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# Exploration of Influential Determinants for the Adoption of Business Intelligence System in the Textile and Apparel Industry

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**Abstract:** The textile and apparel industry is prone to digitization with business intelligence systems (BIS) and big data concepts to contribute the global sustainability. BIS, an impactful and leading technology, is being implemented in many industrial sectors but almost 80% of BIS fail to give expected results due to unknown reasons. Although many scholars put effort into finding the influential determinants for the BIS implementation, they neglect the BIS adoption context, especially in the textile and apparel industry. A purposive and proportionate choice of potential determinants in the context of adoption would contribute significantly to the success of BIS. Multi-stage research is employed to identify and prioritize the significant determinants. In the first stage, twenty-two semi-structured in-depth interviews are conducted with seventeen textile and apparel companies. Ten significant determinants emerged after thematic analysis of interview data. The determinants are sustainability, competitive pressure, market trends, compatibility, technology maturity, leadership commitment and support, satisfaction with existing systems, sustainable data quality and integrity, users' traits, and interpersonal communications that influence the adoption of BIS. In the second stage, the Best Worst Method (BWM) is used to calculate the weights for prioritizing the determinants based on experts' opinion. These weights are then used to evaluate and rank the determinants. The findings of this research show that the leadership commitment and support, sustainability, users' traits, and technology maturity, are the top-ranked determinants that influence the practitioners' choice to adopt the BIS in the textile and apparel industry. The results of this study enable the BIS stakeholders to holistically comprehend the significant determinants that would drive or impede the success of BIS projects in the sustainable textile and apparel industry.

**Keywords:** business intelligence system adoption; textile and apparel industry; determinants; best worst method

## 1. Introduction

An aggressive race towards market shares and international competition drives the practitioners of the textile and apparel industry to seek ways of achieving low manufacturing costs by outsourcing productions in developing countries. The governments of developing countries are inclined and encouraged by international bodies to increase economic growth before implementing any social

and environmental regulations [1]. Thus, the responsibility of industries becomes crucial in introducing industrial ecosystems with improved employment conditions and delivery of affordable environmentally friendly products. Therefore, the textile and apparel industry needs to invest in technologies which are helpful reducing energy use, emissions, and dependence on limited resources. In addition, increasing industrial and corporate competitiveness is directly linked to their sustainability strategies [2]. Consequently, the textile and apparel industry is employing advanced manufacturing technologies with business intelligence system (BIS) and big data concepts for achieving sustainability. The improvements can be observed in all sectors of the industry such as customer relationship management, marketing, supply chain management, logistics, retail, inventory management, distribution, and merchandising [3]. The efficient use of resources benefits not only socio-economic conditions but also affects the environment by reducing cotton growing, emissions, air pollution, water use, energy use and consumption of toxic chemicals for synthetic fiber processes, dyeing, and other industrial processes. The BIS technology is a well-known mature technology and still maintains its position among the top priority technologies of various decision-making authorities such as chief information officers, business owners, and managers [4–7]. This is because, with the help of BIS adoption they can be better aware of their business competitors, market conditions, opportunities, and challenges by integrating and analyzing large data sets [8–10].

BIS is a complete suite of tools, techniques, and procedures that helps decision-makers by (i) offering ad-hoc queries, reporting, forecasting, and analysis solutions; (ii) having advanced processing abilities for the exploration of new knowledge; and (iii) dealing with structured and unstructured data (big data) [4,7,11]. The drastic increase of the worldwide BIS market reveals its great importance that has attained remarkable attention from industry practitioners. In 2017, the BIS market had increased by 7.3% from the previous year with revenues up to $18.3, and by the end of 2020, it is expected to reach $22.8 billion [4,7,12]. By realizing the great benefits of the BIS, many enterprises, including in the textile and apparel industry, have invested considerable resources to leverage the true value of BIS but still the success rate of BI projects is very low. It is confirmed by the literature that almost 70–80% of BIS projects result in failure and are unable to provide the expected outcomes [4,6,7,13–15]. The market for BI technologies is projected to grow at a rapid pace in the coming years but still lingering in terms of success. The literature reveals that researchers have focused more on investigating the critical success factors (CSFs) for BIS implementation [16–23] but have neglected the BIS adoption context. This happens because many researchers believe that both terminologies are the same in meaning, but in practice, they are two different stages. The assessment and identification of significant determinants is crucial before integration and adoption of BIS in companies [6,24]. Researchers have stressed that adoption of BIS is greatly influenced by consideration of the appropriate determinants [6,23]. In extant literature, the scholars and practitioners are still addressing the strategic, management, operational, and tactical strategies contributing to the success of BIS [3,25]. This issue is addressed partially by many researchers [26], but investigation of BIS as a separate entity is scarce [7,17]. Previously, many studies have been led to investigate diverse variables which may influence the information systems adoption decision; factors such as technological characteristics, environmental characteristics, and organizational characteristics are predominant in innovation and BIS adoption at the organizational level but individual characteristics are neglected [4,7]. It is evident from the literature that the role of users cannot be taken out from the BIS adoption process at the organizational level [4,7].

In addition, until now, no study was found on the significant determinants for BIS adoption in the textile and apparel industry; overall, this important industry is neglected by scholarly investigation in this perspective [3,27–29]. Moreover, conventional determinants that are often claimed to ensure the successful adoption of BIS are starting to lose their influence in the presence of a high failure rate of BIS. Therefore, it becomes inevitable to explore and prioritize the new determinants which facilitate or hinder the process of BIS adoption in industries. The objective of this study is to fill the abovementioned gaps by identifying the significant determinants pertaining to BIS adoption in the textile and apparel industry using the proposed hybrid technology-organization-environment (TOE)

framework by Ahmad et al. [7], which includes the technological, organizational, environmental, and individual characteristics. This study is one of the first studies which attempt to identify and prioritize the significant determinants for BIS adoption in the textile and apparel industry by applying Best Worst Method (BWM). Hence, the literature is reviewed to design the research objectives. The study objectives are achieved by the following steps:

1. Exploring the significant determinants which drive decision-makers to adopt BIS in the textile and apparel industry;
2. Investigating the potential determinants that influence the adoption of BIS in the textile and apparel industry;
3. Ranking the determinants according to their significance by using BWM.

Exploring the topic of BIS through the lens of individual, technological, organizational, and environmental aspects provides a precise comprehension of BIS adoption that will contribute to the success of BIS projects with theoretical and practical implications. As a result, decision-making authorities encourage the integration and adoption of BIS for timely, accurate, and smart decisions, which leads to improved industrial productivity and results in high revenues by decreasing manpower and cost, correcting human errors, and delivering better supply chains, customer and logistic services [24]. The efficient resource use directly impacts not only the social and financial sustainability but also environmental sustainability. The rest of the paper is structured as follows: recent literature is analyzed in Section 2. Section 3 elaborates on the research sample and methodology. Section 4 presents the themes which emerged from the synthesized analysis of the first-round research and the results of the second-round research are also presented in this section. Section 5 consists of theoretical and managerial implications and conclusions; research limitations and future research guidelines are also discussed in this section.

## 2. Literature Review

### *2.1. Sustainability Issues of the Textile and Apparel Industry and Solutions with BIS Adoption*

The arrival of fast fashion has put pressure on the textile and apparel industry to harmonize the procedures with manufacturing, production plans, supply chain, inventories of outlets, and logistics warehouses [3]. This is because most textile and apparel products are seasonal in nature and consumers' tastes are changing frequently [30,31]. Therefore, a large amount of money can be lost by textile and fashion companies due to extravagant outdated stock [32]. In addition, the industry is considered generally to have a great environmental sustainability impact as well as causing concern regarding human rights due to hazardous chemical usage in order to grow cotton, dyeing textile products, and other value chain processes. A complete value chain of textile and apparel is illustrated in Figure 1. It is added to the ecosystem impact of this globalized consumption of water, energy, and land, and polluting the rivers and atmosphere to a great extent. Increasing textile wastes from low-quality frequent clothing replacement for short-term use is a critical issue of the textile and apparel industry. A detailed list of socio-economic and environmental issues related to the complete value chain of textile and apparel is presented in Table 1.


**Figure 1.** Textile and apparel value chain.

**Table 1.** Triple bottom line sustainability impacts of the value chain of the textile and apparel industry.

| Value Chain | Environmental Impact | Social Impact | Economic Impact |
|---|---|---|---|
| Cotton growing | Eco degradation by high water, fertilizer, and pesticide use [2] | Forced labor use in cultivation, financial instability due to cotton prices and chemical prices | Global cotton revenues were US$ 50 Billion in 2018 |
| Synthetic fibers | Toxic air pollutants, use of air emission, high energy use, high water use | Health and safety [1]. | In 2016, the revenue of global synthetic fibers was $88.5 billion |
| Fabric manufacturing | High energy use, water waste, air and water pollution, emissions, high toxic chemical use [1]. | Low wages, forced labor, and exposure to hazardous pollutant atmosphere [2] | Global textile mills market value of $748.1 billion in 2016 (WTO report 2018) |
| Garment production | Air emissions, pollutions, toxic chemical use, high energy and water waste | Women and child labor, health and safety issues | Global apparel exports were $494 billion in 2018 (WTO report 2019) |
| Logistics | Energy waste, emissions, air pollution [2] | Working conditions, wages | Financial issues, tracking, transportation |
| Retail network | Packaging, energy waste | Working conditions, wages, customer services | Inventory management |
| Disposal | Landfill, reuse | Positive impact (retail, laundry, logistics) | Generating small business, financial benefits |

Therefore, innovative efforts and procedures are crucial in searching for the best solutions for resolving the economic, environmental, and social issues within the fast-fashion-driven textile and apparel industry. Thus, precise and authentic information is required for decision-making in contemporary business scenarios. In today's digital world with multimedia, social media, and Industry 4.0 concepts, industries are generating data exponentially. This fast pace of data generation creates opportunities and challenges not only for individuals but also for industries. This great volume of data generation is called big data [33]. The use of big data for decision-making drives the industry experts to adopt the BIS [3]. A traditional BIS architecture is comprised of numerous components; for example, extract, transfer, and load (ETL), analytical tools, data warehouse, data marts, dashboards, score board, enterprise resource planning (ERP), supply chain management (SCM), human resource management (HRM), customer relationship management (CRM), online analytical processing (OLAP), and some other related components according to the organizational requirements. [34]. BIS architecture, including other elements, often consists of both structured and unstructured data. These data come from both internal and external sources and are transformed from raw transactional data into logical information, as shown in Figure 2.

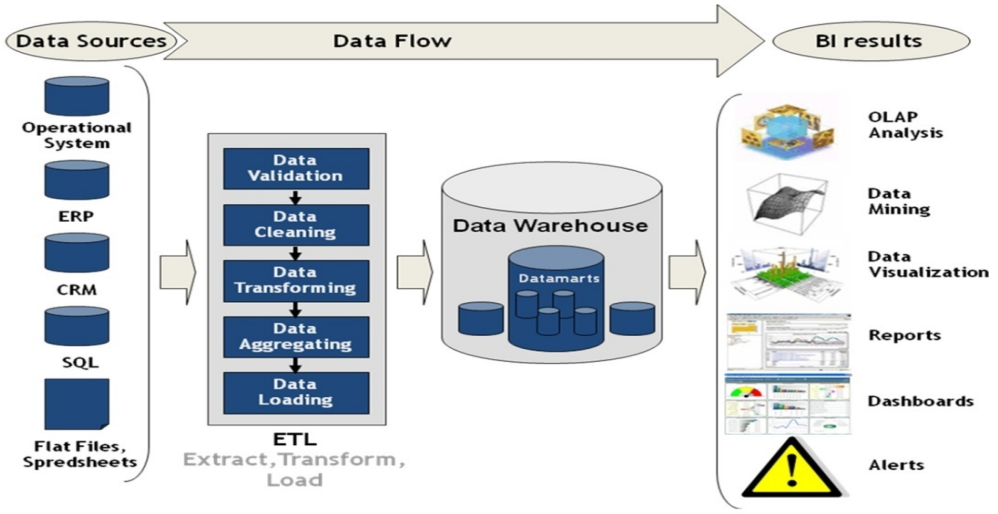


**Figure 2.** Business intelligence system (BIS) architecture with key components and functions.

By integrating BIS, a broad array of benefits is visible for the decision-making processes in different departments of the textile and apparel industry such as SCM, CRM, inventory control/management, manufacturing, production, distribution, marketing, and sales [3]. Some major advantages of BIS are as follows.

**Manufacturing:** BIS empower the industry executives to identify technical, environmental, and economic information relevant to various stages of manufacturing and production. They can reduce the unexpected costs in terms of value creation from product design to final product. BIS are helpful in reducing the production lead time and improving the quality of products by analysis of material consumption [35].

**Production Planning and Control:** BIS enable team members of production and control to analyze resources and shifts, inventory parts and supplies; assess quality issues and supplier issues; create sales plans and forecasts; and inform new product change or upgrade according to seasonal fluctuations. BIS can analyze, control and monitor production plans through key performance indicators (KPI) and metrics with automated alerts, whenever a critical situation arises, or a threshold has been crossed [35]. This information and reports can be shared using concise, clear gauges, charts, graphs, and displays to show results. Production planning optimization and production control become easier with BI tools. Instant decisions can be taken to solve the critical issues with full confidence before they are aggravated.

**Finance Management:** The analysis of financial data improves the financial reports with well-informed decision-making in the Data Warehouse (DW). BIS support budgeting through analytical models using well-established cost analysis methods: market analysis, horizontal and vertical analysis, and ratio analysis which compares provisions, risk evaluation expenses, and actual cost of promotional campaigns. OLAP analyses the increased cost that causes various perspectives [36]. The cost of marketing strategies, policy preparation, and risk evaluation can be calculated directly by using profitability analysis that contributes to the overall cost reduction in the textile and apparel industry.

**Sales/Distributions:** Inventory managers can manage efficiently stock shortage and return back orders using optimization analysis of physical warehouses with specific locations [36]. The inventory managers and merchandisers can discard the obsolete and unsold stock and enhance the demand and supply of textile and apparel products on time. BIS empowers decision-makers to aggregate and integrate various data sets from multiple information systems and sources that provide precise information about dynamic suppliers, customers, and the marketplace. The ultimate aim is to optimize the inventory management and supply chain management [7].

### 2.2. Scholarly Investigation of Significant Determinants for Business Intelligence System

Several researchers believed that the exploration of significant determinants is a pertinent aspect that attributes the success of BIS [7]. According to Yeoh et al. [6], organizations should be aware of and learn about important determinants in order to recognize the potential actions and areas which can guide them in the right direction as well as removing the obstacles in achieving desired targets that would lead to the ultimate success of the complex projects. Therefore, the current study provides an overview of the existing literature. Some well-known databases are identified for downloading papers (i.e., Web of Science, Taylor & Francis online, Google Scholar, Scopus, Springer, Emerald full text, IEEE/IET electronic library, Elsevier, ABI/INFORM, and EBSCO host). Papers searched by using the keywords "BIS adoption", "CSFs for BIS", "BIS adoption", and "sustainability issues in the textile and apparel industry". Only peer-reviewed studies in English were selected which were published from 2011 to 2020 to ensure coverage of the recent development about the topic. Ain et al. [4] conducted a systematic literature review recently that covered two decades of research related to BIS adoption, utilization, and success. The study findings revealed that most available research was related to the components of the BIS rather than considering them as a whole entity, and researchers focused more on the financial industry. Istrat et al. [29] introduced association rules for decision-making models in the textile industry, whereas Ahmad et al. [3] explored the value-creation process and reasons for BIS integration with advanced technologies in the textile and apparel industry. Ngai et al. [27] conducted a review study on intelligent systems and decision support systems in the textile and apparel industry but did not mention BIS for decision-making. In addition, Carvalho et al. [28] conducted an exploratory study for homemade BI solutions. Bhatiasevi et al. [37] elucidated the factors of BIS adoption that influence organizational performance. Recently, a large number of scholars have identified, examined, and explored various critical success factors (CSFs) for BIS in different sectors from various countries. An overview of published studies is presented in the following Table 2.

**Table 2.** Detail of published studies for business intelligence system research with regard to significant determinants.

| Authors | Factors for BIS Success | Countries | Purpose | Sector | Year |
|---|---|---|---|---|---|
| [21] | CSFs | Australia | Implementation | Oil, gas, water, railway | 2010 |
| [22] | Success determinants | Malaysia | Implementation | General | 2011 |
| [20] | Key success factors | Poland | Implementation | BIS vendors | 2011 |
| [38] | CSFs | Poland | Implementation | SME | 2012 |
| [39] | CSFs | South Africa | Improvement | Financial services | 2013 |
| [40] | Important Factors | Malaysia | Implementation | Public sector | 2015 |
| [19] | Factors | Malaysia | Readiness | Higher education | 2016 |
| [6] | Extending the CSFs | Australia | Implementation | Electricity, gas, water, railway | 2016 |
| [41] | Readiness Factors | Iran | Implementation | ICT, Education, | 2016 |
| [19] | Identifying CSFs | Iran | Implementation | Banking | 2017 |
| [15] | Key success factors | Colombia | Implementation | ICT, education | 2017 |
| [16] | Influential factors | South Africa | Usage | Organizations | 2017 |
| [17] | Determinants for BIS | International | Adoption stages | SME | 2018 |
| [18] | Evaluation of CSFs | Egypt | Implementation | Oil, Gas, and Agriculture | 2018 |
| [23] | Identified CSFs | Jordan | Implementation | Public service organization | 2019 |

CSFs = critical success factors.

However, previous studies have mostly addressed the CSFs for BIS implementation not for the adoption. Implementation and adoption are generally considered interchangeably, but the outcomes of both terminologies are entirely different. BIS is no more nascent; many organizations are using it for routine work. Therefore, it has passed the installation and implementation stages. The majority of studies are limited to CSFs for BIS implementation [6,15,17,19,21–23,38,40,41] and almost no scholarly

investigation is available about potential determinants for the BIS adoption context in recent decades, especially in the textile and apparel industry. Additionally, it is true that scholars have particularly investigated the CSFs for the BI implementation stage in organizations of various sectors and neglected the BIS adoption stage which may be different to implementation among different contexts. Some researchers claimed that the same determinants do not necessarily fit with the same contexts for all business types [38]. Therefore, it is very important to identify and select the determinants which fit a specific industry with the context of investigation [21,38]. Thus, in the light of the literature, there is ample space for investigation of significant determinants for BIS adoption, especially in the textile and apparel industry which contributes majorly in many developing and developed countries' economies. As a matter of fact, the textile and apparel industry is still suffering from the lack of investigation into dealing with BIS solutions and their complexity. The industry experts are also lagging in awareness about the significant determinants that influence BIS adoption. Therefore, this study contributes to the success of BIS by assisting industry practitioners for utilization of their efforts and resources optimally to handle the ambiguities and remove the failure risks and hurdles they are faced with in BIS adoption.

## 3. Research Methodology

The textile and apparel industry of Pakistan has been chosen for this study because the Pakistani textile and apparel industry has ample experience and tradition since the 19th century, as well as a good reputation around the world. In addition, Pakistan has a complete textile value chain as compared to many countries which only have a finished or primary base of the textile industry. Complete value chain of the textile industry like in the Pakistani industry is rare in the world [42]. A qualitative research approach was adopted for data collection in two stages, as shown in Figure 3. It was chosen because the exploratory nature of this method allows the researcher to obtain a deep understanding of a hidden phenomenon of interest that is based on human experience and behavior [43]. This approach uses language to obtain deeper insights into human phenomena of interest, in this case, the BIS adoption process [43,44]. In the first stage, data were collected by using semi-structured in-depth interviews. The interpretive nature of interviews enables the researcher to know the detailed descriptions of each process and allows to grasp the true essence of the phenomenon being studied [43,44]. Initially, a purposive sampling technique was applied for participant selection and a snowball sampling technique was used to find additional participants. Both techniques are helpful in identifying, selecting, and approaching experienced and knowledgeable interviewees [45]. Finally, potential experts were identified and selected by applying particular criteria, such as their positions in their organizations, having expertise and being familiar with BIS and their components. Designation levels were used as an indicator of decision-making status in a company with an owner manager, IT manager, and other executive posts which empower them to take decisions for implementation and adoption of any innovation in their organizations. A total of twenty-two interviews were conducted from seventeen textile and apparel companies. The number of cases was considered appropriate following various studies' recommendations that when repetition of ideas or patterns have emerged then the study is deemed to have reached theoretical saturation [46]. However, many researchers have suggested that a minimum number of cases of four or five is considered sufficient to gain theoretical generalizability [46,47] and do not allow more than fifteen cases for comfortable understanding of "local dynamics" [6]. Before final data collection, two pilot interviews were conducted with two industry experts to check the reliability of the questions and whether the questions were understandable. The interview duration was approximately from thirty-five minutes to eighty minutes. A thematic analysis framework was used to code and interpret the data. It was considered appropriate for this study due to its relevance and strength. The current study employed Braun and Clark's [48] six-phase thematic framework for data analysis, which consists of (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining themes, and (6) report writing. Further, biases related to sample and findings were dealt with in the secondary data, which enhanced the results' reliability for triangulation purposes [3]. In the second stage, fifteen experts were selected

by using a purposeful sampling strategy with people of different backgrounds such as experts from textile and apparel industry, software vendors, and academics. The total extracted determinants from the stage-one research were sent to the fifteen experts and they were requested to rank them according to their preference criteria as BEST or LEAST (see Appendix A).

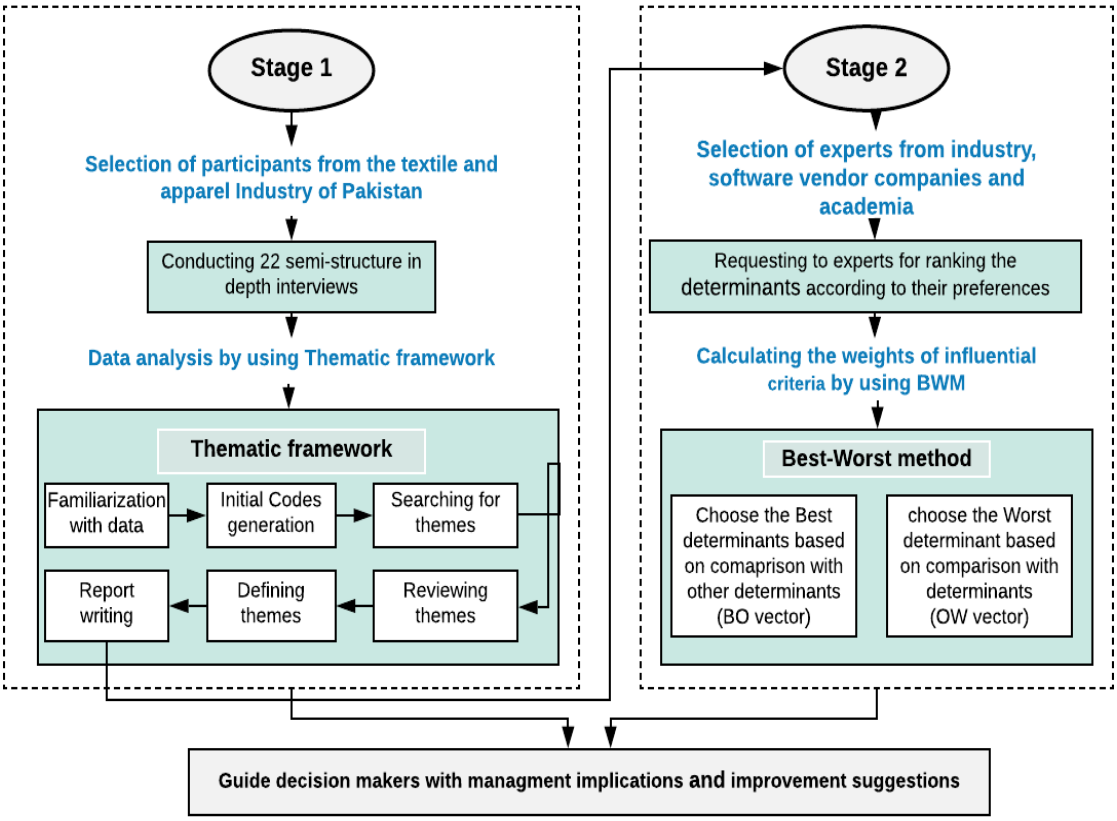


**Figure 3.** Multi-stage applied methodology.

*Weighting Method*

Best Worst Method (BWM) was adopted to rank the significant determinants. This method is considered a more appropriate method than other multi-criteria decision-making (MCDM) methods such as decision-making trial and evaluation laboratory (DEMATEL), analytic network process (ANP), and analytic hierarchy process (AHP). It is evident from the literature that most MCDM methods are determined by matrix-based comparison. Rezaei [49] discussed that decision-makers face inconsistency challenges during the calculation of comparisons among alternatives and criteria in pairs. All pairs should be revised in case of obtaining an inconsistent matrix. Subsequently, decision-makers waste a lot of time in checking consistency ratios again to obtain a consistent comparison matrix. Rezaei [49] emphasized that this issue is caused by the unstructured way of making comparisons. On the other hand, BWM provides robust consistent comparisons while using less data by formulating vector-based comparisons instead of matrices, as compared to other MCDM methods, and weights obtained from BWM are more reliable. It was designed to provide more consistent comparisons as compared to AHP and other matrix-based methods. Additionally, AHP uses fractional numbers and pairwise comparisons for obtaining weights but weights obtained from the BWM are vector-based which is the more robust and reliable type. [49]. For ranking the determinants, the participants were asked to use the numbers between 1–9 to show their preference of the most important determinant over the rest of the determinants, as well as choosing the least one among the other determinants, and choosing each

determinant against the least selected determinants; detail is provided in Appendix A. Rezaei [49] prescribed a leaner problem shown in Equation (1):

$$Minimize\ \xi$$

subject to

$$\left.\begin{array}{c} \left|W_B - W_j.a_{Bj}\right| \le \xi,\ for\ all\ j \\ \left|W_j - W_W.a_{jW}\right| \le \xi,\ for\ all\ j \\ \sum_j W_j = 1 \\ W_j \ge 0 for\ all\ j \end{array}\right\} \quad (1)$$

where $\xi$ denotes consistency ratio; $W_j$, $W_W$, and $W_B$ represent weights of $j_{th}$, worst, and best determinants; $a_{Bj}$ and $a_{jW}$ are the others-to-worst and best-to-others determinants then formulated and calculated in order to decide the best weight of each determinant.

## 4. Results and Discussions

Major themes emerged from the interpretation of the interview data in accordance with each objective. The main themes which emerged reveal how decision-makers reach their BIS adoption decision; further, there is an exploration of significant determinants that influence BIS adoption in the textile and apparel industry and a ranking of the determinants using BWM according to their significance and participants' preferences.

### *4.1. How Do Decision-Makers Reach Their Adoption Decisions for BIS in the Textile and Apparel Industry?*

For this objective, three main sub-themes emerged—competitive pressure, sustainability, and market trends—that led the decision-makers to adopt BIS in the industry.

#### 4.1.1. Competitive Pressure

Competitive pressure alludes to "the degree of stress that companies go through by peers within the industry"; Low et al. [50] stated that these competitive pressures lead high tech industries to adopt best approaches to enhance their productivity and improve their efficiency, thereby heading to competitive advantage [29]. Four informants shared that the *"Competitive environment motivates the managers/owners/CEO to adopt the intelligent technologies to share the competitive market and provoke them to invest more capital for innovations like BIS"*. Competitive advantage is another driver for BIS adoption, as five interviewees described it in this way; *"Competitive advantage has been achieved with well-informed decision-making processes, such as time efficiency, increases in profitability, and cost efficiency, which can be perceived as measurable and tangible aspects through adequate decision-making."*

The businesses that are operating in highly competitive environments are more likely to adopt innovative systems quickly to gain a competitive edge [50]. Therefore, it is justified to claim that high levels of competition put pressure on industry that will result in adopting BIS. For example, it is stated by five informants in the following comment; *"It is believed that businesses tend to adopt new systems due to competition as we have installed and adopted the BIS because of pressure exerted from external forces such as customers, suppliers, competitors, and industry partners. The textile and apparel companies run in a highly competitive environment, that is why it is important to shape the organizational actions and strategies accordingly."*

Competition has been considered as a potential determinant that can encourage the necessary adoption of innovations to maintain market position [51] and can promote speedy diffusion of innovation. The high degree of competition may guide high operational use of new systems [37]. The different competitive pressures from suppliers, peers, and consumers can influence the level and rate of diffusion of BIS. As a result, BIS adoption allows the industry to track development better and remain ahead of industry partners.

#### 4.1.2. Sustainability

Sustainability refers to the triple bottom line approach that includes economic, environmental, and social factors, informally known as profits, planet, and people. The significance of technological innovations in industrial adaptation of particular services and goods in the perspective of sustainability is well known [3]. Recently, it was shown by a survey that customers, especially those who belong to generation Z, have high expectations for eco-friendly products [2]. This directly connects competitiveness to sustainable industries such as the textile and apparel industry. It is stated by eleven interviewees in the following statement: *"This is the era of a consumer-driven economy. Therefore, the textile and apparel industry is facing pressure from eco-aware consumers who prefer to buy eco-friendly products and BIS is really helpful in this perspective with intelligent decision-making for resource management"* Other four participants who are retail managers in the industry said: *"Apparel products are facing more competition in the market than raw material or unstitched textile products. Thus, it is very hard to remain in the market, that is why we have adopted intelligent concepts such as BIS and big data, the ultimate objective is to maintain sustainability."*

It is verified by the literature that apparel companies are more inclined to adapt digitization than textile companies [2,3]. Other seven informants claimed: *We adopted the BIS because it is really helpful in evaluating the resources aligned with triple bottom line approaches (social, environment and finance). Our companies are benefiting in three contexts, by effective inventory control, supply chain management, customer relationship management, chemical consumption and many other areas that resulted in reduction of energy, water, waste and material consumption as well as improving the company revenues with fast customer insights and instant responses. BIS made it possible with informed, quick decision-making*. It is revealed by many studies that the textile and apparel industry is more fragile in terms of sustainability issues because of heavy reliance on fast fashion as compared to other manufacturing industries [3]. The characteristics of the textile and apparel industry are increasing toxic chemical usage, water and energy resources, frequent clothing replacement, and short-term use due to being seasonal in nature, which presents major sustainability challenges [1,52]. Therefore, intelligent decision-making with BIS adoption is crucial for the wise utilization of resources.

#### 4.1.3. Market Trends

Today, enterprises are believed to implement information systems (IS) and innovations in order to serve customers better compared to their competitors. According to Rouhani et al. [53], the enterprise uses new technologies for deeper analysis in order to better understand the marketplace and their customers. As we know, the expectation of market trends is always changing. For example, this is depicted in the following comment by five informants: *The trends are continuing to change because of up-to-date market structures and massive demands of customers/suppliers; thus, it is pertinent for industry stakeholders to cope with the market trend challenges, that is why we adopted the BIS*. Eventually, these determinants lead to competitive pressure between the enterprises in order to be on the top [54]. In order to identify trends in the markets, many enterprises adopt BIS or decision support systems to assist them in analyzing the trends; seven informants discussed it in this way: *The market trend of modern technologies pressurizes our companies to adopt advanced analytical technologies, because we feel that the BIS can enable us to respond to the evolving marketplace for company's success.* In this respect, the uniqueness of the BIS, both in its level of satisfying the potential adopters' needs and the compatibility level according to market trends, is important.

### *4.2. What Are Significant Determinants that Influence the Adoption of BIS in the Textile and Apparel Industry?*

The industry experts were asked what are the determinants which impact majorly the adoption of BIS in the textile and apparel industry. Seven sub-themes regarding technology maturity, compatibility, satisfaction with existing systems, leadership commitment and support, sustainable data quality and integrity, users' traits, and interpersonal communications emerged.

#### 4.2.1. Technology Maturity

Technology maturity defines the degree of maturity at which a technology is considered as mature for broad adoption. In IS literature, the technology maturity factor is investigated rarely as a pre-adoption stage of any innovation [55]. The technology maturity factor has always been studied by researchers from a developer side, in an attempt to qualify the development of technology. Most existing IS studies focus on the technology characteristics and ignore the impacts of technology development status on the diffusion stage. A technology must achieve an appropriate degree of maturity before it can come into practice widely [56]. Potential adopters perceive a technology as mature when they find easily available services and products with stable and reasonable prices in the market, with initial faults removed relating to the technology, and finally achieve the potential benefits of its adoption. The less mature perception of BIS creates a challenge for the adopters, as industry experts are generally hesitant to adopt until the innovation is converted to mature technology; for example, it is revealed by six informants that *"[i]n the context of risk, technology maturity is a critical factor for an adopter's endeavors and expected outcomes in case of an immature technology is adopted."* Other six informant explained thus: *"My company may be reluctant to adopt those technologies that are unable to get enough maturity and a level of stability in the market. My company always prefers to install technology with developed standards and protocols."* Eight informants stated: *"My company prefers to buy technology from well-reputed vendors. We have chosen Oracle for the BIS because it is a well-reputed software vendor company in Pakistan, and we will get vendor support easily in case of any problem."* As a new and emerging technology, the maturity status of BIS in any country in terms of price, easy availability, support, and repute may have significant influence on its adoption. Thus, it is one of the main hurdles for the widespread adoption of BIS [57]. The installation cost of BIS is still a critical barrier for its adoption in developing countries, which highlighted the maturity status of BIS.

#### 4.2.2. Compatibility

All participants agreed that the BIS should be compatible with existing systems, working skills, experience and should be relevant with all contexts of current working conditions of the modern-day executives. For example, it is revealed by the following comment: *"Compatibility is always a great concern. It seems, if the BIS is compatible with existing infrastructure in terms of technology, skills, believes, organizational culture and also flexible and scalable in design, then leadership is not only easily ready to invest in a costly BIS project but also adopt it well"* If BIS are incompatible with the firm's existing infrastructure, users' skills, and expertise, it influences negatively and hinders the adoption of innovation, as two informants discussed: *"—The additional training and systems integration issues can be generated in case of the BIS adoption. The BIS incompatibility with existing legacy systems and procedures is revealed as an important barrier that may influence the decision for the BIS adoption."* Regarding the adoption of BIS, Bhatiasevi et al. [37] explained that BIS should be compatible not only with existing technological infrastructure but also users' skills, beliefs and expertise, etc. The existing infrastructure matters in the context of an organization's adoption decision. [51].

This is depicted by eight interviewees' statement: *"Initially, we face major technological barriers in terms of integration of BI tools with legacy systems such as ERP, SCM, CRM and other 3rd party databases because of gadgets from different vendor companies with distinctive intelligent standards and communication protocols."* The industry requires to make minor changes and adjustments in the context of high compatibility. However, lack of compatibility may lead to low use and adoption of innovation [17,58]. Four informants said: *"The best practice in use of BIS is with multiple disconnected technology solutions, a company may have two dispersed systems or might have ten depending on company size and requirements, lack of integration between them influences negatively users' capability to utilize the data effectively that is generated by those systems"*. Thus, in the light of above statements, if the textile and apparel industry have appropriate infrastructure and are compatible for BIS adoption, then the chances for successful adoption of BIS are high because the industry does not need to invest an extra-large amount for resolving compatibility issues.

#### 4.2.3. Satisfaction with Existing Systems

Satisfaction with existing systems refers to the degree of satisfaction with existing systems usage in the context of BIS adoption. It is confirmed by the earlier studies that this factor is still facing a lack of research effort to develop a significant correlation between technological innovation in pre-adoption stage and satisfaction [59]. This insignificant research offers the opportunity for researchers to further discover the challenges and collaboration within the literature [59,60]. For instance, five informants explained: *"If the level of satisfaction with an existing system is low then it will lead to a performance deficiency, it will pressurize experts to search for new ways of performance improvement that leads to adopting emerging technologies like BIS"*. The performance gap may result in inability to meet the firm's new demands [58]. The above discussion shows that the higher the level of satisfaction with the existing technologies, the lower the chances of adopting a new technology [61]. Another informant made the following comment: *"If the top management is satisfied with existing expert systems such as ERP, SCM, HRM and CRM, they don't feel the need for new systems."*

Thus, the high satisfaction level with the existing systems will negatively affect the possibility of BIS adoption. This research factor, based on this reason, posits an equals' relationship with the BIS adoption context. This acts as a barrier and negatively influences the willingness for BIS adoption among non-adopters, but at the same time, it contributes as a driver and positively influences the willingness of BIS adoption among adopters. Three informants stated thus: *"We have adopted the BIS because we gained good experience by the usage of basic IS and strategic tools. As a result, the satisfaction with existing systems motivates us to adopt complex innovation such as BIS."* Thus, this determinant can be a barrier and driver at the same time for adopters and non-adopters of BIS.

#### 4.2.4. Leadership Commitment and Support

Leadership commitment and support refers to active engagement of leadership for providing long-term strategic vision of industry and it also provides significant resources for BIS implementation [37]. Seven informants made the following statement: *"Initially top management were reluctant to invest in costly BIS. It was really challenging to convince the leadership of the company."* The other two informants revealed that, *"we were already using strategic tools such as ERP, CRM, HRM and SCM for many years,* etc. *The company has all resources in terms of skills, expertise and technology infrastructure for the BIS, but we were unfortunate in getting top leadership support for the BIS adoption for a long time, but when we convinced them then the BIS project was fully supported and integrated successfully."* The given potentials of BIS can significantly influence the industry's business relationship and competitive position; the strong support and active involvement of leadership can improve the better direction and strategic vision by utilizing its power to inform about the importance of innovation [17].

Another informant described that *"[t]op leadership can affect the other personnel's behaviors inside the firm and even among its industry competitors."* Companies require to establish business-led coalitions to guide the development, adoption, and use of BS to enhance the efficiency and profits. Three interviewees stated that *"Return of Investment* (*ROI) on BIS comes from changing business operations and IT cannot bring change in business processes, it can be possible by the business side of the company and whether many company executives consider the BIS as an IT initiative, along these lines the BIS project can face lack of leadership"*. Committed leadership can motivate the entire firm to take part in BIS adoption for long-term strategic vision [62]. Three informants commented in this way: *"The most important determinant is project sponsorship in order to project failure or success. A BIS project is not different from any other IT project in this context—It is required to maintain the support and commitment for the projects sponsorship throughout the adoption and implementation process for a long time because circumstances can change at any time during the project and after the implementation."*

Other four participants with the designation of IT managers stated that *"[i] investments in staff training and rewards in terms of bonuses, promotion and pay increments guarantee the future continuity of the BIS adoption process. And it can be only possible by the top leaderships' involvement"*. In earlier studies, leadership support has been recognized continually as a critical factor for the diffusion and adoption of

large systems [63]. As a result, the individuals and companies need a consistent resource and funding allocation directly from senior management to support the BIS project. It can significantly affect the adoption and non-adoption of BIS.

#### 4.2.5. Sustainable Data Quality and Integrity

The textile and apparel industries continue to generate and ingest data at exponential rates due to the integration of advanced technologies [3]. As a result, the quality of data is at risk because malicious data leads to errors, waste of money and time, which results in inaccurate decision-making. Data integrity is inevitable in successful data driven decision-making. Seven interviewees explained it in following statement: *"Trust among IT executives and business executives builds because of data integrity when using data as a basis for critical decisions", the same can be said using "a single version of the truth" in making decisions or in the absence of data that's readily "actionable, reliable and accessible"*.

Three informants elaborated it in the following statement: *"The actual reality is what the system data are telling you. Therefore, without quality of information the BIS is nothing, this scenario discourages the executives to adopt the BIS for routine work."* Despite investing time, experience, and money, serious issues continue to exist even in conventional systems due to data reliability and quality challenges [64]. Another informant said: *"Poorly designed data queries provide confusing visualizations and flaws in underlying data sets that majorly contribute to BIS' inability to execute required insights."* Two informants described: "*the technology and business landscape changes rapidly due to explosive growth of data by the emerging trend of digitization, companies need not only establish a data governance framework but also keep data quality as a top priority for the successful adoption of BIS."* Thus, it is very important to deal with data quality and data integrity issues for the successful adoption of BIS. Companies need a scalable and streamlined approach for data quality. Three participants stated: *"consistent, reliable, accurate and trustworthy data can give you valuable business insights, achieve business targets, increase organizational value and mitigate regulatory risk."* Therefore, a complete set of quality rules among systems and sources must be ensured for sustainable data quality and integrity throughout the data supply chain for the successful BIS adoption.

#### 4.2.6. Users' Traits

Personal readiness and innovativeness are proved to be the most significant individual determinants for technology acceptance. Individuals' personal innovation motivates them to adopt the BIS for business processes which are innovative in use. It is found that no other scholar addresses the prominence of this determinant that might be pertinent in the perspective of successful BIS adoption at organizational level. Three informants stated that: *"the users' knowledge is a significant trait and by that, knowing the BIS". "Those who are aware of the benefits of using the BIS more easily ready to adopt this complex system."* On the other hand, it is more about a mindset shift that is a real obstacle. Six interviewees argued in this way: *"top management personnel are mostly mature in age and rigid in their practices, as a result, they rely more on their experiences and are inclined to make decisions based on instinct rather than factual based analytics. These actions hinder the adoption process of the BIS in the company."* Three other informants explained: *"the biggest hindrance to BIS adoption is the degree to which decision-makers understand how to extract meaning from analytical insights. It can be a barrier, but also can be an indicator for the BIS adoption in the company."* Constant change in fast fashion puts pressure on textile and apparel companies to respond quickly with new products to maintain their sustainability in the global market [3]. Another participant shared his views in this way: *"There's no persuasive consensus and internal vision or no compelling driver to create a sense of urgency within individuals that can help to realize how critical the adoption of BIS is for fast decision-making."* Personal traits such as awareness, knowledge, curiosity, motivation, vision skills, innovativeness, the internal desire for improvement and personal growth have an impact on how users find ways to use BIS in their routine work, which impacts the adoption of BIS.

#### 4.2.7. Interpersonal Communications

The success of any business strategy would not be guaranteed unless multiple departments of industry work together because everyone perceives success in different contexts. This scenario is elaborated by seven informants in the following statement: *"Collaboration between executives is crucial not only to leverage the full potential of the BIS but also ensure everyone's importance with responsibilities in industry."* Change management is another significant determinant that is considered as a major barrier for BIS adoption in organizations [3]. Four informants explained: *"People respond to changes better when they know the reasoning behind them through effective communication"*.

Two participants said: *"Each department is different, each sector of the textile and apparel industry has different requirements or issues, and there is dire need for establishing the appropriate interpersonal communication platform; it would be really helpful for decision-makers to take a holistic view of business for intelligent decision-making and it would lead to adopting the BIS successfully."* The responsibilities of company executives are different: some are analysts, some are strategic managers, and some are decision makers, while others are from finance, human resource management, supply chain management, or other visionaries. Therefore, interpersonal communication is a key factor for well-informed decision- making that would ultimately contribute to the success of BIS.

### *4.3. Ranking the Determinants According to Their Significance*

The results of the first-stage research were used to select the important criteria for the second-stage research. A total of ten determinants were used as the input for the second-round research. Determinants were categorized into four dimensions (e.g., individual, technological, organizational, and environmental). Ten extracted determinants were considered significant to influence the adoption of BIS in the textile and apparel industry. These determinants are competitive pressure; sustainability; market trends; compatibility; technology maturity; satisfaction with existing systems; leadership commitment and support; sustainable data quality and integrity; users' traits; and interpersonal communication (termed respectively as R1 to R10) in Table 3. By using BWM, the calculated weights of the selected items are also reported in Table 3. The required vector-based comparisons achieved a consistency ratio below the threshold limit of 0.1, validating the appropriateness of the estimated weights [65]. The analysis and threshold values are based upon the suggestion of experts from multiple sectors: textile and apparel industry, software vendor companies, and academia. It is revealed by the analysis of results that the most important factor is the top leadership commitment and support followed by sustainability, users' traits, and technology maturity. Satisfaction with existing systems and interpersonal communications are considered to be the least important. The opinions of experts are inconsistent in terms of given weights and importance of determinants. Industry experts believed that the role of sustainability determinant (R2: 0.366) followed by leadership commitment and support (R7: 0.151), users' traits (R9: 0145), and technology maturity (R4: 0.113) are very important for BIS adoption. On the other hand, software vendors considered the most important determinants for BIS adoption to be users' traits (R9: 0.156), technology maturity (R4: 0.168), sustainable data quality and integrity (R8:0.113), and academic scholars confirmed the value of top leadership commitment and support determinants (R7: 0.191), competitive pressure (R1: 0.158), compatibility (R5: 0.139) as the leading determinant of second and third priority. Finally, the synthesized analysis of results reveals that the leadership commitment and support, sustainability, users' traits, and technology maturity determinants are ranked high as the first, second, third, and fourth from each dimension (R7: 0.446; R2: 0.366; R9: 0.364, R4: 0.346). Graphical detail is also shown in Figure 4.

**Table 3.** Significant determinants with weights and rank for the adoption of BIS.

| No of Items | | Industry Experts | | Software Vendors | | Academic Scholars | | Synthesized | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Weight** | **Rank** | **Weight** | **Rank** | **Weight** | **Rank** | **Weight** | **Rank** |
| R1 | Competitive Pressure | 0.089 | 4 | 0.091 | 6 | 0.158 | 1 | 0.334 | 6 |
| R2 | Sustainability | 0.205 | 1 | 0.052 | 10 | 0.109 | 4 | 0.366 | 2 |
| R3 | Market trends | 0.049 | 9 | 0.072 | 7 | 0.054 | 9 | 0.175 | 9 |
| R4 | Technology Maturity | 0.113 | 6 | 0.168 | 1 | 0.065 | 8 | 0.346 | 4 |
| R5 | Compatibility | 0.078 | 7 | 0.121 | 3 | 0.139 | 3 | 0.338 | 5 |
| R6 | Satisfaction with existing systems | 0.021 | 10 | 0.060 | 9 | 0.020 | 10 | 0.101 | 10 |
| R7 | Leadership commitment and support | 0.151 | 2 | 0.104 | 5 | 0.191 | 2 | 0.446 | 1 |
| R8 | Sustainable data quality and integrity | 0.068 | 8 | 0.113 | 4 | 0.068 | 7 | 0.249 | 8 |
| R9 | Users' traits | 0.145 | 3 | 0.156 | 2 | 0.063 | 5 | 0.364 | 3 |
| R10 | Interpersonal communications | 0.095 | 5 | 0.061 | 8 | 0.096 | 6 | 0.252 | 7 |

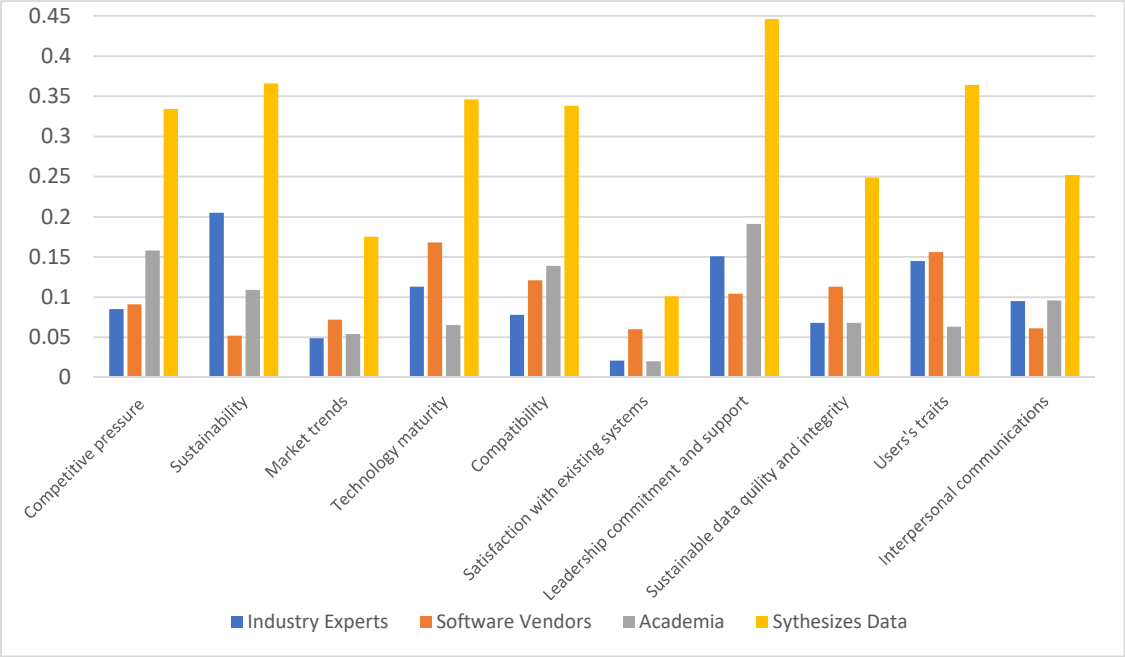


**Figure 4.** Priorities of determinants based on experts' and scholars' opinions.

## 5. Managerial and Theoretical Implications

In spite of many prospects from the BIS, the adoption rate of BIS in the textile and apparel industry is limited due to the number of significant determinants that influence this complex and costly innovation [3,28,29]. As Ahmad et al. [8] described, the failure to adopt BIS may be partially associated with gaps in policy makers' comprehension of the technology, organization, environment, and users' role. Therefore, before adopting BIS, the interference of each context should be assessed because some specific factors can be more significant than others, so they should be prioritized. Therefore, this study makes a great contribution in this perspective. It is observed that every determinant offers a specific contribution in every dimension. In order to enhance sustainability in the textile and apparel industry, a better understanding of each determinant is required to be considered for

the successful integration and adoption of BIS. The study results would solve the managerial and theoretical challenges with real field data. It is evident that complicated technological solutions without technical support and regular updates may quickly be eradicated from the market [66]. As a result, technology maturity and satisfaction with existing systems determinants have great importance in this respect. Software vendor companies and organizations should consider these two important determinants, especially in developing countries as they are facing economic issues for integrating the costly systems. Secondly, the leadership support and commitment and users' traits determinants have a significant relationship with all other determinants because the skilled, innovative decision-makers can leverage the true value from the BIS and other innovations considering the other two important determinants, interpersonal communications and sustainable data quality and integrity. Independent decision-making without involving other departments leads to poor-quality data that contribute to poor decision-making [64]. Sustainability is the ultimate objective to integrate any innovation which is highlighted first by the industry practitioners and scholars' choice of prioritizing the significant determinants for the BIS adoption. The study results in new emerging determinants which draws the researchers' attention to investigate and explore the relevant factors before proposing or refining any existing theory or model for innovation adoption that is generally neglected in the theoretical field [66]. Market trends, sustainability, and competitive pressures are considered drivers of BIS adoption in organizations and bring attention towards socio-economic and environmental benefits in practice. Industry practitioners emphasized that the sustainability determinant is a pertinent prerequisite for the adoption of any technology for those organizations which are operating in highly competitive environments. The reality is that sustainability factors embedded within decision-making provide many benefits to the textile and apparel industry because the major issue is to maintain sustainability. The current study results will encourage the adoption of BIS and other advanced manufacturing technologies that appear to herald a future in which the value chains of the textile and apparel industry are shorter, collaborative, and offer more sustainable benefits [3]. Well-informed decision-making mimics biological processes by analyzing data and resources are less wasteful in manufacturing and production which leads to significant socio-economic value creation from the environmental impact of industry procedures. In addition, the methodological choice of this study offered great value in the overall contribution by incorporating purposely the subjective ideologies and opinions of a diverse group of experts with different perspectives by exploring and ranking the potential determinants, using a qualitative approach and BWM. The range of ideologies and views on the application of BWM enriched the quality of the results. It enables to establish broadly shared insights of the BIS adoption concept, as opposed to those of a single concept. The findings of this research provide valuable insights for industry experts, software vendors, and researchers to remove the barriers and enhance their capabilities for a credible system adoption before entering the era of the fourth industrial revolution, "Industry 4.0". We believe that the proposed determinants offer a crucial comprehension of complex phenomena with new insights which would support not only industry practitioners in the industry but also researchers towards theory development.

*Research Limitations and Future Research Guidelines*

Exploratory research is commonly associated with some limitations. Firstly, a limited number of industries and responders are part of this study due to the nature of the qualitative research. Non-existing literature about the significant determinants that influence the BIS adoption in the textile and apparel industry guided us to deploy this research approach. Broad-based research is not possible when attempting to delve into the level of detail needed to explore the complex phenomenon [3]. This study is limited to only a small portion of the textile and apparel industry of Pakistan. Therefore, the results cannot be generalized. However, this research provides novel determinants and deep understanding using in-depth interviews, which is another significant limitation of this study. Secondly, business situations and infrastructure are different for every company, which might be affecting BIS adoption. Thirdly, the textile and apparel industry of developing countries

might be unable to implement the modern BI solutions due to high costs or unavailability of sufficient software vendors. Therefore, the vendors and researchers should present virtual technology solutions through cloud technology. Fourthly, all case companies are large in size and rich in terms of technology and organizational resources, whereas a large number of textile and apparel companies are small or medium in size, with limited resources. Thus, different determinants might influence BIS adoption in different dimensions. The application of BIS with emerging technologies is still nuanced in developing countries. More research is required to investigate the appropriate determinants in this respect. The various valuable opinions of professional experts and academics might be associated with this credible technology status, subject to the characteristics and personal opinions of respondents, and it is shown by the results of the second-stage research. Therefore, further longitudinal studies are required to evaluate and confirm these determinants in terms of their significance and relationships. Comparing the relationships, reliability, and interdependencies of potential determinants is pertinent to further elucidate the more novel dimensions and their evaluation through proposals for using other MCDM methods such as DEMATEL, Fuzzy sets, Fuzzy topsis, and ANP methods. Proposals of MCDM techniques provide promising validation covering a medium-to-large portion of the population with survey questionnaires [67]. The hidden projected relationships would be disclosed between adoption and four categories of significant determinants inside each category. Understanding the role of every dimension of BIS adoption is crucial not only for organizations, industry experts, software vendors, but also for individuals to overcome the social and environmental risks associated with the textile and apparel industry. Researchers should propose a technological solution with potential determinants, theories, models, and strategies for resolving the triple bottom line sustainability issues in the developing countries under the Industry 4.0 concepts.

## 6. Conclusions

The study objective was to explore and prioritize the determinants that influence BIS adoption in the textile and apparel industry. In fact, cases have previously been reported where large investments in various BI initiatives over lengthier periods resulted in little or no benefits for the organizations implementing them. Therefore, this exploratory study deployed a two-stage study to obtain deep understanding into recent interpretation of BIS adoption from the standpoint of scholars and practitioners together. In the first stage, data is collected by semi-structured in-depth interviews which were conducted with twenty-two executives possessing authoritative designations with decision-making powers. A comprehensive set of determinants were explored that would influence the decision-making process for industry experts and planners involved in this process. A total of ten significant determinants emerged after the thematic analysis of interview data. The significant determinants are sustainability, competitive pressure, market trends, compatibility, technology maturity, leadership commitment and support, satisfaction with existing systems, sustainable data quality and integrity, users' traits, and interpersonal communications; they influence the adoption of BIS in the textile and apparel industry. Explored determinants are divided into four dimensions, technological, organizational, environmental, and individual according to the proposed hybrid TOE framework from Ahmad et al. [7]. Many scholars believed the words implementation and adoption are used interchangeably but the outcomes of this study contradict this perception. In the literature, most studies are about BIS implementation; this is one of the first efforts to explore the adoption determinants that influence the success or failure of the BIS projects. Additionally, BWM has been used for the first time to prioritize the determinants for the BIS adoption, so it provided evidence-based applicability by a valid MCDM method. In the second round of research, the explored determinants were ranked by using weights based on experts' opinions from different backgrounds, such as industry practitioners, software vendors, and academic scholars. The weights were calculated by applying the most recent developed BWM. It is shown by the analysis of the second stage research data that sustainability, leadership commitment and support, sustainable data quality and integrity, technology maturity, and users' traits are the most important determinants while satisfaction with existing systems and

interpersonal communications are the least important determinants for the adoption of BIS. Most new determinants emerged from the synthesized analysis of the interviews data such as sustainability, market trends, technology maturity, satisfaction with existing systems, users' traits and interpersonal communications regarding BIS adoption at the organizational level. The study findings may guide the researchers to conduct more qualitative, quantitative, and mixed-methods research to reveal the dependencies and inter-relationships among determinants by using different MCDM. The results of this multistage research can facilitate the decision-makers to plan the policies and procedures to leverage the true benefits by the successful adoption of BIS that would resolve the triple bottom line sustainability challenges in an eco-aware environment. It may also serve to enhance the practitioners and scholars' understanding to perform effectively and efficiently within theoretical and practical fields.

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## Appendix A. The Second-Stage Research Items

1. It is requested that the respondents select of the MOST IMPORTANT determinant from the given determinants that influence the BIS adoption (Table A1) and put it in the top most second cell of the right column. Please select the numbers from 1 to 9 to show the preferred criteria. Now use a number between 1 and 9 to show your preference for the MOST IMPORTANT determinant over the other criteria. In this way fill rest of the cells with preferred criteiria.

**Table A1.** Ranking with respect to most important determinant.

| The MOST IMPORTANT Determinant | Rank |
|---|---|
| Competitive Pressure | |
| Sustainability | |
| Market trends | |
| Technology Maturity | |
| Compatibility | |
| Satisfaction with existing system | |
| Leadership commitment and support | |
| Sustainable data quality and integrity | |
| Users' traits | |
| Interpersonal communications | |

1 = This criterion has equal preference with the MOST IMPORTANT determinant; 3 = preferred moderately; 5 = preferred strongly; 7 = preferred very strongly; 9 = extremely preferred.

2. It is requested to select the LEAST IMPORTANT determinants from the given 10 determinants that influence the adoption of BIS in industry (Table A2), and put it in the top second cell of the right column using the numbers from 1 to 9 to show the preferred criteria over the LEAST IMPORTANT criterion.

**Table A2.** Ranking with respect to the least important determinant.

| The LEAST IMPORTANT Determinant | Rank |
|---|---|
| Competitive Pressure | |
| Sustainability | |
| Market trends | |
| Technology Maturity | |
| Compatibility | |
| Satisfaction with existing system | |
| Leadership commitment and support | |
| Sustainable data quality and integrity | |
| Users' traits | |
| Interpersonal communications | |

(1 = the LEAST IMPORTANT determinant is equally preferred with this criterion; 3 = preferred moderately; 5 = preferred strongly; 7 = very strongly preferred; 9 = extremely preferred).

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