predictability becomes attainable as historical data are leveraged and advanced analytics are applied to anticipate future trends, demand patterns, and potential challenges. This empowers proactive adjustments and optimizing operations accordingly. Sustainability becomes a key focus as data related to resource consumption, waste generation, and environmental impact are analyzed. This knowledge enables the implementation of strategies that promote ecofriendly practices and minimize the organizational carbon footprint. Traceability is enhanced as the control center facilitates the tracking and monitoring of materials, products, and processes throughout the value chain. This ensures compliance, maintains quality standards, and identifies areas for improvement or optimization.

Velocity refers to the speed and efficiency of operations in response to market demands and changes. By leveraging real-time data from the control center, managers can adapt quickly to market dynamics, make informed decisions, and streamline processes to meet customer expectations in a timely manner. Agility becomes a core capability as the ability to respond swiftly and effectively to economic changes and uncertainties is developed. The control center empowers managers to analyze data, identify emerging trends, and adapt strategies, enabling organizations to navigate economic scenarios with flexibility and resilience.

By establishing a centralized control center and leveraging the data it provides, managers can effectively manage, monitor, and make informed decisions that propel the organization toward operational excellence and success in the digital era. Embracing the operational style facilitated by IR 4.0, particularly through the establishment of an efficient, responsive, effective control center, can elevate organizations to new heights. This data-driven approach has the potential to transform the leadership style from power-driven management to value-driven management.

In a power-driven management approach, leaders rely on their authority and emotions to instruct and guide their teams. However, with the integration of data-driven operations, they can shift toward a value-driven management approach. This transition entails empowering employees by providing them with the necessary information, insights, and resources to make informed decisions and contribute to the organization's success. The beauty of IR 4.0 lies in its ability to support and enhance management practices. By harnessing the power of data, managers can reduce reliance on top-down instructions and instead foster an environment that empowers employees to take ownership of their work and contribute to the organization's value creation.

With a data-driven approach, we can leverage real-time insights, analytics, and performance metrics to make informed decisions that align with the organization's objectives and values. This shift from power-driven to value-driven management enables us to tap into the collective intelligence and expertise of our teams, fostering a culture of collaboration, innovation, and continuous improvement. IR 4.0 technologies enable streamlining of processes, automating routine tasks, and leveraging predictive capabilities, freeing up valuable time and resources. This allows a focus on strategic initiatives, fostering employee growth and development, and nurturing a culture of creativity and agility.

Furthermore, embracing IR 4.0 and adopting a data-driven operational style opens doors to a new era of leadership. It enables transitioning from power-driven management to value-driven management, empowering employees and capitalizing on the potential of data to drive organizational success.

Another crucial aspect is technology. Within IR 4.0, numerous technologies play significant roles. Among them, I would like to highlight the IoT. My partner, Ts. Mohamad Arifin Zulkifli, and I have designed an IoT device that incorporates various sensors and operates using USB-C connecting power (Figure 5). It's called Hibiscus Sense [10]. Its creation was motivated by the challenges brought about by the COVID-19 pandemic, including limitations and restrictions imposed on businesses. We aimed to simplify the adoption of IR 4.0, particularly in relation to the IoT, for SMEs. Our device offers a straightforward solution: simply plug it in and utilize open-source programming to capture data. It is designed to be user-friendly, requiring only a basic understanding of programming. SMEs have found this technology instrumental in navigating the pandemic and sustaining their operations.

FIGURE 5

The Hibiscus Sense IOT device.
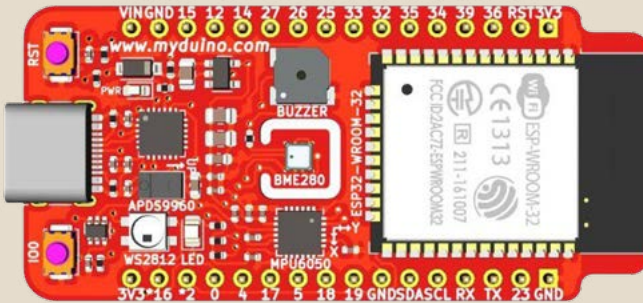
Source: Hibiscus Sense [10]

The case studies below demonstrate the positive impact of our IoT device. These real-world examples shed light on how businesses have leveraged technology to overcome challenges, improve efficiencies, and drive growth. By showcasing these case studies, I hope to inspire other organizations to embrace technology, particularly the IoT, as a powerful tool in their digital transformation journey. The simplicity, accessibility, and practicality of our IoT device make it an ideal solution for SMEs looking to harness the potential of IR 4.0, even amid challenging circumstances.

Case Study 1: Capturing Motion Data of Machines Utilizing the IoT

A fascinating case study involves Company A, which faced significant challenges with downtime. It operated two shifts, and it was observed that the machines were running considerably slower during the night shift compared with the day shift. The company was determined to uncover the root cause behind this discrepancy, suspecting that either the machines were idling or the technicians overseeing the operations were not fully engaged.

To address this issue, the company implemented IoT device installation to capture motion data. A clever mechanism was put in place: if a machine remained inactive for more than five minutes, the IoT device would trigger an alert message and send it to the respective superior via a group telegram. This system, known as the

"ANDON," acts as a real-time alert mechanism, providing valuable insights into what is transpiring on the shop floor. The sensor continuously monitors the machine, triggering an alert every five minutes until the machine resumes normal operation.

This case study showcases the utilization of the IoT for two levels of control and monitoring within the company's operations. However, it is worth noting that there are two additional levels that were not implemented in this particular scenario: optimization and autonomation. The optimization phase focuses on refining and enhancing processes based on the insights gathered from IoT data, while the ultimate goal of autonomation involves allowing the machines to operate independently with minimal human intervention.

By deploying this IoT-based system, Company A was able to identify and address the issues causing reduced productivity during the night shift. This case study serves as a testament to the power of IoT technology in improving operational efficiency and enabling timely interventions to mitigate downtime. It also highlights the potential for further optimization and the transition toward autonomous machine operations, demonstrating the progressive nature of IR 4.0 [1] implementation.

Case Study 2: Capturing Real-time Temperature Data with an IoT Device

An intriguing case study features Company B, a manufacturer of carbonated drinks. One of the challenges it faced was the lack of precise temperature control when mixing cold water with the gas inside the bottles. This uncertainty regarding the temperature had implications for the overall process and productivity.

In an innovative effort to address this issue, the company decided to incorporate an IoT device to capture real-time temperature data during the mixing process. By accurately monitoring the temperature, it gained valuable insights into the dynamics of the process and was able to make informed decisions to optimize operations. The use of the IoT device provided Company B with a deeper understanding of how temperature variations impacted product quality and efficiency. Armed with this newfound knowledge, it could finetune processes to achieve consistent results, ensuring that the carbonated drinks met the desired standards in terms of taste, carbonation levels, and customer satisfaction.

This case study serves as a powerful example of how embracing technology, specifically IoT devices, can significantly benefit businesses by enabling data-

driven decision-making and process optimization. It emphasizes the importance of leveraging innovative solutions to overcome operational challenges and enhance productivity. By embracing technology and harnessing its potential, organizations like Company B can stay ahead of the curve in an increasingly competitive market.

Case Study 3: Capturing Machine Behaviors, Sales Figures, and Customer Behaviors Using the IoT

In the fascinating world of retailing, Company C operates self-service laundry facilities. To enhance operations, each laundry machine has been equipped with IoT devices, enabling the capture of valuable data on machine behaviors, sales figures, and customer behaviors.

By harnessing the power of the IoT, Company C gains insights into the operational status of each machine. It can monitor whether the machines are operating efficiently or if any issues need attention. This proactive approach minimizes downtime and ensures a seamless experience for customers.

Beyond machine behavior, the IoT devices also provide invaluable data on sales trends. Company C can analyze the sales figures on a daily basis, enabling it to identify patterns and fluctuations in customer demand. For instance, data revealed a decline in sales on Tuesdays, Wednesdays, and Thursdays. Armed with this knowledge, the company can devise targeted strategies to boost sales during these periods.

To attract more customers during the slower days, Company C implements a discount promotion. By offering discounts on these specific days, it creates incentives for customers to utilize the laundry services, effectively increasing sales and optimizing business operations.

This case study showcases the power of IoT-enabled data insights in the retail industry. By leveraging IoT devices to capture behavioral data, Company C gains a deeper understanding of customer preferences and trends. Armed with this knowledge, it can make data-driven decisions to enhance customer experiences, optimize operations, and ultimately increase revenue.

Embracing IoT technology enables businesses like Company C to capitalize on BIs, adapt their strategies, and stay competitive in a dynamic retail landscape. By

combining technology and data-driven approaches, they create a win–win situation for both the business and its customers.

Case Study 4: Capturing Production Output Reports Using the IoT

Next, let us explore the experience of Company D, which decided to implement IoT technology on one of its eight machines. As mentioned above, it is crucial not to fear failure when adopting new technologies. Company D encountered a hurdle initially when it failed to retrieve output data from the IoT device. The machine operated at such a high speed that the sensor was unable to capture the necessary output data. However, instead of giving up, the team persevered and embarked on a study and testing phase that lasted several weeks.

In the quest for success, Company D made the decision to replace the sensor with a more suitable one. This adjustment proved to be the breakthrough needed. With the new sensor in place, it successfully captured the required data. These data were then stored and processed using cloud technology, ensuring secure storage and efficient computation.

The implementation of IoT technology brought about a significant change in data reporting for Company D. Gone were the days of manual reporting, as the captured data were now automatically transmitted to management. This streamlined process eliminated manual errors, reduced reporting time, and provided real-time access to critical data. With the data readily available, management could leverage visual analytic tools to gain meaningful insights and make informed decisions promptly.

The journey of Company D exemplifies the determination to overcome obstacles in implementing IoT technology. By embracing failure as an opportunity to learn and improve, it eventually achieved the goal of capturing and utilizing valuable data. The successful integration of the IoT device not only transformed data management practices but also empowered the management team with actionable insights for enhanced decision-making.

This case study serves as a reminder that technology implementation may encounter challenges along the way, but with perseverance, adaptability, and a willingness to learn from setbacks, organizations can unlock the immense potential of the IoT and revolutionize their operations.

Case Study 5: Gaining Data on Machine Performance and Output through the IoT

The next case study involves an example of a large company that utilizes IoT devices on a wider scale. In this case, the company employs a technology known as a manufacturing execution system (MES) to enhance operations. With over 20 machines embedded with IoT devices, it gains detailed insights into the performance and output of each machine.

The MES system enables real-time monitoring and provides comprehensive information about the production process. By integrating it with the company's enterprise resource planning (ERP) system, it establishes seamless communication between the two systems. This integration allows for a holistic view of manufacturing operations, from material input to finished products. One of the remarkable capabilities of this advanced technology is its ability to calculate and optimize production. The system can determine which products should be produced by each machine or by the entire production line based on various factors such as demand, resource availability, and production capacity. This ensures efficient allocation of resources and maximizes productivity.

Furthermore, the MES system empowers the company to implement precise quality control measures. Through real-time data collection and analysis, it can identify any deviations or anomalies in the production process, allowing for timely interventions and adjustments to maintain product quality and minimize waste. The integration of IoT devices and the MES system on this scale represents a significant advance in technology adoption. It enables the company to streamline operations, improve productivity, and make data-driven decisions for better resource allocation and planning.

This example showcases how IoT technology can be deployed on a larger scale, catering to the needs of big companies with complex manufacturing processes. By leveraging advanced systems like the MES, organizations can achieve heightened visibility, control, and optimization across their operations, resulting in improved efficiency and overall performance.

IR 4.0 AND BEHAVIORAL INSIGHTS

In our daily lives, we are surrounded by vast amounts of data, but the key lies in unlocking the insights hidden within that data. It is crucial to understand how data can contribute to the improvement and innovation of our organizations and manufacturing processes. Data must be processed and analyzed to derive meaningful insights. The data have a story to tell, provided that we are willing to listen.

To harness the power of data, we need to employ data analytics. By computing the data and visualizing them on a dashboard, we gain the ability to perform various types of analytics. Descriptive analytics help us understand what has happened in the past, while diagnostic analytics allow us to uncover why certain events occurred. Predictive analytics enable us to forecast future outcomes, while prescriptive analytics guide us on how to optimize and improve our processes for better productivity.

When we effectively manage and leverage data analytics, we can ascend to higher levels of cognitive analytics, where AI comes into play. Cognitive analytics involve using AI algorithms and techniques to gain deeper insights and make more sophisticated decisions based on the data. Ultimately, this journey can lead to the development of autonomous systems, where machines and processes can operate and adapt independently.

It is important to note that the maturity of the IoT follows a progression of stages: monitoring; controlling; optimizing; and automating. As we collect data, we gain hindsight into past events. Through analysis, we transform that data into knowledge. By visualizing the data on a dashboard, we gain insights and analytics to drive optimization. Proactivity and being actively engaged in utilizing data are key to driving change and improvement. Data empower us to achieve significant advances, such as making machines more productive, as exemplified in the case study mentioned above.

Data collection is just the beginning. It is through the analysis and interpretation of data that we derive valuable insights and knowledge. By leveraging data

analytics, we can visualize and understand our data better, ultimately driving optimization and transformation. Embracing a proactive and active approach to data allows us to tap into its immense potential and bring about positive change in our organizations and processes.

Overall, BIs [4] in the context of IR 4.0 empower organizations to make data-driven decisions, optimize processes, enhance user experiences, and drive innovation. By leveraging the power of data and understanding human behaviors, organizations can unlock new opportunities, drive organizational growth, and remain competitive in the rapidly evolving digital landscape of IR 4.0.

CHALLENGES

Embracing IR 4.0 presents several challenges that organizations need to address. These challenges can be categorized into different areas.

1. Wall of Governance: This includes challenges related to funding and strategy. Organizations need to allocate sufficient budget for IR 4.0 initiatives and develop a clear strategy to guide their implementation.

2. Wall of Infrastructure: Communication and connectivity are fundamental infrastructure requirements for IR 4.0. Ensuring reliable, efficient connectivity, especially in remote areas, is crucial. Additionally, organizations must comply with legal regulations governing IR 4.0 technologies, such as drones, data sharing, and privacy.

3. Wall of Human Capital: Skills and talent play a crucial role in IR 4.0 adoption. Organizations need to invest in training and upskilling programs to equip their workforces with the necessary skills to thrive in an IR 4.0 environment.

4. Wall of Technology: While technology is important, organizations should not prioritize it over people and processes. Instead, they should align technology with their specific needs and leverage it as a tool to enhance productivity and efficiency.

5. Wall of Acceptance: Ensuring acceptance and understanding of IR 4.0 among society and internal teams is essential. Organizations should educate and engage stakeholders to create a knowledgeable society that embraces the potential of IR 4.0 and drives innovation.

By addressing these challenges, organizations can overcome barriers and successfully navigate the path toward IR 4.0, unlocking its benefits and driving transformative change.

WAY FORWARD TO IR 4.0

To successfully navigate the path to IR 4.0, it is crucial to adopt a proactive, engaged approach. Here are some key steps to move forward:

1. Embrace a Growth Mindset: Foster a culture of continuous learning and growth. Encourage employees to embrace change and see challenges as opportunities for improvement.

2. Cultivate Change Management: Implement effective change management practices to ensure smooth transitions and successful adoption of new technologies and processes.

3. Set Clear Goals: Define clear objectives and milestones along the way. This will help align efforts and provide a roadmap for progress.

4. Invest in Human Resources: Prioritize upskilling and reskilling initiatives to empower employees with the necessary skills and knowledge for IR 4.0. Encourage a mindset of lifelong learning.

5. Adapt to Technology: Select technology solutions that align with your organization's needs and objectives. Avoid choosing technologies solely based on trends, but rather consider their suitability and compatibility with your business.

6. Maintain a Positive Attitude: Stay positive and persistent in the face of challenges. Embrace technology as a tool for growth and improvement. Do not give up easily and keep striving for success.

Remember these key principles: Stay focused, motivated, and dedicated to your IR 4.0 journey. Turn off any excuses and embrace the opportunities that come with reinventing your business for a better future.

Questions and Answers

Some questions from viewers of my APO Productivity Talk on Industry 4.0 Behavioral Insights broadcast on 17 November 2022 with my answers are summarized below.

Question 1:
Could you demonstrate how data are collected and analyzed and how we can develop a database?

Answer 1:
For data to be collected, we hook up the IoT device with any sensor to capture the data. After programming, the data are captured in real time. The raw data contain the date, time, and output. When you convert data into analytics, they give a better understanding, allowing better decision-making. Looking closely at the data, we can grasp the "hindsight" of the overall data. From this we can also predict what will happen in future, or the "foresight." So many things can be done with data recorded by a small IoT device in your process.

Question 2:
After the IOT device is installed, do companies need to perform maintenance or upgrading frequently? Can they do this by themselves, or do they need external expertise or technicians to do it?

Answer 2:
Before designing IoT devices, we take into consideration the maintenance issues. This device works on very low maintenance. The sensor needs to be free from dust and this can be cleaned by the company monthly or quarterly depending on where it is installed. IoT devices work on electricity and connectivity and these two factors are the most important for the devices to be able to capture data efficiently. If there is a problem, it can also be handled remotely.

Question 3:
Based on your experience, are digitalization efforts in companies usually top-down or bottom-up?

Answer 3:
In the scenario before COVID-19, every company was aiming to increase sales

and ignoring IR 4.0. When COVID-19 came into the picture, top management began thinking about digitalization and digital transformation. When it comes to IR 4.0, the flow is top-down. Management needs to understand which direction it wants to move in. If you start from the bottom when you want to innovate, the only way to get funding is from top management. Top managers need to be involved or at least aware of the situation.

Question 4:
Can your innovative device be used for CNC machines to detect machine downtime as in your case study?

Answer 4:
The IoT device can suit any machine. As described in the case study, when a machine is not running for more than 5 minutes, the data are recorded as downtime and the team is alerted. There are other devices on the market that you can choose, and there should be no problems using them with any CNC or other machines.

Question 5:
How long would it take for human resources to gain the necessary IoT skills?

Answer 5:
Collaboration between companies and inventors of IoT devices is essential for successful implementation. SMEs should focus on understanding how to operate the devices, while the responsibility for maintenance lies with the inventor. To support reskilling and upskilling efforts, programs like the MPC's [5] "reskilling and upskilling" have been implemented to create awareness and train individuals in IoT technology. Over 6,000 companies have already been trained through this program, highlighting the importance of promoting understanding. If continuous support is offered by the inventors, the skills could be gained in two months.

Question 6:
Do you have any advice on how to shift from a fixed mindset to a growth mindset?

Answer 6:
To foster a growth mindset, it is important to give people the opportunity to identify and express their pain points. Encourage the sharing of ideas and suggestions from employees, as this stimulates critical thinking and promotes a growth mindset. By involving people in the problem-solving process, you can

witness the development of their mindset. When success stories emerge from these collaborative efforts, they further reinforce and nurture a growth mindset among individuals.

Question 7:
What can the government do to address the challenges, such as governance, infrastructure, and legal system?
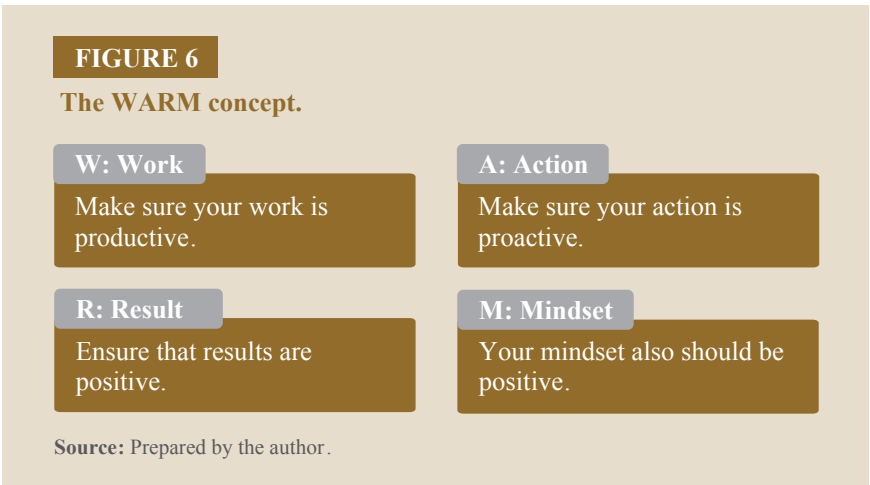
Answer 7:
In Malaysia, the government plays a key role in driving IR 4.0 initiatives, which helps address certain challenges. However, one of the main challenges lies in the allocation of sufficient funds for implementing IR 4.0 strategies. While the government's involvement is beneficial, it is essential to ensure that adequate financial resources are allocated to support the adoption and integration of IR 4.0 technologies and practices across various industries. By addressing the funding challenge, Malaysia can accelerate its progress in embracing the opportunities and benefits offered by IR 4.0.

SUMMARY

In today's rapidly evolving world, it is crucial not to shy away from technology. Instead, we should embrace it and explore its vast potential. Rather than fearing technology, we can adopt a curious mindset and play around with it, discovering innovative ways to leverage its capabilities. By actively engaging with technology, we can unlock new opportunities for productivity and growth.

A basic message is "Do not be afraid of the technology; you can play around with it." As shown in Figure 6, it is helpful to remember the "WARM" concept.

FIGURE 6

The WARM concept.

W: Work
Make sure your work is productive.

A: Action
Make sure your action is proactive.

R: Result
Ensure that results are positive.

M: Mindset
Your mindset also should be positive.

Source: Prepared by the author.

The Importance of Productive Work

Within the realm of productivity, the letter W represents work. It is essential to ensure that our work is not just busy activity, but rather productive and purposeful. To achieve this, we should focus on tasks that align with our goals and contribute to meaningful outcomes. By prioritizing productivity in our work, we can maximize our efficiency and effectiveness, ultimately leading to greater success.

Proactive Action for Positive Results

Acting is a vital component of achieving productivity. The letter A reminds us to be proactive in our approach. Instead of passively waiting for things to happen, we should actively seek out opportunities, take initiative, and make things happen. By adopting a proactive mindset, we can overcome obstacles, seize chances for

growth, and drive positive change. Every action we take should be purposeful and aligned with our goals, propelling us closer to the desired outcomes.

Striving for Positive Results

R emphasizes the importance of positive results. As we work toward our objectives, it is crucial to evaluate the outcomes we achieve. By focusing on positive results, we can gauge our progress and make necessary adjustments along the way. This mindset encourages us to continuously improve and strive for excellence. Positive results not only signify successful completion of tasks but also motivate and inspire us to pursue further productivity gains.

Cultivating a Positive Mindset

Finally, the letter M highlights the significance of mindset. To maximize productivity, it is essential to cultivate a positive mindset. Our attitude and perspective significantly influence our approach to work and our ability to overcome challenges. By adopting a positive mindset, we can maintain resilience, stay motivated, and find creative solutions to problems. A positive outlook fosters an environment conducive to productivity and fosters a sense of fulfillment in our work.

In summary, by embracing technology, ensuring productive work, taking proactive action, striving for positive results, and cultivating a positive mindset, we can unlock our true productivity potential. Remember, productivity is not just about completing tasks; it is about optimizing efforts to achieve meaningful and fulfilling outcomes - doing more with less.

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LIST OF FIGURES

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