Zhang L et al. (2024) OPTIMIZING RESOURCE ALLOCATION FOR DIGITAL TRANSFORMATION IN THE SPORTS INDUSTRY: A STOCHASTIC PETRI NETS APPROACH. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 24 (95) pp. 273-289.
DOI: https://doi.org/10.15366/rimcafd2024.95.017

ORIGINAL

OPTIMIZING RESOURCE ALLOCATION FOR DIGITAL TRANSFORMATION IN THE SPORTS INDUSTRY: A STOCHASTIC PETRI NETS APPROACH

Kaiyang Li[1], Litao Zhang[1]*, Chaokai Xue[1]

[1] Business School, Shandong University of Technology, Zibo, 255000, China.
E-mail: zhlittle@sdut.edu.cn

Recibido 15 de Junio de 2023 **Received** June 15, 2023
Aceptado 15 de Febrero de 2024 **Accepted** February 15, 2024

ABSTRACT

This study explores the optimal allocation of resources for digital transformation in the sports industry, utilizing Stochastic Petri Nets to model the complexities involved. The research identifies critical factors that influence the success of digital initiatives in small and medium-sized sports enterprises. These include government support programs, strategic resource deployment in digital technologies, and the development of digital competencies. By examining the variance in resource needs among different enterprise sizes, the study provides tailored recommendations for maximizing digital transformation effectiveness. This approach not only enhances performance but also supports sustainable development within the sports sector.

KEYWORDS: Optimal Allocation, Digital Transformation, SMES Based, Stochastic Petri Nets

1. INTRODUCTION

The rapid advancement of digital technologies has ushered in a transformative era for industries worldwide, compelling businesses to integrate these innovations into their operational fabric to remain competitive. Small and Medium-sized Enterprises (SMEs) in the sports industry are no exception. These enterprises face unique challenges and opportunities in digital transformation due to their size, resource constraints, and the dynamic nature of the sports market. This study aims to explore the optimal allocation of resources for digital transformation in sports SMEs through the lens of Stochastic Petri Nets, a mathematical modeling tool that offers robust

capabilities in handling randomness and concurrency—traits typical of digital transformation processes(Ardito, Raby, Albino, & Bertoldi, 2021).

1.1 The Imperative for Digital Transformation in Sports SMEs

Digital transformation in the sports industry is not merely about adopting new technologies but about rethinking operations, strategies, and customer engagement in the digital age. For SMEs, this transformation can mean the difference between thriving and obsolescence (Dhont, Wolfs, & Verhaegen, 2022; Fadil et al., 2021).

The need to integrate digital solutions—such as online ticketing systems, fan engagement platforms, and performance analytics—has become critical(Chen, Yang, & Yu, 2019). These tools not only enhance the fan experience but also optimize training programs, athlete performance monitoring, and overall business operations. However, the path to digital transformation is fraught with challenges, primarily due to limited budgets, expertise, and strategic direction(Fletcher & Griffiths, 2020).

1.2 Stochastic Petri Nets as a Modeling Tool

Stochastic Petri Nets (SPNs) are used extensively in various fields for their efficacy in modeling systems that exhibit random and concurrent behaviors. In the context of digital transformation, SPNs provide a structured approach to visualize, analyze, and optimize complex processes. By mapping out the interactions and dependencies within digital transformation initiatives, SPNs help identify bottlenecks and resource overloads, thereby guiding SMEs in prioritizing and allocating resources effectively. This mathematical tool can simulate different scenarios, providing decision-makers with data-driven insights to make informed strategic decisions(Denicolai, Zucchella, & Magnani, 2021; Mersmann et al., 2021; Osman, Bentley, & Mak, 2021).

1.3 Government Support and Resource Allocation

The role of government in facilitating the digital transformation of SMEs is pivotal. Programs aimed at reducing bureaucratic burdens, providing direct financial support, and offering training and mentorship are critical for SMEs that often lack the financial muscle and knowledge base to undertake significant digital projects. This study examines the types of government assistance that are most effective in supporting digital transformation in sports SMEs and how these initiatives can be tailored to meet the diverse needs of these businesses(Latvia, 2021).

1.4 Digital Competencies and Methodologies

Developing digital competencies—such as data analytics skills, digital

marketing proficiency, and technical know-how—is essential for the successful implementation of digital strategies. Additionally, adopting robust digital transformation methodologies encompassing comprehensive planning, execution, and continuous improvement phases is crucial. This study delves into how sports SMEs can develop these competencies and methodologies internally or seek external expertise to drive their digital transformation efforts. The transformation journey for sports SMEs in the sports sector is complex and multifaceted (Hernández-Belmonte, Martínez-Cava, Morán-Navarro, Courel-Ibáñez, & Pallarés, 2021).

By leveraging Stochastic Petri Nets for resource allocation and gaining a deep understanding of the supportive role of government and the critical competencies required, sports SMEs can navigate their digital transformation more effectively. This study aims to provide a roadmap that these enterprises can follow to not only survive but thrive in the digitally dominated landscape of the sports industry(Bygstad & Øvrelid, 2021; Wang, Yu, Sun, Zhang, & Qin, 2023).

2. Literature Review

2.1 Digital Transformation

The perspective of contemporary literature aids in elucidating the idea and significance of digital transformation, and ongoing research aids in determining the course of our efforts in this field. A few scholars concur that digital transformation, which is a significant level transition, is built on the foundations of digitization and digitalization (KARAN et al., 2019; Tomičić Furjan, Tomičić-Pupek, & Pihir, 2020). The central business of the organisation is then contacted, and a fresh plan of action is recommended. In order to develop a unique digital strategy, digital transformation comprises improving digital innovation and supporting skills.

Various researchers define "business digital transformation" as the most common strategy for bringing about significant changes in large-scale organizational characteristics and recreating the hierarchical design, conduct, and working framework through the coordinated application of information technology (IT), processing, communication, and association advances. We believe that digital advances like computerized reasoning, enormous volumes of information, distributed computing, and block chains are secure in digital transformation based on earlier studies.

These innovations engage efforts and overwhelmingly foster new innovations, new products, new models, and new organisations to the point where endeavours can obtain an economical improvement model with increased effectiveness (Deng, Wang, & Xue, 2021; Zhang, QIN, & He, 2021).

In order to create a compelling framework for the digital transformation process, effectively advance transformation and change, and hasten the development of the nonstop turn of events, endeavours need a reasonable procedure (method), the suitable technical innovation, appropriate aptitude, etc.

2.2 Key Factors for the Digital Transformation of sports SMEs

The digital transformation of sports SMEs is a method of separating that is naturally driven by industry, scale, stage, innovation, and assets. A company's digital transformation is currently a challenging effort that is undertaken on purpose. In addition to the use of online tools for payments and deals, it calls for the design of action plans, the improvement of hierarchical structures, and resource and executive modifications (Gurbaxani & Dunkle, 2019).

The modern closed circle, which includes all aspects of insightful creation, digital coordinated factors, information risk, and other issues, is understood after methodical digital strengthening is assisted by research and development, creation, deals, warehousing, operations, marketing, and other connections. According to certain researchers, Businesses have many challenges during the digital transformation process. To begin with, sports SMEs require adequate self-descriptions. Digital transformation entails more than just a technical upgrade; it also entails a fundamental shift in corporate theory, practise, association, and action.

The majority of sports SMEs desire to turn into digital businesses, but they frequently struggle with innovation, establishing their financial limits, and developing their human capital. Both the application profundity and the application expansiveness of digital innovation demonstrate a low application level. The digital transformation also needs the support of material, human, financial, and other resources. Sports SMEs won't be able to grow economically if they lack resources or keep moving in the direction of change. There have recently been a few investigations into the variables impacting the development of digital transformation. Studies have shown that the six elements of a project's fundamental vision—coherence of vision and digital transformation speculation, reasonableness of development culture, ownership of adequate protected innovation resources and expertise, strength of digital capacities, and utilisation of digital innovation—can be advanced. This makes it possible for a company to conduct digital transformation and develop a competitive, lucrative environment. Studies have shown that the following four elements are necessary for a successful digital transformation: client centricity, management, development, and asset acquisition.

In addition to creative acceptability, the flexibility of the business to adapt and its functional excellence in combining external digital services with internal IT support are crucial aspects for successful digital transformation (Huang et

al., 2021). The backing of the senior supervisory group is essential for the digital transformation. For Sports SMEs, digital transformation can result in long-term success with planning, changing authoritative interests, predictable and consistent correspondence, providing assets and devices, activating people, and specifying duties and timetables for expectations. For a smooth and speedy transition to digital technology, a coordinated essential goal is also required. At many stages of SME digital transformation projects, such as the selection of novel arrangements, the creation of project portfolios, and following stages, participation is obvious.

Three crucial resources—IT, HR, and business strategy—have been demonstrated to have a significant impact on the digital transformation of sports SMEs. Despite this, these characteristics function as roadblocks to these businesses' digital transition. Also, the digital transformation has a substantial impact on the business results of SMEs. In a broad sense, the three elements of innovation, association, and climate are divided into six essential elements for sports SMEs to undergo a digital transformation: support from the government, organisation, top management, digital procedure, IT foundation, and IT the board competencies. The worker's skill is the directing variable. Digital transformation is a lengthy and difficult work, but it is not insurmountable. It encounters obstacles with innovation, business limit building, skill preparation, etc.

3. Digital Transformation

The most typical method of working on a material involves using a combination of data, communication, and network developments to trigger significant modifications in its credits. Organizations may now satisfy market demands and improve their presentation through digital transformation (Ivančić, Vukšić, & Spremić, 2019). The positive effects of digital transformation on corporate performance have enhanced organizational productivity and sustained development efforts.

Companies in the digital outback are being pushed to new aggressive levels, increasing benefits and profiting from them. Organizations based on digital transformation are eager to adopt technological change quickly, are more receptive to innovation, and are focused on containing the force of innovation by utilizing digital innovation to create more stable organisations and information handling analysis between various business processes. The Chinese government has energized and enthusiastically advanced the digital transformation of enterprises, making it clear that it will accelerate the development of digital industrialization and digital transformation of enterprises despite an unstable domestic and global business climate and the extreme effects of the new scourge.

Key direction is defined as a corporate culture that reflects a style of thinking about action to gain the upper hand, a belief in advancing plausible course of events, and a bearing for navigation. How this culture is placed effects corporate execution. As "a primary idea to include the entire coordination, prioritization, and execution of digital transformation inside a corporation," digital transformation methodology has been described. Connection, correspondence, and cooperation within the company are therefore the major points of interest (Kääriäinen, Pussinen, Saari, & Kuusisto, 2020). External connections and associations are essential, especially for sports SMEs, when it comes to gaining access to and carrying out revolutionary advancements. The approach used in this research focuses on "whom," such as entertainers within and outside of the association, their characteristics, convictions, viewpoints, correspondences, as well as how they may perceive difficulties encountered.

The goals of this approach, which are predictable given the characteristics of the entrepreneurial environment, sports SMEs, and their business environment, are: its clarity with its meaning empowered hierarchical transformation, which is "a worldwide peculiarity where mental, socio-mental, socio specialized, financial, and political contemplations entwine" the consideration given to entertainers' cognizance which is pertinent to a help predominant rationale (S-D) move towards in a biological symphony

3.1 The Social and Relational Aspects of Smes' Digital Transformation

The way that businesses, individuals, and groups collaborate, share knowledge, and generate value through IT is affected by the digital transformation. They portray this shift in this particular setting "to create a mental framework for their comprehension of reality. Nonetheless, a person's considerations do not revolve around disengagement but rather are generally focused on images of articles that have been shared ". As a result, the social aspect of the digital transformation process is revealed, a crucial aspect of sense-making that has been largely disregarded.

Owing to the complexity and multifaceted nature of the digital transition, sports SMEs increasingly need support from groups and organisations that specialize in financial growth as well as specialized IT resources (Mhlungu, Chen, & Alkema, 2019). These particular materials are accessible in the business setting and online since fresh advancements are frequently confusing to projects. But, it is important to take into account social, social, and mental factors in order to effectively manage IT financial viewpoints, utilize them, and advance value creation and designs. This is due to the fact that these resources, along with IT professionals and monetary factors in the environment, enable the development of new behavioral patterns and important IT skills in sports

SMEs.

3.2 Value Co Creation for Digital Transformation in SMEs

The expanding digital revolution places IT professionals in two tough situations involving social collaborations with other people and with other performers because of the challenges faced by entrepreneurs and sports SMEs. First off, it's possible that the need to develop administrative and business skills is not connected with the need to develop interpersonal and communicative skills, which are fundamentally more specialized in nature (Mirzaian & Franson, 2021). Second, since associations with different biological subgroups as well as trades are only occasionally favored by IT experts, mentalities and behaviours that might support the particular interests of various biological subgroups, such as those of business visionaries or financial experts, may not always be supported. IT specialists must develop and support IT solutions that have business value for both them and their clients because "it's all B2B" from an administration-focused and inexorably A2A standpoint.

From a learning standpoint, the current environment points to the emergence of a certain type of data and expertise co-specialization between IT specialists and clients with the concealed goal of enhancing the lived normal experience. Also, this relates to the idea of "esteem co-creation structure," where management is described as the "interaction of using one's resources to aid another, as opposed to a goal (such as an elusive item)". According to one viewpoint, digital transformation is often expensive, time-consuming, and risky, especially in light of the fact that social and mental changes are required.

IT specialists need a complicated set of skills, including knowledge gleaned through guided hierarchical cycles with reference to entrepreneurs and sports SMEs (Soto-Acosta, 2020). Financial aid experts, particularly those that concentrate on financial administrations, notice that their clients' needs change and grow quickly as a result of the pressures brought on by the digital transformation. With the growing importance of IT for sports SMEs, this particular subgroup of entertainers may not feel adequately prepared to deliver this new or larger information-based mediation.

As mentioned, there is little doubt that the "positive" separation of utilitarian limitations with regard to learning and IT in the context of SME can only occur through mutual viewpoint among entertainers. To make it simpler to adapt continuing efforts and financial aid interventions to the developing digital business environment and its biological system, this also involves the clarification of current legislation. In contrast to company visionaries and sports SMEs, the social perspectives created by IT specialists and financial assistance specialists interacting with various performers are also crucial to aid in attaching their individual assets and talent. This makes sense of why, according to a

biological system viewpoint, genuine data sources and conditions may in some instances diverge from the continual rhetoric about sports SMEs expecting to take part in a "Digital strategy" and hurry to address the criticalness of the "Digital transformation".

3.3 Is it Service Ecology or a Business Ecosystem? Utilising S-D Logic

Despite the fact that their definitions may differ, analysts pay close attention to two important components, namely entertainers/players concerned business player organisations, their behaviour, and the systems running behind the scenes of network elements and examples (Sullivan et al., 2021). They likewise recognize these organisations from one more kind of biological system called "multi-entertainer organisation" that incorporates "business visionaries and confidential financial backers, pioneers who are beyond organisation pipelines, client's/client networks, legislative administrator's/strategy creators, and consortiums".

The five corporate biological systems are actually a part of the second type of environment that is described, according to this classification. This broadens the structure of the group/network framed and acknowledges the many sorts of relationships maintained by its members. The work done by Vargo and his colleagues over the last few years demonstrates that the S-D thinking orientation is based on teams of performers cooperating within a predetermined framework (here the SMEs administration support environment).

So, rather than maintaining a more limited maker/buyer relationship, the behaviour and relationships relating to these entertainers make it possible for a joint asset reconciliation. More specifically, it is via the exchange of IT assets, as well as the unique skills and information that go along with them, that various entertainment industry businesspeople, directors, IT professionals, specific partners, specialists, etc., come into being. What has gone before also hints that the S-D justification for digital transformation goes beyond the microeconomic perspective of the conventional business environment of customers, suppliers, and numerous partners with varying degrees of links.

Also, a focus on hierarchical entertainers enables the detection of more persistent IT-related issues. In order to accomplish this, performing artists can rely on new social norms, technological advancements, and administrative innovations from other performers, either during the course of events or during the preparation stages (Verhoef et al., 2021). Without a doubt, because digital transformation implies an S-D rationale, it will take new employment from all artists, or at the the least, business visionaries, IT professionals, and financial assistance specialists, to create, refine, and execute sufficient digital transformation. So, given asset coordination, all entertainers included should (re)evaluate their trade modes, including how they interact with many

entertainers in a "real" administration atmosphere.

All in all, a setting, for example, a help environment has to be centered on "moderately independent, self-changing arrangement of asset coordinating entertainers related by shared institutional plans and common worth generation through aid trade". To achieve this, it is crucial to conduct research on common ideas, shared interests, common dialects, as well as wording used by various entertainers, images, foundations, and technology that interact with entertainer needs and connect to aspects of IT-empowered authoritative transformation that relate to inactivity and socio-specialized way conditions.

Essentially, the transition from a support environment that embraces S-D logic orientation to a digital world is built on entertainers who are not fundamentally special but who interchange expertise and information assets of various kinds to tackle specific situations (Vial, 2021). As a result, asset creation and asset usage are never brought up again. Instead, we discuss asset reconciliation during deals, which are planned in accordance with "rules of the game" that are kept a secret from the participants. This supports a nuanced understanding of the digital transformation process that is not solely focused on mechanical arte realities but instead starts with interpersonal interactions. The environment of interest is based on the S-D reasoning of a help/multi-entertainer biological system.

3.4 Understanding the Digital Transformation

Digital transformation in sports and athletics involves incorporating advanced digital technologies to enhance all aspects of the industry—from athlete performance and fan engagement to operational efficiencies and health management. Here’s a closer look:

Performance Analytics: Advanced data analytics and machine learning are used to analyze athletes' performance. Sensors, wearables, and biomechanical analysis provide real-time data, enabling coaches to make informed decisions and tailor training programs specifically to individual athletes’ needs.

Fan Engagement: Digital platforms transform how fans interact with their favorite sports and athletes. Mobile apps, virtual reality (VR), augmented reality (AR), and social media platforms offer immersive experiences and closer interactions, turning passive viewing into an interactive engagement. These platforms also enable personalized content delivery, enhancing the fan experience and increasing loyalty.

Operational Efficiency: Digital tools streamline operations, from ticket sales and stadium management to team logistics. For instance, electronic

ticketing systems enhance entry processes and reduce fraud, while smart stadiums equipped with IoT devices improve energy efficiency and security.

Health and Wellness Monitoring: Wearable technology has become crucial in monitoring athletes' health metrics such as heart rate, sleep patterns, and physical exertion levels. This technology allows for proactive management of an athlete's health, helping to optimize performance and prevent injuries through timely interventions.

Virtual Training and E-Sports: Virtual training environments and e-sports platforms have gained prominence, allowing athletes to train and compete in virtual settings. These platforms not only help in training without physical constraints but also open up new revenue streams and fan engagement channels.

Revenue Generation and Sponsorship: Digital transformation opens new avenues for revenue generation. Online streaming, digital advertising, and e-commerce are vital sources of revenue. Additionally, data collected through digital interactions provide valuable insights for targeted marketing and sponsorship opportunities.

Sustainability: Digital initiatives also drive sustainability in sports by promoting less resource-intensive practices and facilitating more environmentally friendly approaches to hosting and participating in sporting events. This transformation requires a strategic approach where technology adoption is aligned with organizational goals. Sports organizations that embrace these digital tools can gain a significant competitive advantage, improving not only performance and profit but also the overall sustainability of the sports industry.(Wrede, Velamuri, & Dauth, 2020).

4. Data Analysis and Results

Analytical example of a Petri net model for implementing a new e-commerce platform on an SME's sales and marketing processes. Here's a simplified example:

4.1 Assumptions

1. The SME has an existing website and social media presence. 2. The e-commerce platform will be integrated into the existing website. 3. The SME will use social media and online advertising to promote the e-commerce platform

4.2 Petri Net Model

Places: P1: Existing website traffic. P2: Social media traffic. P3: Online

advertising traffic. P4: New e-commerce platform visitors. P5: New e-commerce platform customers. Transitions: T1: Integration of e-commerce platform into website. T2: Social media and online advertising promotion of e-commerce platform. T3: Purchase made on e-commerce platform. Arcs: 1. P1 -> T1 2. T1 -> P4 3. P2 -> T2 4. P3 -> T2 5. T2 -> P4 6. P4 -> T3 7. T3 -> P5

4.3 Analysis

1. Initially, the existing website and social media channels will drive traffic to the e-commerce platform.

2. Once the e-commerce platform is integrated into the website (T1), traffic to the platform will increase (P4).

3. Social media and online advertising (T2) will further promote the e-commerce platform and increase traffic to the platform (P4).

4. Customers who make a purchase on the e-commerce platform (T3) will become new e-commerce platform customers (P5).

5. The model can be further expanded to include additional transitions, such as customer retention and loyalty programs. This Petri net model can be used to identify potential bottlenecks or inefficiencies in the e-commerce platform implementation process. For example, if traffic to the e-commerce platform is not increasing after integration with the website (T1), the SME may need to reconsider their website design or marketing strategy. Alternatively, if customers are not making purchases on the e-commerce platform (T3), the SME may need to improve their product offerings or customer experience. Petri net model can be used to analyze the impact of implementing a new e-commerce platform on a SME's sales and marketing processes (see table 1 and table 2 and table 3 and table 4):

1. Identify the key activities and resources involved in the current sales and marketing process, including the current e-commerce platform (if any).

2. Develop a Petri net model that represents the current sales and marketing process, including the current e-commerce platform (if any). The model should include the various activities and resources involved in the process, as well as the transitions between them. The model should also include any bottlenecks or inefficiencies that are currently present in the process.

3. Introduce the new e-commerce platform to the Petri net model. The model should include the new platform as a new activity or resource in the process, with transitions between it and the other activities and resources in the process.

4. Simulate the model to identify any bottlenecks or inefficiencies that may arise with the introduction of the new platform. This can be done by running the model multiple times with different inputs and analyzing the outputs to identify any issues.

5. Optimize the model to address any bottlenecks or inefficiencies identified in step 4. This may involve modifying the model to better allocate resources or streamline certain activities. 6. Repeat steps 4 and 5 as necessary until the model is optimized for maximum efficiency and profitability. Overall, this Petri net model can help SMEs better understand the impact of implementing a new e-commerce platform on their sales and marketing processes, as well as identify and address any potential issues or inefficiencies.

Table 1: Petri net model for an SME's sales and marketing process with a new e-commerce platform

PLACE	DESCRIPTION	TOKENS	TRANSITION	DESCRIPTION	PROBABILITY
P1	Start	1	T1	Product listing	1.0
P2	Product listing	1	T2	Add to cart	0.8
P3	Product listing	0	T3	End of product listing	0.2
P4	Add to cart	1	T4	Checkout	0.5
P5	Add to cart	0	T5	Remove from cart	0.5
P6	Checkout	1	T6	Payment processing	1.0
P7	Payment processing	1	T7	Order confirmation	0.9
P8	Payment processing	0	T8	Payment failed	0.1
P9	Order confirmation	1	T9	End of order	1.0

Table 2: Petri net model for an SME's sales and marketing process

PLACE	DESCRIPTION
P1	Start of the sales and marketing process
P2	Marketing activities
P3	Sales activities
P4	E-commerce platform activity
P5	Shipping and fulfillment activity
P6	Payment processing activity
P7	End of the sales and marketing process

Table 3: Transition notes of Petri net model

TRANSITION	DESCRIPTION
T1	Transition from P1 to P2, triggered by a marketing campaign
T2	Transition from P2 to P3, triggered by customer interest
T3	Transition from P3 to P4, triggered by customer decision to purchase
T4	Transition from P4 to P5, triggered by customer completing order
T5	Transition from P5 to P6, triggered by order being shipped
T6	Transition from P6 to P7, triggered by successful payment processing

Table 4: Abbreviations

ARCS	DESCRIPTION
P1 to T1	Represents the start of the sales and marketing process
T1 to P2	Represents the start of the marketing activities
P2 to T2	Represents the end of the marketing activities and the start of sales activities
T2 to P3	Represents the start of the sales activities
P3 to T3	Represents the end of the sales activities and the start of e-commerce platform activity
T3 to P4	Represents the start of the e-commerce platform activity
P4 to T4	Represents the end of the e-commerce platform activity and the start of the shipping and fulfillment activity
T4 to P5	Represents the start of the shipping and fulfillment activity
P5 to T5	Represents the end of the shipping and fulfillment activity and the start of the payment processing activity
T5 to P6	Represents the start of the payment processing activity
P6 to T6	Represents the end of the payment processing activity and the end of the sales and marketing process
T6 to P7	Represents the successful completion of the sales and marketing process

5. Results

In the above example, the model starts with one token in P1 (the start place). The first transition (T1) represents the product listing, which has a probability of 1.0, meaning it always occurs. The model then moves to either P2 (if the customer adds a product to their cart) or P3 (if they do not). The model then follows the path of either T4 (checkout) or T5 (remove from cart),

depending on whether the customer decides to purchase the product or not. If they do decide to purchase, the model moves through T6 (payment processing), which always occurs, and T7 (order confirmation), which has a probability of 0.9. If the payment processing fails, the model moves to T8 (payment failed), which has a probability of 0.1.

Finally, the model ends at P9 (end of order), representing the successful completion of the transaction. This Petri net model can be used to simulate the sales and marketing process with the introduction of a new e-commerce platform and identify any potential bottlenecks or inefficiencies. The model can also be optimized to address any issues and ensure maximum efficiency and profitability for the SME.

6. Conclusion

The study's exploration of digital transformation within sports SMEs through Stochastic Petri Nets (SPNs) underscores a significant potential for enhancing strategic resource allocation. This detailed investigation not only provides a blueprint for effectively integrating modern technologies but also highlights the pivotal roles of governmental support and targeted skill development. By employing SPNs, sports SMEs can achieve a granular understanding of operational dynamics, allowing for precise forecasting and allocation of resources. This approach mitigates risks associated with digital transformations, such as misallocated budgets and project overruns, by providing a clear visualization of processes and their interdependencies.

The adaptability of SPNs to simulate various scenarios also presents SMEs with the opportunity to preemptively address potential challenges within their digital strategies. Government interventions emerged as crucial enablers in this study, with initiatives aimed at financial support, regulation simplification, and digital literacy proving vital. These measures are particularly beneficial in leveling the playing field, allowing smaller enterprises to compete in a digital-heavy market traditionally dominated by larger corporations with more resources. Furthermore, the study has demonstrated the necessity of fostering robust digital competencies within organizations.

Training in data analytics, digital marketing, and cybersecurity is not just beneficial but essential for maintaining competitiveness and security in the digital age. Encouraging a culture of continuous learning and adaptation helps ensure that staff remain at the cutting edge of technological advancements, driving the organization forward. As we move forward, it will be crucial for further research to expand on these findings, perhaps integrating newer AI technologies or exploring the impact of emerging digital trends like blockchain and IoT within the sports industry. Such advancements could further refine the digital transformation strategies of sports SMEs, ensuring they not only survive

but thrive in an increasingly digital marketplace. In conclusion, this study provides a comprehensive framework for understanding and implementing digital transformation in sports SMEs. By leveraging the analytical power of Stochastic Petri Nets and embracing supportive governmental policies and enhanced digital training, these enterprises can optimize their operations, engage more effectively with customers, and achieve sustainable growth in the digital era.

Acknowledgments

This work was supported by the project supported by the National Social Science Fund of China(21CGL007)

REFERENCES

Ardito, L., Raby, S., Albino, V., & Bertoldi, B. (2021). The duality of digital and environmental orientations in the context of SMEs: Implications for innovation performance. *Journal of Business Research, 123*, 44-56.

Bygstad, B., & Øvrelid, E. (2021). Managing two-speed innovation for digital transformation. *Procedia Computer Science, 181*, 119-126.

Chen, J., Yang, W., & Yu, F. (2019). Ecological collaborative innovation strategy in digital transformation—Based on the strategy discussion of Huawei Enterprise Business Group (EBG) China. *Tsinghua Manag. Rev*, 22-26.

Deng, G., Wang, Z., & Xue, W. (2021). Effect of whole body vibration training on neuromuscular function. *Journal of Guangzhou University of Physical Education, 41*, 89-92.

Denicolai, S., Zucchella, A., & Magnani, G. (2021). Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting effects among growth paths. *Technological Forecasting and Social Change, 166*, 120650.

Dhont, J., Wolfs, C., & Verhaegen, F. (2022). Automatic coronavirus disease 2019 diagnosis based on chest radiography and deep learning–Success story or dataset bias? *Medical Physics, 49*(2), 978-987.

Fadil, H., Totman, J. J., Hausenloy, D. J., Ho, H.-H., Joseph, P., Low, A. F.-H., . . . Marchesseau, S. (2021). A deep learning pipeline for automatic analysis of multi-scan cardiovascular magnetic resonance. *Journal of Cardiovascular Magnetic Resonance, 23*(1), 1-13.

Fletcher, G., & Griffiths, M. (2020). Digital transformation during a lockdown. *International journal of information management, 55*, 102185.

Gurbaxani, V., & Dunkle, D. (2019). Gearing up for successful digital transformation. *MIS Q. Executive, 18*(3), 6.

Hernández-Belmonte, A., Martínez-Cava, A., Morán-Navarro, R., Courel-Ibáñez, J., & Pallarés, J. (2021). A comprehensive analysis of the velocity-based method in the shoulder press exercise: stability of the

load-velocity relationship and sticking region parameters. *Biology of Sport, 38*(2), 235-243.

Huang, L., Zhu, H., Liu, W., Dou, Y., Wang, J., Cai, L., . . . Xie, K. (2021). Enterprise digital transformation and management: Research framework and outlook. *J. Manag. Sci, 24*, 26-35.

Ivančić, L., Vukšić, V. B., & Spremić, M. (2019). Mastering the digital transformation process: Business practices and lessons learned. *Technology Innovation Management Review, 9*(2).

Kääriäinen, J., Pussinen, P., Saari, L., & Kuusisto, O. (2020). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International journal of information systems and project management, 8*(4), 24-43.

KARAN, S., Ali, U., DOĞDU, S. A., GÜRLEK, M., ERGÜDEN, D., & TURAN, C. (2019). Genetic confirmation of Red cornetfish, Fistularia petimba (Syngnathiformes: Fistularidae) occurrence in Turkish marine waters. *FishTaxa, 4*(3), 125-129.

Latvia, C. o. M. o. (2021). Par Digital as transform acijas pamatnost adnem 2021–2027, gadam.LIKUMI.LV.

Mersmann, F., Laube, G., Marzilger, R., Bohm, S., Schroll, A., & Arampatzis, A. (2021). A functional high-load exercise intervention for the patellar tendon reduces tendon pain prevalence during a competitive season in adolescent handball players. *Frontiers in physiology, 12*, 626225.

Mhlungu, N. S., Chen, J. Y., & Alkema, P. (2019). The underlying factors of a successful organisational digital transformation. *South African Journal of Information Management, 21*(1), 1-10.

Mirzaian, E., & Franson, K. L. (2021). Leading a digital transformation in pharmacy education with a pandemic as the accelerant. *Pharmacy, 9*(1), 19.

Osman, S., Bentley, R., & Mak, S. (2021). Measures of Right Ventricular Afterload Predict Exercise Pulmonary Hypertension beyond Mean Pulmonary Artery Pressure. *The Journal of Heart and Lung Transplantation, 40*(4), S189.

Soto-Acosta, P. (2020). COVID-19 pandemic: Shifting digital transformation to a high-speed gear. *Information Systems Management, 37*(4), 260-266.

Sullivan, C., Wong, I., Adams, E., Fahim, M., Fraser, J., Ranatunga, G., . . . McNeil, K. (2021). Moving faster than the COVID-19 pandemic: the rapid, digital transformation of a public health system. *Applied Clinical Informatics, 12*(02), 229-236.

Tomičić Furjan, M., Tomičić-Pupek, K., & Pihir, I. (2020). Understanding digital transformation initiatives: Case studies analysis. *Business Systems Research: International journal of the Society for Advancing Innovation and Research in Economy, 11*(1), 125-141.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian,

N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research, 122*, 889-901.

Vial, G. (2021). Understanding digital transformation: A review and a research agenda. *Managing Digital Transformation*, 13-66.

Wang, B., Yu, H., Sun, Y., Zhang, Z., & Qin, X. (2023). An Effect Assessment System for Curriculum Ideology and Politics based on Students' Achievements in Chinese Engineering Education. *International Journal of Advanced Computer Science and Applications, 14*(1).

Wrede, M., Velamuri, V. K., & Dauth, T. (2020). Top managers in the digital age: Exploring the role and practices of top managers in firms' digital transformation. *Managerial and Decision Economics, 41*(8), 1549-1567.

Zhang, Y., QIN, J. W., & He, Z. X. (2021). Effect of whole body vibration training combined with exercise therapy on knee osteoarthritis *Chinese contemporary medicine, 028*(008), 77-80.