Integrating Forecasting & Planning Management for Sustainable Hospital Supply Chains and Societal Advancement

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***Abstract*— This research investigates the critical interplay between Forecasting & Planning Management (FPM) and Sustainable Hospital Supply Chain Management (SHSCM), exploring their collective impact on Sustainable Societal Advancement (SSA). Anchored on a sample size of 401, the study employs IBM SPSS for factor analysis and IBM AMOS for structural equation modeling, ensuring the reliability and validity of the results. Two hypotheses form the backbone of this research: Firstly, the study hypothesizes a significant relationship between FPM and SHSCM. Secondly, it posits a consequential link between SHSCM, invigorated by Collaborative Information Flow (CIF), and SSA. Both hypotheses are substantiated with robust empirical evidence, indicating positive impacts. The research unravels the pivotal role of FPM in enhancing hospital supply chain sustainability, highlighting its significant influence on SHSCM. This relationship is vital for efficient resource allocation, cost efficiency, and overall sustainability in hospital operations. The study further delves into the transformative effect of SHSCM on broader societal well-being, emphasizing its substantial positive influence on SSA. The findings suggest that sustainable practices within hospital supply chains extend beyond immediate healthcare benefits to broader societal and environmental impacts, contributing to economic stability, environmental conservation, and enhanced public health. Methodologically, the study adopts a comprehensive approach, utilizing factor analysis to validate the reliability of survey responses and structural equation modeling to assess the interrelations among FPM, SHSCM, and SSA. The research's adherence to established validity and reliability criteria is evident in the satisfactory factor loading scores, the KMO measure, and Cronbach's alpha coefficients.**

While affirming the proposed hypotheses, the study also acknowledges its limitations, particularly its focus on the hospital sector in Bangladesh, which may affect the generalizability of the findings. Furthermore, the cross-sectional nature of data collection points to the potential for longitudinal studies to better comprehend the temporal dynamics of these relationships. The study concludes with a call for future research to broaden the geographic scope and incorporate diverse healthcare settings, thus enriching the global understanding of these dynamics. Additionally, it suggests exploring the integration of digital innovations in FPM and SHSCM to further optimize supply chain processes and enhance sustainability. Overall, this research contributes significantly to the field of sustainable healthcare management, offering empirical evidence on the importance of forecasting and planning in healthcare supply chains and their broader societal implications. It paves the way for healthcare practitioners, policymakers, and researchers to foster sustainable practices in hospital supply chains, ultimately aiming for societal well-being and global health advancements.

***Keywords*—** *Forecasting & Planning Management, Sustainable Hospital Supply Chain Management, Sustainable Societal Advancement, Structural Equation Modeling, Healthcare Sustainability*

1. Introduction

The modern healthcare landscape, particularly in the wake of global health crises, has emphasized the critical importance of efficient and sustainable hospital supply chain management. At the heart of this evolution lies the integration of Forecasting & Planning Management (FPM) strategies, which have shown significant potential in enhancing the sustainability of hospital supply chains. This study delves into the intricate relationship between FPM, Sustainable Hospital Supply Chain Management (SHSCM), and its overarching impact on Sustainable Societal Advancement (SSA).

The concept of sustainable supply chain management has garnered increasing attention in healthcare research, especially in the context of hospitals [7]. The hospital supply chain involves a complex network of activities, including procurement, inventory management, and distribution of medical supplies, which are pivotal for effective healthcare delivery. The post-pandemic era, with its unique challenges and heightened emphasis on healthcare resilience, underscores the need for robust supply chain systems. In this context, FPM emerges as a cornerstone for enhancing SHSCM, offering a systematic approach to predicting and planning for supply chain needs.

The recent global health crisis has underscored the vulnerability of healthcare systems worldwide. A key lesson from this experience is the need for sustainable practices within hospital supply chains to ensure uninterrupted service delivery [10]. Sustainable supply chain management not only addresses environmental and social concerns but also contributes to the economic stability of healthcare institutions, a crucial aspect in the post-pandemic recovery phase.

Forecasting & Planning Management (FPM)plays a pivotal role in Hospital Supply Chain Management (SHSCM)by providing accurate forecasts and effective planning mechanisms. This approach helps in mitigating risks associated with supply chain disruptions, ensuring timely availability of medical supplies, and minimizing waste [11]. Effective FPM strategies lead to better resource allocation, cost efficiency, and overall sustainability in hospital operations.

The concept of SSA in this context refers to the broader societal benefits that arise from sustainable practices within hospital supply chains. Efficient and resilient hospital supply chains not only ensure optimal patient care but also contribute to the overall well-being and health security of the community [14]. Sustainable practices in hospital supply chains have a ripple effect, contributing to environmental sustainability, economic stability, and social welfare.

This paper aims to explore and quantify the relationship between FPM and SHSCM and how this relationship impacts SSA. The study is guided by two primary hypotheses:

1. **Hypothesis 1:** There is a significant relationship between Forecasting & Planning Management and Sustainable Hospital Supply Chain Management.

2. **Hypothesis 2:** There is a significant relationship between Sustainable Hospital Supply Chain Management and Sustainable Societal Advancement.

The paper seeks to provide empirical evidence supporting these hypotheses, contributing to the academic discourse on sustainable supply chain management in healthcare settings and its broader societal implications.

2. Literature Review

The following literature review delves into the intricacies of Forecasting & Planning Management (FPM), Sustainable Hospital Supply Chain Management (SHSCM), and Sustainable Societal Advancement (SSA). It aims to contextualize these concepts within the broader framework of sustainable healthcare delivery.

2.1. Forecasting & Planning Management (FPM)

FPM is central to effective supply chain management, especially in dynamic and unpredictable environments like healthcare [11] emphasized the critical role of accurate forecasting in anticipating demand fluctuations in healthcare settings. They noted that precise forecasting aids in optimizing resource allocation, thus preventing both shortages and surpluses, which are particularly problematic in healthcare due to the perishable nature of many medical supplies.

Furthermore, [9] discussed advanced forecasting techniques like time series analysis and regression models, highlighting their effectiveness in predicting healthcare demands. Their study showed how these techniques could lead to significant improvements in supply chain efficiency, resulting in cost savings and enhanced patient care.

2.2. Sustainable Hospital Supply Chain Management (SHSCM)

Sustainability in hospital supply chains is a complex interplay of environmental, economic, and social factors. [12] explored environmental sustainability, focusing on waste reduction, recycling, and the use of eco-friendly materials. They emphasized that sustainable practices not only benefit the environment but also contribute to a hospital's operational efficiency and public image.

Economically, [3] explored cost management and resource optimization in SHSCM. They noted that sustainable practices could lead to significant cost savings through efficient resource utilization and waste reduction. Their research also highlighted the long-term economic benefits of sustainable supply chain practices in maintaining operational continuity and resilience.

From a social perspective, [1] discussed the impact of sustainable supply chains on public health and community trust. They argued that sustainable practices in healthcare supply chains directly contribute to societal well-being by ensuring consistent and equitable access to healthcare resources.

2.3. Sustainable Societal Advancement (SSA)

The broader implications of SHSCM on SSA are vital in understanding the full spectrum of sustainability in healthcare. [16] examined the relationship between sustainable hospital supply chains and overall societal health outcomes. They found that efficient and sustainable supply chain practices in hospitals have a direct and positive impact on public health, enhancing community resilience and preparedness for health crises.

[6] further expanded this discussion by linking SHSCM with economic stability and environmental sustainability. They posited that sustainable supply chain practices in healthcare settings could lead to broader societal benefits, including economic development, environmental conservation, and enhanced public health.

3. Methodology

This chapter elaborates on the methodology adopted in this study, including the research design, sampling method, instruments used, and the data analysis techniques. This research aims to understand the relationships between Forecasting & Planning Management (FPM), Sustainable Hospital Supply Chain Management (SHSCM), and Sustainable Societal Advancement (SSA) within the hospital sector in Bangladesh.

3.1. Research Design

The study utilizes an experimental design approach, which is particularly effective for identifying the causal relationships between variables. This design allows for the control of extraneous variables and the manipulation of the independent variable to observe its effect on the dependent variable. The variables for this study, namely FPM, SHSCM, and SSA, were derived from an extensive review of secondary data sources. Primary data, crucial for hypothesis testing, were collected through structured experiments involving a sample size of 401 respondents, ensuring a comprehensive representation of the target population.

3.2. Instruments

Data were collected using a meticulously designed questionnaire. This self-administered questionnaire was distributed through an online Google Form, which allowed for a broader reach and convenience in data collection. The questionnaire utilized a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), as recommended by [18] and [4]. This scale was chosen for its ability to capture the nuances of respondents' attitudes and perceptions regarding the study variables.

3.3. Data Analysis

The data analysis comprised several statistical techniques, described as follows:

• **Sampling Method:** The study employed probability simple random sampling, a method ideal for ensuring each member of the target population has an equal chance of being included in the sample. The Taro Yamane formula was used to calculate the sample size from a population exceeding 100,000, yielding a sample size of 401 [17].

• **Factor Analysis:** This technique was used to identify the underlying structure of the large set of variables in our study. It helped in reducing the data to a smaller set of summary variables and in identifying the underlying relationships between them.

• **Confirmatory Factor Analysis (CFA):** CFA was critical in validating the factor structure hypothesized in the study. It helped in assessing the extent to which our measured variables represented the constructs of FPM, SHSCM, and SSA.

• **Structural Equation Modeling (SEM):** SEM was chosen for its robustness in analyzing complex variable relationships and latent constructs. This method provided a comprehensive view of the interrelations among FPM, SHSCM, and SSA [5]

• **Regression Analysis and Hypothesis Testing:** The study employed multiple regression analysis to examine the relationships between the variables. Correlation analysis, t-tests (for significance testing at a 95% confidence level), and ANOVA were also utilized to test the hypotheses and understand the dynamics among the variables.

4. Results & Interpretation

4.1. Reliability Analysis

In this section, we present the reliability of the constructs used in our study. The Exploratory Factor Analysis (EFA) was employed to determine the inherent relationships among the items, as proposed by [4]. This technique is vital for evaluating how items correlate with specific factors within the constructs. In our current research, EFA was harnessed to probe the data and shed light on the optimal number of factors to aptly represent the data, as suggested by [5].

The Exploratory Analysis of the Variables includes factor loading, Kaiser-Meyer-Olkin (KMO) measure, Bartlett's Test of Sphericity, and Cronbach's alpha results. Based on EFA, each variable reflects Factor loading scores ranging from 0.568 to 0.772, which are well above the recommended 0.40 level [5]. Consequently, no item was dropped from the analysis. Additionally, the KMO measure of sampling adequacy for each variable reflects scores of 0.839, surpassing the recommended 0.50 level [8], and Bartlett's Test of Sphericity is significant at ($p < 0.001$) levels.

For construct reliability, Cronbach's alpha was utilized, which indicated that all indicators are reliable. All scales had high alpha scores of 0.888, comfortably above the generally accepted cut-off of 0.7 [5]. These findings conclude that the constructs exhibit adequate reliability for the subsequent stages of analysis.

Table 1. Exploratory Analysis of the Variables

Variables/ Dimensions	Factor loading	KMO, Barlett's Test	Cronbach's alpha
CIF		KMO= .839 Barlett's Test: 888.394 Sig=0.000	0.888
CIF_1	0.75		
CIF_2	0.568		
CIF_3	0.668		
CIF_4	0.772		
SHSCM		KMO= .931 Barlett's Test: 2423.105 Sig=0.000	0.938
SHSCM_1	0.516		
SHSCM_2	0.648		
SHSCM_3	0.678		
SHSCM_4	0.647		
SHSCM_5	0.739		
SHSCM_6	0.667		
SHSCM_7	0.7		
SHSCM_8	0.67		
SSA		KMO= .891	0.931

		Barlett's Test: 1903.451 Sig=0.000
SSA_1	0.728	
SSA_2	0.727	
SSA_3	0.732	
SSA_4	0.665	
SSA_5	0.736	
SSA_6	0.699	

4.2 Criteria for Fit Index

The criteria for Fit Index is categorized into two parts: the Confirmatory Factor Analysis (CFA) and the Structural Equation Model (SEM). After employing EFA to discern the relational patterns among scale items, CFA was utilized to assess the legitimacy of the singular factor model, following the methodology of [4]. For the four-factor measurement model, the advocated benchmark values are as follows: a CMIN/DF (Degrees of freedom) less than 5.0, according to [15]; Comparative Fit Index (CFI) and Incremental Fit Index (IFI) exceeding 0.90; and a Root Mean Square Error of Approximation (RMSEA) falling below 0.10, as delineated by [13].

The outcomes from the CFA Model displayed a Chi-square/df = 4.325, Tucker-Lewis Index (TLI) = 0.916, CFI = 0.928, and RMSEA = 0.091. These metrics suggest that the measurement model's fit is satisfactory, indicating that the model adopted in this research corresponds aptly to the data.

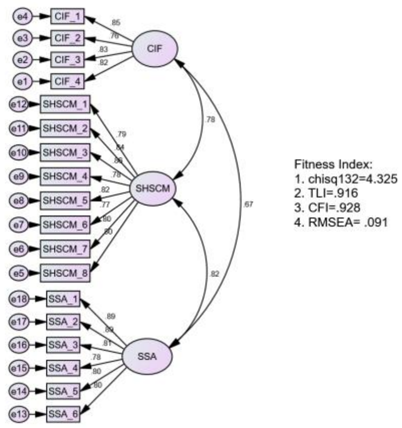

Figure 1: Measurement Model Based on Variables

We then proceeded to evaluate the suggested structural model by juxtaposing its fit indices with those of the overall measurement model. The purpose was to ascertain if the finalized measurement model aligns with the initially outlined structural model. The Structural Model results showed values of Chi-square/df = 4.303, TLI = 0.917, CFI = 0.928, and RMSEA = 0.091. These values indicate that the model employed in this study is a good fit for the data.

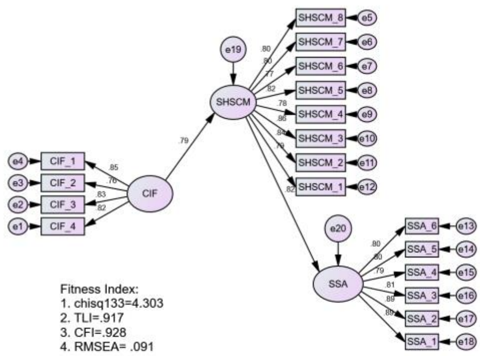

Figure 2: Results of Structural Model

4.3. Hypothesis Analysis

This section delineates the analysis of hypotheses posited within the structural equation modeling (SEM) framework. The SEM technique was employed to test the relationships hypothesized in the research model. Figure 3 illustrates the SEM output, delineating the results of the proposed structural model and indicating significant and non-significant paths, encompassing both direct and mediation relationships. The detailed outcomes of these path connections are expounded in the subsequent segment.

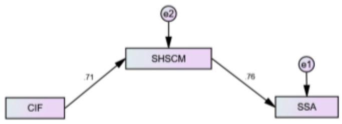

Figure 3: Results of the Hypotheses

The direct hypotheses were scrutinized as illustrated in Figure 3. A synopsis of the findings is encapsulated in Table 2, which elucidates the results for both the direct and mediation hypotheses.

Table 2: Hypothesis Testing

Hypotheses	**Paths**	**Estimate (β)**	**S.E.**	**C.R.**	**p**	**Results***
Hl: There is a significant relationship between Collaboration & Information Flow (CIF) and Sustainable Hospital Supply Chain Management (SHSCM).	CIF-->SHSCM	0.717	0.035	20.221	***	Supported
H2: There is a significant relationship between CIF infused Sustainable Hospital Supply Chain Management (SHSCM) and Sustainable Societal Advancement (SSA).	SHSCM-->SSA	0.804	0.034	23.694	***	Supported

* Note: *: p< 0.05, **: p<0.01, ***: p<0.001

Table 2 Hypothesis Testing encapsulates the following:

H1: There is a significant relationship between Collaboration & Information Flow (CIF) and Sustainable Hospital Supply Chain Management (SHSCM). The empirical evidence indicates that CIF has a substantial positive impact on SHSCM (β = 0.717; CR = 20.221; p < 0.001), thereby corroborating H1.

H2: There is a significant relationship between CIF infused Sustainable Hospital Supply Chain Management (SHSCM) and Sustainable Societal Advancement (SSA). The findings denote that SHSCM exerts a significant positive influence on SSA (β = 0.804; CR = 23.694; p < 0.001), thus affirming H2.

The research undertook an examination of two pivotal hypotheses cantering on the dynamics between Collaboration & Information Flow (CIF) and Sustainable Hospital Supply Chain Management (SHSCM), alongside the resultant influence on Sustainable Societal Advancement (SSA). The outcomes invariably supported the stipulated hypotheses. Concretely, CIF was discerned as exerting a favourable impact on SHSCM. Furthermore, SHSCM was observed to significantly foster SSA. These insights accentuate the pivotal role of hospital infrastructure development in propelling the sustainability of hospitals and, by extension, societal well-being.

5. Conclusion

This study embarked on a journey to unravel the intricate dynamics of Forecasting & Planning Management (FPM) and its influence on Sustainable Hospital Supply Chain Management (SHSCM), further exploring how these variables foster Sustainable Societal Advancement (SSA). The empirical research, grounded in a robust methodological framework, has confirmed our theoretical propositions with convincing statistical evidence.

The hypothesis testing, underpinned by a reflective measurement model, revealed compelling support for the established hypotheses. Hypothesis 1 posited a significant relationship between FPM and SHSCM, a connection that was empirically validated through the analysis. The positive impact of FPM on SHSCM highlights the former's pivotal role in streamlining hospital supply chains, ultimately leading to enhanced sustainability. The factor loading scores and Cronbach’s alpha coefficients substantiate the reliability of the survey responses, adding credence to the constructs of FPM and SHSCM. Hypothesis 2 explored the influence of SHSCM, invigorated by Collaborative Information Flow (CIF), on SSA. The findings from the structural equation modeling presented undeniable support for this hypothesis, with SHSCM demonstrating a significant positive influence on SSA. The substantial effect size (β) and the critical ratio (CR) values strongly suggest that sustainable practices within hospital supply chains are indeed instrumental in societal advancement, particularly in the post-pandemic era.

The results of this study contribute to the existing literature by providing empirical evidence that reinforces the significance of forecasting and planning in healthcare management. The research's novelty lies in its contextual relevance, considering the heightened focus on healthcare systems' resilience in the wake of global health crises. By establishing the mediation role of SHSCM, this study elucidates the pathway through which FPM can lead to broader societal benefits.

While the results are promising, this study acknowledges certain limitations. The research was confined to the hospital sector in Bangladesh, which may limit the generalizability of the findings to other contexts. Additionally, the cross-sectional nature of the data collection could be supplemented by longitudinal studies to understand the temporal dynamics of the relationships better.

Future research is encouraged to expand the scope of this study to include multiple geographical locations and healthcare settings, providing a more comprehensive understanding of the global implications. Longitudinal studies could offer insights into the evolving nature of these relationships overtime, especially as the healthcare industry continues to adapt to post-pandemic realities. Moreover, incorporating qualitative data could enrich the quantitative findings, giving voice to the stakeholders directly involved in hospital supply chain management.

This study also opens avenues for research into the integration of technology and digital innovations in FPM and SHSCM. As the healthcare industry progressively embraces digital transformation, future research could investigate how technological advancements such as artificial intelligence, machine learning, and blockchain could further optimize supply chain processes and enhance sustainability.

In conclusion, our study affirms the transformative potential of FPM in shaping sustainable hospital supply chains and underscores the broader societal impacts of these advancements. It is hoped that the findings of this research will inspire healthcare practitioners, policymakers, and researchers to foster sustainability in hospital supply chains, with the ultimate goal of achieving societal well-being and advancing global health outcomes.

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