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Unveiling the Domino Effect: Barriers and Strategies in the Adoption of Telecommuting as a Post-Pandemic Workspace

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***Abstract*—**In a post-pandemic workspace, identifying the barriers, solutions, and strategies related to telecommuting becomes crucial. Amidst the COVID-19 outbreak in 2020, remote work emerged as a vital business continuity measure. This study investigates telecommuting's modern work model, exploring benefits and obstacles. Utilizing Interpretive Structural Modelling, it uncovers barriers hindering telecommuting adoption. A validated set of thirteen barriers is examined through departmental surveys, revealing interrelationships. The resulting model highlights interactions and dependencies, forming a foundational framework. By addressing dominant barriers, a domino effect on subservient barriers is demonstrated. This research fosters further exploration, proposing management strategies for successful telecommuting adoption, reshaping the traditional workspace.

***Keywords*—**Barriers, interpretive structural modelling, post-pandemic, telecommuting.

I. Introduction

THE ergonomics of a work system plays a pivotal role in shaping an individual's job satisfaction and psychological well-being, which, in turn, significantly influences their ability to execute tasks effectively. As humans, our psychological stability holds substantial sway over our cognitive functions, including reasoning abilities, verbal and numerical skills, analytical prowess, and overall intelligence across various contexts [1]. This psychological dimension profoundly impacts an employee's performance within their role. Organizations gauge employee competence and performance through criteria outlined in job descriptions [2]. These criteria encompass the quality and quantity of work, accuracy, meeting deadlines, and the broader assessment of Organizational Citizenship Behavioral (OCB) competence [3]. OCB evaluates an employee's ethical and social conduct, as well as their commitment to the strategic vision for business growth [4].

When designing business work models, careful consideration of job performance and industrial psychology is essential. Traditional work cultures are built around in-person interactions and people management. In contrast, remote working, or telecommuting, represents a modernized work model that enables employees to fulfill their responsibilities without physical office presence. IBM has successfully employed this model for over a decade, showing considerable promise in managing off-site employees [2]. Telecommuting has become the new standard for numerous businesses and organizations, especially amid the COVID-19 pandemic [5]. This shift has prompted organizations to reevaluate their work strategies and allocate resources to develop new, pandemic-compatible work models. Remote work allows organizations to continue their operations seamlessly, with options ranging from fully remote to hybrid work strategies, combining remote and in-office work hours [6]. This transformation has been made feasible through the utilization of a wide spectrum of information technologies, encompassing collaboration platforms, video conferencing, cloud computing, and high-speed internet [7].

The adoption of remote working has brought forth both positive and negative ramifications. Benefits include cost and time savings from reduced fuel consumption and commutes, enhanced schedule flexibility, improved performance, childcare flexibility, and increased scope for innovation within organizations [8]. The surge in technology usage has catered to the rising demand for flexibility and agility in business operations. However, it is crucial to acknowledge that telecommuting is not universally applicable; it was more readily embraced by white-collar professionals compared to their blue-collar counterparts, who faced higher unemployment rates [9]. Negative impacts on worker well-being, such as increased stress, discomfort, anxiety, and a blurred work-life balance, have also been observed [10]. Telecommuting necessitates clear measurable outcomes and deliverables that can be remotely monitored by managers.

To systematically address and devise a strategic solution to overcome barriers in the adoption of telecommuting, particularly in a post-pandemic landscape, a Multi-Criteria Decision-Making (MCDM) scientific approach can be employed. The Interpretive Structural Modelling (ISM) approach, a tool within the MCDM framework, enables the establishment of relationships between factors or obstacles [11]. This research aims to utilize the ISM technique to identify and establish systematic relationships among the barriers that deter businesses (both employers and employees) from embracing telecommuting in a post-pandemic context.

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II. Literature Review

A. Work Models in Prominent Tech Companies

In the current landscape of work models, Google, a prominent tech giant based in Silicon Valley, has garnered recognition for its exceptional corporate culture, as acknowledged by Forbes [12]. Google's commitment to enhancing productivity in the workplace is evident through its attractive employee benefits and flexible work arrangements, which prioritize employee satisfaction and work ergonomics as pivotal factors influencing job performance and overall company growth. Remarkably, Google has extended the option of returning to the workplace or continuing to work from home (WFH) to 85% of its current workforce [13]. This WFH option is accompanied by a salary deduction, a practice increasingly observed among organizations like Microsoft, Facebook, and Twitter.

IBM, a trailblazer in remote working initiatives, boasts a global workforce in which 95% of its employees operate remotely across 175 countries [2]. Notably, IBM conducted a comprehensive COVID-19 consumer survey, encompassing responses from 13,500 adults residing in Brazil, China, Germany, India, Mexico, Spain, the United States, and the United Kingdom [14]. The survey results, presented in Table I, reveal a marginal decline of 2-3% in the preference for remote working within a month's timeframe (from the August survey to the September survey). Factors contributing to this decline in WFH preference include concerns related to mental health, a longing for human interaction, and the aspiration to enhance productivity. It is worth noting that the psychological weariness associated with WFH, akin to the frustration experienced during quarantine or lockdown, appears to be a significant factor in this shift. However, it is important to acknowledge that the survey did not delve deeply into an exploration of the underlying barriers to remote working adoption.

TABLE I
Work Preference for the Future Work Environment (Sept) [14]

	US (%)	Brazil (%)	India (%)	Mexico (%)
Remote working	28	23	36	19
Hybrid model	37	49	48	60
In-person	14	11	12	12
No preference	20	17	4	9

B. Potential Barriers to Telecommuting Work Model

Telecommuting, as a flexible work model, has gained widespread popularity in the wake of the COVID-19 pandemic, offering several advantages to organizations. These include cost reduction, decreased physical space requirements, and increased potential for offshore work. However, it is essential to acknowledge that not every department or organization is well-suited for remote work. As a result, numerous factors and barriers must be carefully considered before implementing such a work model [15]. Remote working introduces its unique set of challenges, especially concerning how a company's operations align with its workforce. Traditional workplace environments typically prioritize the continuous development of employee skills, both individually and as part of a team, to enhance work ethics, motivation, and overall performance within the organization [16]. Transferring these character-building commitments into a telecommuting work model requires strategic planning and integration into people management practices. This transition and recognition of these commitments can pose significant barriers for many organizations.

Identifying and prioritizing industry-specific barriers have been pivotal challenges for businesses in their transition towards adopting remote working [17]. Fortunately, there are qualitative and quantitative methods, such as MCDM tools, which have demonstrated effectiveness in identifying and addressing multifaceted issues [18]. These tools have shown positive results in various operational studies focused on barrier analysis. The hybrid work model is another alternative to telecommuting, which combines both office and remote work within an employee's schedule [19]. This approach allows employees the flexibility to choose their work location. Companies typically tailor the hybrid work model based on their specific needs and employee preferences. This model is further categorized into various subtypes, including remote-first, office-occasional, and office-first or remote-allowed, depending on the balance of on-site and remote work encouraged by the organization.

C. Interpretive Structural Modelling

MCDM tools offer a comprehensive framework for conducting both qualitative and quantitative analyses to select the most suitable decision or choice based on established criteria [20]. This method provides a systematic and logical approach to identifying the optimal solution for complex decision-making problems. In the context of this research, the ISM technique is employed to elucidate the intricate relationships among barriers to the implementation of telecommuting in a post-pandemic environment. ISM, originally developed by John N. Warfield, finds its application in evaluating complex socioeconomic systems and has been widely adopted by researchers across various disciplines [21]. Leveraging fundamental principles from discrete graph theory, ISM transforms intricate models into graphical representations, facilitating the hierarchical visualization of relationships between variables [22].

By utilizing ISM, this study aims to transcend the limitations of individual barrier analysis and present a more accurate depiction of the interconnected challenges inherent in the adoption of telecommuting in the evolving landscape of work models.

III. Research Methodology

The research methodology, as illustrated in Fig. 1, encompasses two distinct phases: a preliminary investigation, referred to as the pre-study, and the subsequent utilization of the ISM approach. The pre-study phase primarily entailed the identification of pertinent barriers through an extensive review of existing literature. Additionally, it involved the formation of an expert panel and the administration of a questionnaire survey. This survey aimed to validate the identified barriers and ascertain the contextual relationships among them. Subsequently, the second phase of the study revolved around the analysis of survey responses, utilizing the ISM approach as the primary analytical framework. This methodology enables a comprehensive exploration of the intricacies surrounding the adoption of telecommuting in the post-pandemic work environment.

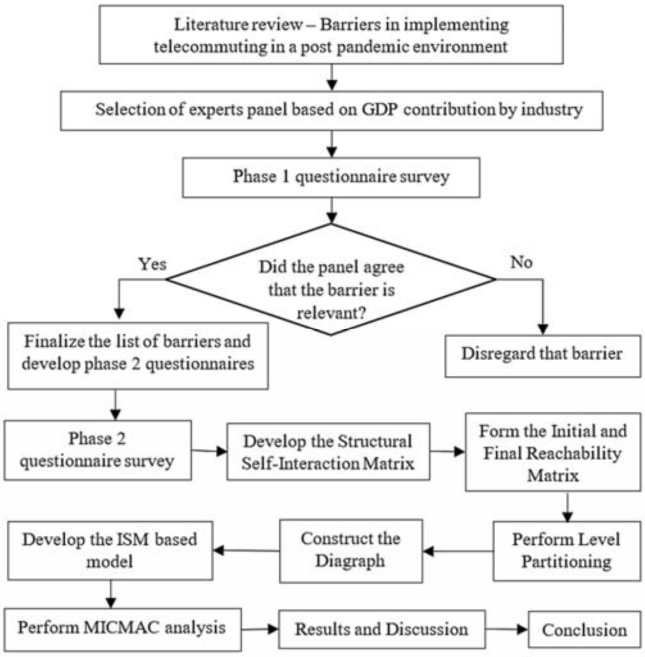

Fig. 1 Research methodology

A. Methods Application

Following an exhaustive literature review, a limited number of barriers pertaining to the implementation of telecommuting (remote working) within the context of Fiji were identified. These barriers, when identified, either exhibited vague definitions or closely resembled one another in nature. In response, our research team, comprising individuals with expertise in industrial engineering, embarked on the task of identifying additional barriers and categorizing them into distinct groups. Subsequent deliberations and consultations led to the creation of a final list of 14 barriers, as presented in Table II. To validate these barriers and establish relationships among them, the field study was divided into two phases.

Phase 1

An expert committee, consisting of both industry and academic experts, was formed to refine and validate the selected barriers and to identify any additional barriers that may have been overlooked. The committee comprised three academic experts and three industry experts. The industry experts boasted a minimum of four years of practical experience, with a collective working experience totalling 23 years. Similarly, two of the academic experts possessed at least four years of industry experience, and all three possessed extensive academic backgrounds, amounting to over 35 years in total. One of the academic experts possessed a comprehensive understanding of MCDM tools. Their combined work experience encompassed various sectors, including business, manufacturing, education, design, construction, building services, and procurement. When selecting experts for the committee, industries that significantly contributed to Fiji's GDP in 2019 were given priority, as these industries were likely to have a substantial impact on Fiji's GDP upon transitioning to remote working. The industries represented by the experts and their contributions to the GDP in 2019 are delineated in Table III. Phase 1 questionnaires were disseminated to the respective experts via email. To be considered applicable for the research work, a barrier was needed to secure a minimum of two votes (33.33%) among the expert committee members. Consequently, one barrier (B14 – Reduced Pay) was removed from consideration, yielding a final list of 13 barriers.

TABLE II
PRELIMINARY BARRIER DESCRIPTION

Code	Barrier	Reference
B1	Increased employee workload	Expert Committee
B2	Technical Issue	[23]
B3	Industrial Fatigue	[6]
B4	Lower Levels of Organizational Citizenship Behavior	Expert Committee
B5	Reduced Employee productivity	[24]
B6	Additional Employee training	[25]
B7	Additional Operational Expense	Expert Committee
B8	Distraction to work responsibility	[26]
B9	Limited Network Security	[23]
B10	Ineffective Communication	[27]
B11	Management Issues	[28]
B12	Limited planning capability	Research Team
B13	Unequal work distribution	Research Team
B14	Reduced pay	Research Team

TABLE III
INDUSTRY CONTRIBUTION TO GDP [29]

Nominal GDP by Industry (Base Weight)	
Mining and Quarrying	1%
Manufacturing	11%
Construction	2%
Education	6%
Professional, Scientific and Technical Activities	2%
Other	78%

Phase 2

With the final list of barriers in hand, questionnaires were devised to explore the contextual relationships among them. The responses obtained served as input for the ISM tool. A significant portion of the respondents hailed from the Education industry and the Professional, Scientific, and Technical Activities industry, together accounting for 7.9% of the Nominal GDP. These industries swiftly embraced remote working following lockdown measures, thanks to the nature of their work. The prolonged exposure of employees to telecommuting due to COVID-19 proved advantageous for the study, offering valuable insights into the intricate relationships between the identified barriers. Questionnaires were exclusively administered to fields of work capable of adopting telecommuting, with no outreach to blue-collar industry staff.

B. ISM Approach

In the ISM methodology, the first step involves establishing how one barrier influences another using symbols like V, A, X, and O, forming the Structural Self-Interaction Matrix (SSIM). Then, this matrix is transformed into the Initial Reachability Matrix (IRM) using 1s and 0s. To account for indirect relationships, a Final Reachability Matrix (FRM) is created by adding '1*' [22]. The FRM is organized into levels through Level Partitioning, creating a hierarchy of barriers. This hierarchy is depicted in a diagraph, with the most influential barriers at the top. The diagraph is then turned into an ISM-based model, replacing nodes and removing transitivity. Finally, a cross-impact matrix multiplication (MICMAC) analysis classifies barriers into four clusters: autonomous, dependent, linkage, and independent barriers, based on their impact. For a comprehensive, step-by-step breakdown of the ISM approach, further details can be found elsewhere in the literature [30].

IV. Results

A. ISM Approach

Following the analysis of responses from the second phase questionnaire survey, an initial SSIM was constructed, as presented in Table IV. Each cell within this matrix represents the number of responses indicating the influence of one barrier on another. For instance, seven respondents believed that Barrier B1(i) had an influence on B13(j), while none indicated that B1(i) influenced B9(j). Subsequently, the SSIM (Table V) was derived from the values, and these values were replaced with corresponding letters 'V,' 'A,' 'X,' and 'O'. Referring back to Table IV, the value for B1(i) influencing B13(j) is 7, while B1(j) influenced by B13(i) is 11. Given that more respondents perceived B1 to be influenced by B13, it was concluded that cell B1-B13 should be denoted as 'A'.

TABLE IV
INITIAL DEVELOPMENT OF SSIM

	Barrier j												
Barrier i	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
B1	7	3	3	2	0	7	1	6	10	8	7	1	
B2	7	6	8	7	14	7	7	10	10	3	3		10
B3	3	3	7	3	1	8	0	2	3	6		0	2
B4	5	4	7	6	2	2	3	2	4		9	1	2
B5	4	2	5	4	1	5	3	2		7	5	3	7
B6	4	3	2	7	3	0	6		7	7	4	6	5
B7	3	4	6	4	7	0		6	3	1	1	9	0
B8	4	2	1	4	0		3	1	10	7	10	1	8
B9	2	3	3	4		4	8	4	4	2	2	13	4
B10	3	3	6		2	1	3	2	5	7	4	3	0
B11	8	8		6	4	4	10	9	8	3	2	4	5
B12	5		7	3	3	5	2	11	2	1	3	5	3
B13		3	4	2	0	8	2	1	11	8	9	0	11

Within the framework of the ISM methodology, the FRM was established, as depicted in Table VI. The summation of each row within this matrix elucidates the driving power of each barrier, indicating the extent of its influence on other barriers. Simultaneously, the summation of columns reveals the dependence power of each barrier, reflecting how significantly it is influenced by other barriers. Notably, Barrier B2 emerged as the most influential, boasting a driving power of 12 and a dependence power of 2.

As part of the ISM methodology, the barriers were categorized into four distinct levels, necessitating an iterative process that spanned four iterations to achieve the final four levels, as outlined in Table VII. In total, four levels were established, with Barriers B3, B5, B7, B9, B12, and B13 occupying the top level in the ISM hierarchy, and Barrier B2 being positioned at the bottom level.

TABLE V
STRUCTURAL SELF-INTERACTION MATRIX

Barrier i	Barrier j												
	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
B1	A	X	A	V	A	A	V	V	V	V	V	A	-
B2	V	V	V	V	V	V	A	V	V	V	V	-	
B3	A	X	V	A	A	A	A	A	A	A	-		
B4	A	V	V	A	X	A	V	A	A	-			
B5	A	X	A	A	A	A	X	A	-				
B6	V	A	A	V	A	A	X	-					
B7	V	V	A	V	A	A	-						
B8	A	A	A	V	A	-							
B9	V	X	A	V	-								
B10	V	X	X	-									
B11	V	V	-										
B12	V	-											
B13	-												

TABLE VI
FINAL REACHABILITY MATRIX

	Barrier j													
Barrier i	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	Driving Power
B1	1	1*	1	1	1	1	1		1*	1	1*	1	1*	8
B2	1	1	1	1	1	1	1*	1	1	1	1	1	1	12
B3	1*		1		1*		1*	1*	1*	1*	1	1	1*	3
B4	1*		1	1	1*	1*	1*	1*	1	1*	1	1	1*	5
B5		1*	1*	1	1	1*	1	1*	1*	1*	1*	1	1*	5
B6	1*	1*	1	1	1	1	1	1*	1*	1	1*	1*	1	7
B7	1*	1	1	1	1	1	1	1*	1*	1	1*	1	1	9
B8	1	1*	1	1	1	1*	1	1	1*	1	1*	1*	1*	7
B9	1	1*	1*	1	1	1	1	1	1	1		1	1	10
B10	1*		1	1	1	1	1*	1*	1*	1	1	1	1	8
B11	1	1*	1*	1*	1	1*	1	1	1	1	1	1	1	9
B12	1		1*	1*	1	1*	1*	1	1	1	1*	1	1	7
B13	1		1	1	1*	1	1*	1	1*	1*	1*	1*	1	6
Dependence Power	7	2	10	10	10	7	7	6	5	9	5	10	8	

TABLE VII
LEVEL PARTITIONING

Barriers	Reachability Set	Antecedent Set	Intersection Set	Level
		Iteration 1		
1	1,2,4,5,6,10,11	1,2,4,6,8,9,10,11	1,2,4,6,10,11	2
2	2	2	2	4
3	1,3,5,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	1,3,5,7,8,9,10,11,12,13	1
4	1,4,6,810,11	1,2,4,6,8,10,11	1,4,6,8,10,11	2
5	2,3,4,5,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	2,3,4,5,6,7,8,9,10,11,12,13	1
6	1,2,4,6,8,10,11	1,2,4,6,8,10,11	1,2,4,6,8,10,11	2
7	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	1
8	2,8,10	2,8,10	2,8,10	3
9	1,2,3,4,5,6,7,8,9,10,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,12,13	1
10	8,10	2,8,10	8,10	3
11	1,2,4,6,8,10	1,2,4,6,8,10,11	1,2,4,6,8,10	2
12	1,3,4,5,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	1,3,4,5,6,7,8,9,10,11,12,13	1
13	1,3,4,5,6,7,8,9,10,11,12,13	1,2,3,4,5,6,7,8,9,10,11,12,13	1,3,4,5,6,7,8,9,10,11,12,13	1

The study successfully categorized the barriers into distinct levels, creating a hierarchical structure that visually represents the relationships between each barrier and their respective directions. This hierarchical representation, in the form of a diagraph, can be seen in Fig. 2. By replacing the nodes in the diagraph with relevant statements, the research team constructed the ISM-based model, depicted in Fig. 3.

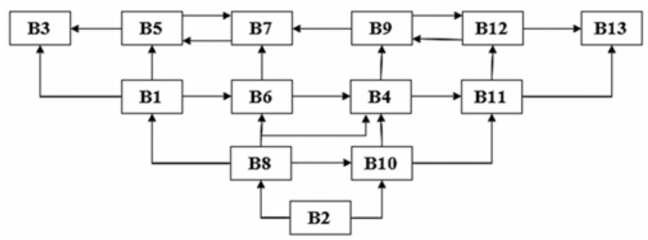

Fig. 2 ISM diagraph

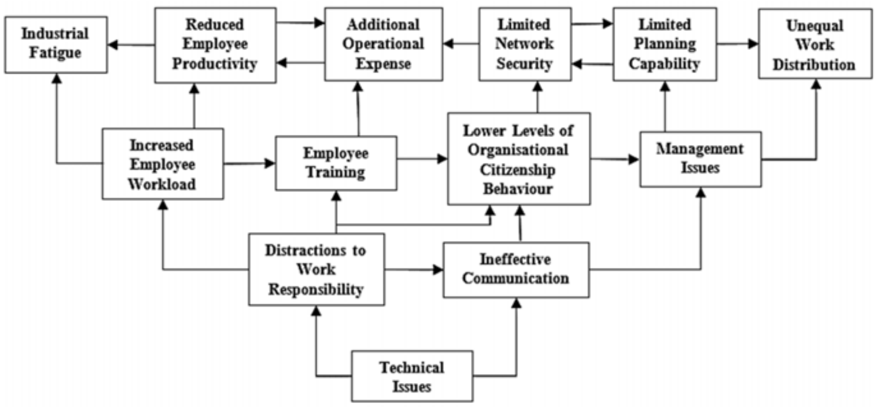

Fig. 3 ISM based model representing the barrier levels of implementing telecommuting in a post pandemic environment

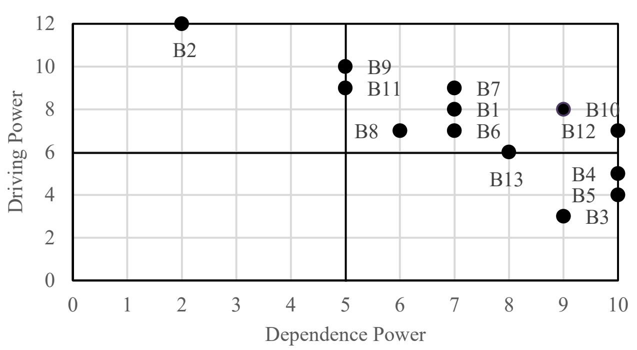

Fig. 4 Cross-impact matrix multiplication applied to classification of the listed barriers

To delve into the dynamics of the relationships between the driving power and dependence power among the barriers in implementing telecommuting within a post-pandemic context, MICMAC analysis was employed. This analysis classifies the barriers into four distinctive clusters, as exemplified in Fig. 4: autonomous, dependent, linkage, and independent.

Remarkably, none of the barriers were classified within the autonomous barriers cluster (Cluster I), emphasizing the significant role each barrier plays. In Cluster II, comprising dependent barriers, such as B3, B5, B4, and B13, as these barriers are influenced by independent ones. Cluster III, encompassing linkage barriers, comprises eight barriers, including B1, B6, B8, B7, B9, B10, B11, and B12. Notably, barrier B2 is the sole member of Cluster IV, signifying its status as the most dominant barrier.

Considering these findings, for a successful transition from traditional working to telecommuting in a post-pandemic environment, it becomes imperative to prioritize the management and mitigation of this dominant barrier, B2.

V. DISCUSSION

In this study, we have identified and validated the barriers to the implementation of telecommuting in a developing country, Fiji, through the expertise of a committee comprising academic and industry professionals. The responses obtained were subjected to analysis using the ISM, a MCDM technique, to establish the interrelationships among these barriers. This information serves as a valuable input for designing frameworks and strategies to facilitate the successful adoption of a telecommuting work culture within businesses. Given the intricate interplay among these barriers, organizations do not need address all of them; instead, they can focus on the most influential ones. By addressing these dominant barriers, a cascade effect can be initiated, impacting the subservient barriers.

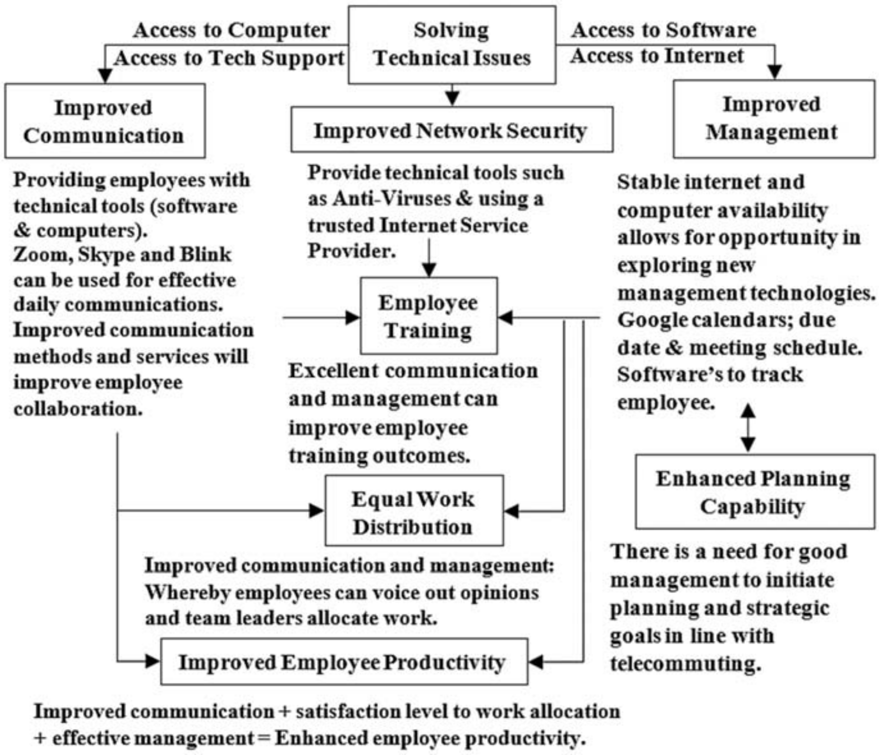

Fig. 5 Effect of solving the dominant barrier

As our results indicate, Barrier B2, identified as "Technical Issues", emerges as one of the most influential barriers, possessing the highest driving power. Technical issues encompass challenges related to inadequate access to technology, software, and hardware for employees, which can significantly contribute to security risks, communication difficulties, and increased operational expenses. The general framework depicted in Fig. 5 demonstrates that investing in addressing technical issues can effectively mitigate numerous other barriers in the telecommuting implementation process. This framework aligns with the ISM prediction model, as it directly addresses 8 out of the 13 barriers (61.54%). Notably, Barrier B2, "Technical Issues", has a direct influence on 7 of these barriers, implying that resolving technical issues initiates a chain reaction to solve these 7 barriers – a domino effect is set in motion.

Furthermore, the framework, in conjunction with other barriers at their respective levels alongside technical issues, indirectly addresses the remaining 5 barriers: B1 ("Increased Employee Workload"), B3 ("Industrial Fatigue"), B4 ("Lower Levels of Organizational Citizenship Behavior"), B7 ("Additional Operational Expense"), and B8 ("Distraction to Work Responsibility").

To illustrate, ineffective communication resulting from technical issues can lead to distractions from work responsibilities, causing a backlog of tasks and an increase in employee workload. Industrial fatigue can be alleviated by addressing reduced employee productivity and the burden of increased workload. With a heavier workload, enthusiasm and motivation may dwindle, leading to decreased productivity. Consequently, technical issues not only directly address reduced employee productivity but also indirectly improve employee workload.

Lower levels of Organizational Citizenship Behavior (OCB) can be mitigated by addressing ineffective communication and providing employee training, both of which are intertwined with technical issues. Resolving technical issues indirectly contributes to resolving OCB. Additionally, technical issues can divert attention from work responsibilities, causing distractions.

Lastly, while there may be an additional operational expense associated with setting up remote working infrastructure such as laptops and software for employees, this expenditure can be offset and even turned into a profit for the organization by enhancing management practices and employee productivity. Technical issues directly impact management and employee productivity, aligning organizational objectives effectively with revenue generation as a core goal.

VI. Conclusion

The identification of thirteen barriers to the implementation of telecommuting in a post-pandemic environment was achieved through an extensive literature review and collaboration with industrial and academic experts within a committee. Subsequently, the second phase of the field study was conducted to discern the intricate relationships among these identified barriers. To systematically structure and delineate these interconnections, the MCDM tool known as ISM was employed.

Through the analysis, the most influential barrier, "Technical Issues" (B2), was identified. The MICMAC analysis further underscored this finding, as Barrier B2 exhibited the highest driving power and the lowest dependence on other barriers. Conversely, barriers B3, B4, and B5 emerged as the most dependent barriers, displaying the highest levels of driven power.

Leveraging the ISM model, the research team crafted a comprehensive framework capable of directly and indirectly addressing all the identified barriers. A pivotal aspect of this framework revolves around addressing the dominant barrier, Technical Issues (B2), which effectively triggers a cascading effect, mitigating or alleviating the challenges posed by other subservient barriers.

This preliminary framework provides a solid foundation for future research endeavors in this domain, encouraging the development of more robust and tailored strategies. These strategies can be industry-specific or organization-specific, aiding businesses in formulating policies and approaches to navigate the telecommuting work model within the unique context of a post-pandemic environment.

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