Unlocking the value of AI: Employee Scheduling Effectiveness, Efficiency and Consistency Investigation.

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ABSTRACT

This paper aims to investigate the effectiveness, efficiency, and consistency of the AI-assisted scheduling system when generating a short-term (daily/weekly) work shift schedule for employees who work in a 24/7 industry. Overall, the interviewed AI developers, experts, and founding companies reflected their confidence in the effectiveness and efficiency of the system, although they acknowledge challenges in producing a consistent schedule due to the dynamic environment of the organisation. Additionally, the study also found a strong connection between the quality of the datasets provided to the system and the effectiveness and efficiency of the system. However, it is crucial to note that this study's limited focus on AI developers and founders restricts the generalisability of the result. Future research should also include perceptive from other key stakeholders to provide a more comprehensive understanding of their user experience.

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Keywords

Artificial intelligence(AI), AI-assisted scheduling system, Short-term scheduling, Effectiveness, Efficiency, Consistency, Planning, Dataset

1. INTRODUCTION

Scheduling has been a critical activity in various industries. It involves assigning the valuable resources of a company such as time, money and workforce to specific tasks or activities. Generally, workforce scheduling was done by a scheduler who manually delivers a schedule based on planning. This planning method involved schedulers formulating schedules for an organisation with a time frame of short-term (daily/weekly) and long-term (monthly/yearly) (Shobrys & White, 2000). This current scheduling system does not benefit the involved parties, namely the firms, employees, and the scheduler. For the firm it is cost ineffective where they need to hire a professional scheduler who is there just for generating schedules for the company, however, this can actually be done with the support of technology. For the employee, the schedule developed by the scheduler may involve personal biases due to the relationship between employees and the scheduler. And lastly, the scheduler, schedulers may not be able to deliver a schedule in a short period of time when there are unpredictable situations such as sick leaves or work demand change. Therefore, the experts are looking for a way to arrange work schedules for employees that aims to reduce labour expenses while ensuring a specific level of employee satisfaction (Castillo et al., 2009). Moreover, Maxson-Cooper (2011), found that the current hype is seeking a consistent and predictable working schedule with no difference in the 24/7 industries. Therefore, in order to achieve the consistent and predictable working schedule, scheduling-generating tools started to evolve. Workforce scheduling began to evolve through innovation and technological improvement. The process of evolution can reveal a variety of stakeholders who view a product from different perspectives, which can be modified to suit the constantly changing environment. Therefore, the scheduling method began to move forward from the traditional fully manual method to the computer-assisted approach and now to a self-scheduling method.

Self-scheduling methods provide employees with the freedom and flexibility of filling up the day and time employees are available to work instead of the scheduler constantly constructing an optimised work schedule that all employees are satisfied with. Moreover, employees are able to gain more control over their private life and they are able to have consecutive time off for leisure-time activities, sleep, and family life to achieve work-life balance (Nabe-Nielsen et al., 2013). However, it appears to be difficult to provide workers with the freedom to make plans for their off day while maintaining predictability and consistency, as work hours are renegotiated within a few weeks, therefore, traditional fixed schedules that remain unchanged for years are yet preferred by employees (Ingre et al., 2012). As a result, this self-scheduling method was limited in its ability to optimise schedules and was not efficient enough to apply in today's world of employee shortage.

Due to the disadvantages of both traditional and self-scheduling methods, as well as technological advancement, together artificial intelligence (AI)-assisted scheduling system was developed. This system emerged to become a significant tool in all fields which can achieve the goal of automated construction and optimisation of work schedules that is possible to overcome the human resource shortage problem in the market.

The AI-assisted scheduling concept is a system or software designed to dynamically manage workload, and aimed to efficiently utilise resources, employ an optimized solver for problem-solving, and, maintain user engagement with the schedule through interactive features (Čyras et al., 2020; Geng et al., 2021) which is fairly important in the working environment.

Chan et al. (2012) suggested that the shortage of nurses in the healthcare industry has been a problem for most of a century. The authors further reflected that the shortage of nurses in a hospital is mainly caused by the number of nurses quitting their job due to some influential factors such as job satisfaction, social support, work environment, and assigned workload. In the healthcare industry, for example, hospitals may employ schedulers who may have a nursing background. These schedulers can be reassigned to positions that better utilise their skills and expertise, and their task on schedule can pass it to an AI-assisted scheduling system. By doing this hospitals would then be able to reduce and avoid the workforce shortage. The use of AI-assisted scheduling can, therefore, benefit the company by reducing the generating time creating a more consistent and systematic approach that formulates a fair employee schedule and eliminating the need to oversee the scheduling process that reduces department managers' workload (Smart Scheduling: How to Solve Workforce-planning Challenges With AI, 2022).

The aim of this research paper is to explore the effectiveness, efficiency, and consistency of AI-scheduling systems in creating short-term (weekly and daily) workforce schedules within the industry that operate 24/7. According to Peter (2023), the current market is experiencing a shortage of employees, especially in the healthcare industry. Hence, the exploration of whether AI-assisted scheduling systems can alleviate this issue by assuming tasks traditionally handled by humans becomes intriguing. To find out a solution to this problem first we need to investigate whether this system is actually benefiting organisations. Therefore, investigating the effectiveness, efficiency, and consistency of the AI-assisted scheduling system is necessary before other investigations.

As highlighted by Bailey and Barley (2020), the outcomes of new technology implementation are heavily influenced by how individuals interpret and utilize the technology. Therefore, this study will explore the perspective of system developers, and founders regarding the effectiveness, efficiency, and consistency of the AI-assisted scheduling system during its utilisation phase.

Based on the existing literature, there is yet no research conducted on the related field, therefore, it is critical to note that this research takes an exploratory approach to have a deeper understanding of the topic at hand.

With such motivation in mind, therefore this study aims to answer the following research question.

RQ: *Whether AI-assisted scheduling systems demonstrate effectiveness, efficiency, and consistency when generating short-term (daily/weekly) work shift schedules in the 24/7 industry?*

2. THEORY

The scheduling of the workforce is a critical aspect of managing human resources in a company in many industries and especially in the healthcare field due to the shortage of staff that has been experienced for decades (Peters, 2023). With the advancement of technology, the scheduling process evolved from human-made to computer-assisted and now to AI taking over the whole process. The literature search identified several factors that seem to play a role in the AI-assisted scheduling system. Identified factors are AI-assisted scheduling, effects of AI with subfactors of effectiveness, efficiency, and consistency, datasets, and lastly, user acceptance further discussed below.

2.1 AI-assisted scheduling

Artificial Intelligence (AI) is defined by Kaplan and Haenlein (2019) as the capacity of a system to accurately interpret external data, acquire knowledge from it, and utilize that knowledge to achieve specific objectives and tasks through adaptive and adjustable means. The field of planning and scheduling has witnessed significant engagement from the AI research community since the 1960s (Spyropoulos, 2000). The role of AI technologies, therefore, cannot be underestimated as it enhances and optimises the process of creating schedules for various tasks and activities, from scheduling operation rooms with surgeons to supply chain management in production companies and optimising delivery routes (Faghihi et al., 2015).

Researchers employ diverse tools and techniques to solve scheduling problems faced by planners in an organisation. The adoption of AI tools provides a means to construct improved schedules that are tailored to individual perspectives and specific planner requirements. Hussain and Al-Turjman's (2023) evaluation, found that AI-scheduling methods, particularly utilising hybrid genetic algorithms, outperformed traditional scheduling methods and other AI-based approaches regarding execution time, resource utilisation, throughput, and cost. By this mean, it is found that AI scheduling tools is therefore an important element that should be further discussed, the benefits of AI scheduling systems extend beyond these factors.

AI-scheduling systems offer automated activity placement and optimisation based on user-defined rules and regulations. This capability significantly reduces the time spent on constructing schedules and facilitates the formulation of the "best-fit" schedule for specific industries. During this process, AI is capable to generate an output required by users without any human interface. Moreover, the application of AI systems holds tremendous potential across various sectors, with particular relevance in the healthcare field, where operations run around the clock without days off. Therefore, AI emerges as a versatile system that can revolutionise scheduling practices in numerous industries, especially the 24/7 healthcare sector.

2.2 Effects of AI

2.2.1 Effectiveness

The emergence of AI-systems has brought anticipated benefits to management by transforming data-centric decisions into effective actionable strategies (Chowdhury et al., 2022). In essence, AI technologies bring a range of advantages to organisations such as improved efficiency, less time consumed and more accurate results, and enhanced strategic outcomes at the organisational level (Makarius et al., 2020). Paschen et al.'s (2020) research emphasised that AI encompass problem-solving, reasoning, and machine learning to exhibit intelligent behaviour. Machine learning, in particular, leverages the capabilities to acquire new knowledge or modify existing knowledge leading to more effective outcomes. This means AI does not only acquire new and modified knowledge but also improves its effectiveness in overcoming complex decision-making compared to human capabilities (Jarrahi, 2018). Through the integration of AI with big data analytics, organisations gain new opportunities for tackling complex and present more effective ways of equipping human decision maker with comprehensive data insights. This approach will be able to solve employee timetabling challenges and facilitate effective work scheduling (Pereira et al., 2021). Overall, AI technologies benefit management by enhancing decision-making processes and achieving more effective outcomes by integrating with data analytics and intelligent technologies.

2.2.2 Efficiency

As mentioned by Hussain and Al-Turjman (2023), the AI-scheduling method takes into account several factors. By leveraging machine learning (ML) techniques, a subset of AI, organisations can ensure the efficiency and management of human resource work through this technology system by providing quality datasets for the system to learn. Moreover, the adoption of AI in e-commerce and financial industries improved the efficiency of supply management and business operation while maintaining cost-effectiveness (Pallathadka et al., 2021). Drawing from these studies, it can be inferred that the application of AI in workforce placement holds the potential to generate similar benefits. This aligns with the findings of Brusco et al. (1995), who emphasise that an efficient workforce scheduling system can minimise costs, optimise resource utilisation, and reduce time consumption. By integrating AI technologies into scheduling processes, managers and planners can enhance efficiency while optimising resource allocation, thereby creating value in workforce management. Therefore, efficiency can be an interesting factor to explore when relating to AI technology.

2.2.3 Consistency

The consistency of outcomes generated by AI technology is a compelling area to look into. It raises the question of whether AI systems can constantly perform and produce similar results when fulfilling specific requests. Hussain et al. (2023) emphasize the importance of AI's consistency in evaluating internal candidates for specific roles in the pharmaceutical sector. These are conducted using the AI system of serial mediator of evaluation. However, workforce scheduling, for instance, may require non-consistent outcomes to accommodate employees' work preferences and demands in order to create the most satisfactory schedule acceptable to all employees. Therefore, it is worth noting that Howard et al. (2023) identify consistency as a significant challenge when implementing AI technology in systems like chatGPT when asking questions that may provide uncertain responses to the users.

2.3 Datasets

AI make decisions or predictions by analysing big datasets and learning from them (Lee, 2017). Datasets can be considered as the fundamental component to train deep learning which will directly affect the performance of the trained model. Shamaev (2023) indicated that in order to achieve high-quality AI data training, high-quality datasets are needed. These datasets include indicators such as number and quality samples and annotation quality which will affect the analysing and evaluation process of constructing an output by the AI system. According to Roselli et al. (2019), if the datasets are insufficient or of low quality, the performance level of AI will be affected leading to biased or unexpected results. Moreover, if the model does not match the production needs, re-training is needed by using fresher data. Therefore, regularly refreshing inputted datasets is important for future production inference. Furthermore, due to societal biases embedded in the training datasets, AI unfairness arises and will result in AI deploying them at scale. To conclude, providing good quality and non-biased datasets for training the AI system is an important factor, therefore, it can construct and optimise production needs.

2.4 User acceptance

Before approaching the next step of AI innovation it is crucial to delve deeper into user acceptance. According to Choi's (2021) finding, individual factors such as role, motivation and ability play an important role in enhancing user acceptance of AI. Therefore, developers of AI devices should focus on ensuring AI users perceive a high-level experience in role clarity, motivation and ability. Where AI operators must ensure users perceive a high level of trust throughout their experience. However, young individuals such as Generation Z are still sceptical when it comes to attributing consciousness, mind, intention, and potential emotions to AI devices. They do not agree that imbuing human characteristics into AI devices could enhance consumer engagement and lead to positive performance (Vitezić and Perić, 2021). Therefore, it is beneficial to gain some understanding of user acceptance of innovative technology for predicting the success of a new product (Kim, 2015). With this understanding, researchers are able to understand how users perceive and interact with a new technology product that can provide valuable feedback about the product according to its usability and user experience. Moreover, user acceptance studies can identify barriers or resistance to the adoption of a new product and the reasons behind it. Therefore, this factor is crucial to look into when researching a new product.

2.5 Conceptual model

The conceptual model (Figure 1) represents the inter-relationships among various variables that impact the effectiveness, efficiency, and consistency of the AI-assist workforce scheduling system. This model is developed with guidance from the framework developed by Chowdhury et al. (2022). This framework determined automation, assistance and augmentation through AI capability which has impacts on the human workforce and outcomes of the organisation. It is designed to study the value of AI in human resource management, therefore, it is used as a reference to develop the conceptual model for this study. Within this framework, AI capability is supported by two types of resources: technical resources and non-technical resources. Technical resources encompass data resources such as internal datasets from the internal operations and external datasets from its stakeholders, suppliers and market environment. These datasets have an impact on the outcome produced and the human workforce in the company. The technology infrastructure component takes care of the data storage, management, cleaning and aggregation as well as processing power to ensure the quality of the output produced achieved user needs. Therefore, the moderating variable of "datasets" was considered in the conceptual model.

According to Chowdhury et al. (2022), Effective leadership helps to develop clear strategies, resource allocation, understanding employee needs and facilitating transparent communication mechanisms specifically regarding the purpose of AI utilisation. Following by the next factor in the framework, Organisation change refers to how fast can AI respond to changes while minimising resistance from employees thereby promoting business growth, effective communication, strategic management, and performance gains. The impact of these mechanisms depends on the presence of strong leadership within the non-technical resource aspect of AI. These mechanisms can influence various aspects of the human workforce such as job design, trust and confidence, job satisfaction, and motivation, which ultimately affect the outcome of an organisation's process efficiency, data-driven decision-making, and employee productivity (Chowdhury et al., 2022). Therefore, the variable of

"user acceptance" was considered as the second moderating variable that may create impacts on the dependent variable.

With reference towards Chowdhury et al.'s (2022) framework, the model comprises four key components: the AI-scheduling system, effects, datasets, and user acceptance. These factors are expected to influence the outcome generated by the AI device which subsequently affects the effectiveness, efficiency, and consistency of the system within this study.

The AI-assisted scheduling system represents the independent variable in this model. It encompasses factors such as management demand, work preferences, system limitations, and company goals which are concerns of managers as shown in Figure 1. These factors may influence the outcomes generated by the AI system, which subsequently affect the outcome's effectiveness, efficiency, and consistency.

Then the second component of this study is the main topic of this research, the effectiveness, efficiency, and consistency of the AI-assisted scheduling system and it represents the dependent variable in the conceptual model.

Moreover, datasets and user acceptance are the third and fourth components representing the influencing variable, exerting influence on the relationship strength and direction. These variables play a crucial role in enhancing the system's performance and producing desired or optimised outcomes. Datasets encompass factors like fairness, completeness, and freshness, which contribute to the AI's learning process. User acceptance factors, such as user-friendliness and ease of use, enhance user satisfaction and engagement, which are important considerations for workers and leaders in an organisation.

Overall, figure1 provides a visual representation of the variables and factors that influence the outcome produced by the AI-scheduling system. This diagram guides the investigation into the relationships and interactions within the AI system and its performance of effectiveness, efficiency, and consistency.
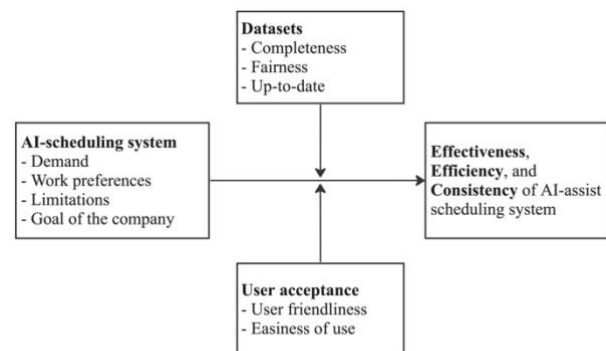

Figure 1. Conceptual Model

3. RESEARCH METHODOLOGY

3.1 Research design

The research design for this paper employed a qualitative explorative approach to study the phenomenon of the effectiveness, efficiency, and consistency of AI-assisted scheduling systems. An inductive approach was used in this paper due to the lack of literature review and information directly relating to the research topic of the AI-scheduling system (Thomas, 2003). A qualitative research methodology was chosen to gain a better understanding of the underlying factors that could

possibly influence the effectiveness, efficiency, and consistency of this system. The study involved conducting semi-structured interviews with AI software companies and developers focusing on gathering detailed and nuanced information about the AI system. This method allowed a natural flow and leaves space for follow-up questions based on the interviewee's response. The interviewees are selected using cluster sampling and volunteer sampling. Firstly, the population was divided into clusters, in this case focusing on the AI industry, then interviewees are selected randomly based on the relevance and relatedness to the research topic by sending out invitation emails to participate in the interview. Then interviews will be conducted with samples who are willing to accept the invitation to participate in this research study. Informed consent was sent out to the participant before the interview and confidentiality and any potential power dynamics between participants and researchers were notified both in the consent and during the interview. The interviews were conducted through Microsoft Teams with the recording function of automatic transcription for data analysis.

3.2 Interview protocols design

According to Cleland (2017), with the use of a framework when designing interview protocols, the questions asked during an interview can be more concise and coherent with the problem statement and the research question. Therefore, the conceptual model (Figure 1) was used as a guideline to generate interview questions for AI developers and founders. In order to conduct an interview specific questions are tailored to elicit valuable insights based on their role and perspective. Developers and founders were questioned about the system's performance, optimisation, and functionality of the system relating to the EEC (effectiveness, efficiency, and consistency). They were also asked for insights into any negative feedback received from their customers encountered for future improvement. These tailored interview questions designed based on the participant's position/role can develop a comprehensive understanding of their viewpoints towards the AI-assisted scheduling system. this procedure can ensure that the data collected from these interviews were directly aligned with the research objective and yield valuable insights for the study. View Appendix 1 for the interview questions.

3.3 Participants

A total of six participants were recruited for the study by using convenient sampling through invitations by email, phone calls and verbal. The research sample consisted of three AI developer companies, one AI expert, one personnel planning company, and one AI-assisted scheduling system company.

The three AI-developer were invited through a verbal invitation to the Zorg & ICT 2023 Utrecht exhibition. These companies preferred to stay anonymous, therefore, they will be addressed as companies A, B, and C in this paper. Company A is a healthcare professional in the use of robotic process automation and artificial intelligence. They provide digital assistants to take over the manual administrative work of doctors, nurses, and support staff. Moreover, company B is an organisation that helps organisations to accelerate their digital transformation, modernise business processes and maximise the value of technology investments. Additionally, company C is a developer of innovative solutions that helps to smoothen the implementation of new technologies and processes and improve productivity and quality of work which increases the overall efficiency of an organisation.

Furthermore, the company Intus was invited to participate in this research interview found from the Zorg & ICT 2023 exhibition. This company is a personnel planning company that developed its planning system based on the "user-centric" philosophy. The AI expert Prof. Jason S. Chang, from the National Tsing Hua University in Taiwan, was invited to this research through phone calls. A professor of computer science specialising in Natural language processing, Digital Learning, Machine Translation, and Question Answering. Lastly, Tonos Care is a smart, digital software company that develops solutions that allows healthcare workers to quickly and flexibly create an optimal planning schedule and walking routes. And they are invited through the email invitation.

3.4 Data analysis

To evaluate the data collected from interviews, a coding method was employed in this study. In order to begin data analysis, the following steps are followed: (1) transcript all the data collected through recorded interviews to create a written record of the data. This step ensured the information captured during the interviews is accurately documented and ready for analysis. Transcription is automatically generated by Microsoft Teams. (2) Identify and create codes that were emerging with the research question and this process helps to extract key information and identify recurring themes and perspectives. (3) Code analysis and draw a final conclusion about the investigation.

The main focus of this study was to explore the variables discussed in the conceptual model (Figure 1). These variables contain effectiveness, efficiency, consistency, datasets, and user acceptance. However, during the data analysis section additional significant elements including "usage frequency" and "de-humanisation" emerged as suggested by the participants. With these unexpected findings, the study gained valuable insights beyond its initial scope, allowing a more comprehensive understanding of the factors influencing the performance of the AI-assisted scheduling system.

To provide clarity and consistency, a detailed table (Table 1) was created containing a complete list of all codes used in the analysis process along with their corresponding definitions. As a reference guide, this table was assist in coding the data accurately, ensuring that the interpretations and categorizations are consistent.

Table 1. Interview codes and definition

Codes	Definition
Effectiveness	By applying AI to the scheduling process, its effectiveness improved.
Efficiency	AI will improve the overall efficiency of the scheduling process.
Consistency	The consistency and accuracy of the schedule generated by the system.
Dataset	The amount of datasets needed to set up the AI system.
User acceptance	The interaction and acceptability of users contacting with new technology products in the market.

Usage frequency	The usage frequency of the AI system and its relationship with effectiveness.
Human-AI interaction	Human interference during the production process is still needed in order to best-satisfied employees by taking their opinion into account.

4. RESULTS

4.1 Effectiveness

According to the insights shared by all respondents, six out of six participants, the system AI is believed to improve the effectiveness of the scheduling process within an organisation. All respondents reflected a positive view on arranging raw data for scheduling purpose, turns to be more effective if AI is applied in the process. They emphasised that an AI-assisted scheduling system can generate workforce schedules more effectively compared to other scheduling methods such as self-scheduling or traditional scheduling methods. For example, the interviewee from Tonos Care mentioned that *"It is pretty effective I would argue, it works and works very fast."* when asked about the effectiveness of the system generating daily or weekly schedules for employees. The AI expert from the National Tsing Hua University in Taiwan also affirmed that *"AI can of course be an effective tool to apply in all kinds of fields, however, under some constraints such as database, the most influential factor should be considered."* The other four interviewees shared the same view on the effectiveness of AI-scheduling system. Therefore, these responses highlight the role of effectiveness in AI-scheduling system.

4.2 Efficiency

In terms of efficiency, all six respondents argued that AI can be an efficient tool when it is applied appropriately to align with the organisation's demand. Tonos Care expressed their point of view on effectiveness by quoting *"Efficiency is definitely supported by using AI as long as the data is right, that is very important."* Similarly, Intus shared the same point of view by arguing *" You can put in the requirements that you need and it will make a staffing level that will fit your needs. For example in the home care service, there are all these clients you need to visit and by one of your employees, they can make a route that is very efficient and/or really conforms to the needs and the wishes of the clients."* Similarly, the rest of the respondents also reported with a similar point claiming that efficiency is indeed significant in AI- scheduling, however, strong and clear data is necessary in order to use AI-scheduling system efficiently. As a result, efficiency is a significant role in AI to be applied in any kind of field.

4.3 Consistency

Consistency, as another studied factor of this study, was proposed to be a significant factor in terms of AI-scheduling systems. Tonos Care acknowledged that *"due to the dynamics, it can be different every day, therefore, about consistency getting the same answer every time the answer is no."* The rest of the respondents does not provide their opinion in response to questions related to consistency.

4.4 User acceptance

No comment was made by any of the interview participants about the user acceptance of the AI-assisted scheduling system. As participants argued that:

"We are kind of responsible for the first stage of the system development, so we kind of prototype [...] so I don't know much about that." (Jason S. Chang, 2023)

"I do not handle customer or you call it the user so I do not have any comment on this question. This is handled by my colleagues." (Company A, 2023)

"Not really receiving any information on this, so I don't know." (Company B, 2023)

"I get come out with the prototype there is another department, the programmers, who will interact with users to improve the AI system." (Company C, 2023)

4.5 Datasets

To ensure the effectiveness and efficiency of the AI system in the scheduling process, all six respondents emphasised the importance of datasets that are needed for the AI to learn. They addressed that the quality and quantity of the dataset provided during the initial setup phase are very important.

"AI need a huge amount of high-quality data to start working." (Company B, 2023)

"In scheduling, we found that in order to pray to work, you need lots of data. That we do have data, on the employees and on schedules and all that kind of stuff." (Intus, 2023)

4.6 Usage frequency

Furthermore, the AI developers from companies A, B, and C stressed the significance of the frequent usage of the system, which is another factor that will influence the effectiveness and efficiency of the system. the relationship between usage frequency and effectiveness and efficiency of the system is having a direct relationship.

"AI can work without human influence to update and refresh the system. But this can only work under when the system is constantly used." (Company A, 2023)

"The more the system is used by users, AI gain more data through the process, so, in future, AI can learn by itself without human interaction with the AI, so it is effective." (Company B, 2023)

"If you asking about effectiveness, AI can learn by itself without people's help but data is crucial in the case." (Company C, 2023)

4.7 Human-AI interaction

Interestingly, Tonos Care and Intus, both personnel professional planning companies argued that AI cannot fully take over human work. Excluding employees from the scheduling process, the output generated may not fully fulfil workers' demands.

"No, I don't believe. An ideology is AI should support humans, bring to the expertise and then they make better decisions themselves with what they know. If you fully automated, you dehumanised." (Tonos Care, 2023)

"We are quite fond of involving the employees in the scheduling process. And we feel that the best results can be achieved by involving them as much as possible. So basically, the scheduling is done by the employees. So there is no real way of replacing that with AI." (Intus, 2023)

5. DISCUSSION

The purpose of the study is to investigate the effects of the AI-assisted scheduling system specifically focusing on effectiveness, efficiency, and consistency when generating a short-term workforce schedule for an organisation such as healthcare centres and hospitals. This study used qualitative research practices in the form of semi-structured interviews with six AI-related parties who were most relevant and important findings are available in the results section of this paper. The main outcome is found to be that all the participants from the AI technology field highly agree that AI-assisted scheduling systems can benefit organisations to produce workforce schedules effectively and efficiently. However, given the dynamic organisational environment and diverse employee needs, achieving consistent scheduling outcomes appears to be challenging. Consequently, human factors remain essential in the scheduling process to ensure an optimal schedule that achieves all employees' requirements.

Efficiency is a significant factor in the AI-assisted scheduling system. It plays a crucial role when formulating an outcome requested by the users. The system is able to customise outputs according to the inputs received from users and formulate the most optimised outcomes such as planning the most efficient routes to visit clients that aligned with user requirements. However, according to the collected data, it highlighted that in order to achieve the efficiency of using AI in the scheduling process, accurate and relevant data are needed to promise the efficiency of the system. This finding can be proved by Pallathadka et al., (2021), who mentioned that in order to become efficient in managing human resource, leveraging the AI system with quality datasets are very important to achieve the objective.

In general, all six respondents revealed a positive perspective towards the application of AI in the workforce scheduling process, especially studying raw data for output generation in a short period of time. From this perspective, AI can virtually reduce the time spent on producing a workforce schedule that satisfied the majority of employees within an organisation. Additionally, this scheduling system can easily deal with unpredictable circumstances such as staff taking sick leave last minute or extra workforce needed in a department, the system is able to produce a new workforce schedule in a very short period of time when compared to other scheduling methods such as traditional scheduling. This result aligned with the study of Makarius et al. (2020) who did research on AI technology to benefit organisations in the way of fast and accurate results.

On the other hand, the factor of consistency emerges to be a more complex aspect. The dynamic nature of organisational demands can make it challenging for AI to produce a consistent workforce schedule every time as employees will have different demands and needs over time. This finding of a constantly changing environment aligned with Howard et al. (2023) where consistency is a challenge to AI when it needs to produce uncertain results for users. This changing environment or so-called dynamic nature of an organisation can be referred to as the unpredictable incidence that may happen during or after the generation of the workforce schedules. Unpredictable incidents such as employees taking sick leaves, constantly changing demands of the workforce needed during the morning, afternoon, and night shifts, or personal preferences of employees. Therefore, it is a difficult task for the AI-assisted scheduling system to develop a consistent schedule for the employees.

Given the current niche market of the AI-assisted scheduling system, the study engaged exclusively with AI developers, experts, and product founders for interviews. However, interview questions related to user acceptance yielded no responses, such topics fell beyond their purview possibly due to lacking interaction with users and feedback, as noted in the results (Section 4.4, user acceptance). Users hesitated to share due to some privacy concerns. Therefore, valuable data about user acceptance was not able to be collected during the research.

Additionally, AI technology is highly dependent on datasets provided in order for the system to learn (Shamaev, 2023). This study found out that a vast amount of high-quality raw data is essential for the AI to learn and function effectively and efficiently. Therefore, special attention is needed in the initial set up stage where high-quality and large quantity datasets are needed to be provided for the AI system to learn in order to produce optimised outputs that satisfied the users. By providing a good amount of dataset with high accuracy, the effects such as effectiveness and efficiency of the system can be achieved as discussed above.

Furthermore, usage frequency provides a clear overview of the relationship between frequency of use and the scheduling system's effectiveness. Based on this, revealed that the more frequently the scheduling system is being used by the users, AI can have a better ability to learn and update by itself without any human interference in the future. Therefore, this is an advantage to support the idea that an AI-assisted scheduling system is effective to be applied in an organisation to generate workforce schedules.

Notably, the finding in the result section also highlighted that AI cannot fully replace humans when producing a workforce schedule. The schedules produced by the scheduling system may not fully fulfil all employees' preferences in an organisation, and changes may be required. Therefore, involving employees' preferences and demands in the scheduling process, the scheduling system is able to produce an optimised schedule to satisfy all employees within an organisation.

Overall, the study is aimed to investigate the perceptions of AI-assisted scheduling systems in terms of effectiveness, efficiency, and consistency of related individuals. The result indicated that the scheduling system is indeed effective in formulating short-term shift schedules because it can rapidly generate outcomes while reacting to unpredictable circumstances. The efficiency factor of the system is crucial, it can generate outputs based on user demand and needs. However, in order to achieve this factor, accurate and relevant data is necessary. Moreover, this finding showed a direct connection between the datasets and the dependent variable of effectiveness and efficiency, highlighting the importance of high-quality data. The other dependent variable consistency proves to be not a considerable variable when producing a workforce schedule that varies constantly due to the dynamic environment and changing nature of organisational demands. This study also showed how datasets are crucial to AI-assisted scheduling systems by highlighting the importance of accurate, relevant, and sufficient data provided at the set up stage. Furthermore, the frequency of usage of the system influenced the system's ability to update and learn by itself. However, the study did not provide any evidence to support the variable of user acceptance, although usage was identified as a new significant variable to consider in a research study.

Based on the provided responses, the result of the interview suggested that an AI-assisted scheduling system is feasible and applicable with some constraints.

6. LIMITATIONS AND FUTURE RESEARCH

This paper mainly focuses on the effectiveness, efficiency, and consistency of the AI-assisted scheduling system but has some limitations found during the research process. First of all, the sample size of the research group is too small due to the niche market of this AI-scheduling system. This does not take away the value of the results found. However, a larger research group would add to external validity. Secondly, the research group in this study only focused on AI developers, experts, and scheduling system founders, excluding the main user of the scheduling system. As this paper is researching the effects of the system, therefore, it will be interesting to also include users in the research. By also taking account of the user experience of using the scheduling system this research topic ideologically can be more persuasive with any stereotype that may appear from the AI developers and product founders. Lastly, the variable of user acceptance in the conceptual model developed (Figure 1) suggested changes to the codes identified during the data analysis process which are "usage frequency" and "human-AI interaction". This can be referred to Figure 2 – revised sample conceptual model. Which may provide an idea for future investigation of AI-assisted scheduling systems.
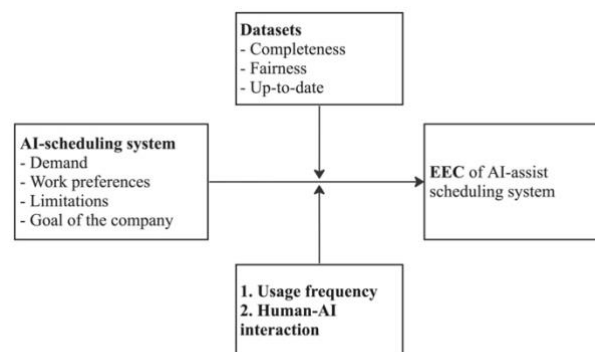

Figure 2. Revised Sample Conceptual Model

Furthermore, the future investigation will mainly be focusing on user experience with the AI-assisted scheduling system in order to further complete this research study. According to Nurkka et al. (2009), user experience is able to find out why users choose to use a product, their motivation to use a product, and what terms they evaluate their experience on using a product. This can better explain the effectiveness, efficiency, and consistency of the AI-assisted scheduling system in the user phase without any professional experts' stereotypes. The investigation will be recommended to be conducted under the situation when the market of AI-assisted scheduling systems is mature enough and widely adopted with more industries implementing this system in their organisation. The last suggestion will be to specify a certain industry field to conduct the investigation. For example, focusing on airports, an industry that works 24/7 and with many unpredictable situations such as weather changes.

7. CONCLUSION

This study attempted to gain insights into the effectiveness, efficiency, and consistency of AI-assisted scheduling systems in generating short-term schedules, particularly focusing on employee shift allocation in the 24/7 industry.

The results show that AI-assisted scheduling systems are thought to be an effective and efficient tool used in generating work shift schedules for employees. However, to achieve this high-quality and accurate datasets are needed. The system's ability to generate schedules quickly was highlighted as a notable advantage when considering the effectiveness of the system. The factor consistency does not apply to this research due to the changing demands of the organisations over time. Rather than fully replacing humans, AI acts as a supporter to support humans by providing possibilities that users can use as a reference to help them make better decisions. Considering the unique requirements and complexities of organisations, achieving optimal scheduling outcomes requires a balanced relationship between AI and humans.

In summary, this research provides valuable insights into how AI-assisted scheduling systems can be beneficial, highlighting the importance of combining technology and human judgment to ensure successful scheduling. With AI, organizations can best optimise the scheduling process while valuing human contribution in order to deliver optimised schedules to employees.

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9. APPENDIX

Appendix 1. Interview protocol

1. What is your perspective of AI-assisted scheduling systems in the apply to healthcare industries? (founders/developers); to what extent do they support scheduling (what parts of the planning process)?

2. How do you perceive the effectiveness, efficiency, and consistency of the AI-scheduling system?

3. How effective can the system be in generating a work schedule in a timeframe of daily and weekly?

4. How much time does the system need to construct one work schedule?

5. Considering the limited production time, how does the AI-scheduling system ensure optimal scheduling comparable to longer production time schedules?

6. What are the feedbacks from your customers? Do you receive any negative feedback (from users) about the output generated by the AI-scheduling system?

e.g. the output is not concise, the output does not meet the demand or work preference from the managers.