

A model of acceptance factors for business intelligence in manufacturing using theoretical models

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ABSTRACT

Manufacturing organizations implemented Business Intelligence (BI) due to many advantages offered by it. The lack of research on the acceptance of BI in manufacturing motivates the initiative in this study to have an understanding of the factors that influence the acceptance of BI in manufacturing sector. Therefore, the research proposes a model which indicates the acceptance factors of BI in manufacturing. An integrated model consisting of underlying models of Technology Acceptance Model (TAM), Expectation Confirmation Theory (ECT) and Task-Technology Fit (TTF) will be developed. The new model will formulate 19 hypotheses and 11 factors contributing to the continuance and acceptance of BI. The model will be tested using quantitative and qualitative survey conducted to Malaysian manufacturing companies and validated using Structural Equation Modelling (SEM) to investigate the causal and mediating relationships between the factors. The expected result is hoping to suggest that selected factors in the model are positively related towards the acceptance of BI in manufacturing. The results are also hoping to guide future initiatives by industrial practitioners to develop and distribute BI to the manufacturing market.

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1. INTRODUCTION

Business Intelligence (BI) is claimed to overcome manufacturing problems as it is widely used in the manufacturing industry with the advantage of transforming plenty of data into information and knowledge [1]. With BI, information that came from tedious reports and spreadsheets are able to be turned into a single view and in real-time operational data [1]. The study by Shollo (2013) also claimed that the information presented and consolidated using BI is able to foresee the future trend, thus would enable the organization to plan its operation effectively. The future data that is able to be forecasted are the monthly delivery requirements and the operational data that is real-time and in a single view.

The top management team from the large number of firms support and provide resources for implementing new technologies that cover many business processes in the firms such as process management, IT governance, regulatory compliance and many others [2]. This implementation will help them to achieve their business goals, make decisions and allocate resources. Thus, investing on the BI systems are one of the initiatives taken by more and more firms now. They are useful in generating information to analyze data extensively, eventually facilitating the firms to decide on proper actions to be taken [3].

This makes the BI trend becomes more competitive and responsive to business demands and to improve operational performances.

2. BUSINESS INTELLIGENCE IN MANUFACTURING

Yusof et al. (2013) defined BI as information obtained to aid the decision making process of a business segment through the transformation of the existing data [4]. The information is presented visually to give the intended users a clear guidance for a smooth decision making process and most importantly, an accurate and fairly fast decision. Numerous organizations in the world have adopted BI due to its capability to make effective and well-timed business decisions to increase profit [5]. BI usage in manufacturing has shown an uplifting trend. The implementation of BI in manufacturing industries has helped many manufacturing organizations improved their business processes [6]. BI implementation in the manufacturing industry has given many advantages such as achievement of managerial aims, providing faster fact-based decision making that improves business processes, promoting teamwork, and even identifying potential profitable customers [7]. There are many other advantages of BI offered across manufacturing and other sectors as well [7].

3. USER ACCEPTANCE OF BUSINESS INTELLIGENCE SYSTEM IN MANUFACTURING

Although research has been carried out on BI system's acceptance and adoption on small enterprises (SME) [8], [9], almost none research has been done on the acceptance of BI by manufacturing. This lack of research can be attributed to the fact that BI might be rarely used or accepted by manufacturing organisations due to knowledge and resource constraints. Therefore, an understanding of the factors that influence the acceptance of BI in manufacturing sector will help researchers and industry to develop and distribute BI to the manufacturing market. Primarily, the investigations described factors that are significant leading to use, acceptance, and adoption of a technology, subsequently leading to usability.

In view of this, the research proposes a model which indicates the acceptance of BI for manufacturing order management. Many organisations have neglected the importance of soft factors. This may influence the organizational performance [10]. Hence, the purpose of this research is also to examine the impact of acceptance factors on BI system in manufacturing industries. A novel model will be proposed in this research.

4. THE UNDERLYING MODELS

Numerous mature models and theories have been utilized by past researchers in justifying continuance intention of technology encompassing, Unified Theory of Acceptance and Usage of Technology (UTAUT) by Venkatesh *et al.* (2003) [11], Theory Acceptance Model (TAM) by Davis *et al.* (1989) [12], Theory of Reasoned Action (TRA) by Ajzen & Fishbein (1973) [13], Expectation – Confirmation Theory (ECT) by Oliver (1980) [14], Theory of Planned Behavior (TPB) by Ajzen (1991) [15] and Task-Technology Fit by Goodhue and Thompson (1995) [16]. Due to varying acceptance factors, identified across a number of information system research domains that focus on TAM, ECT and TTF, there is no cohesive list of BI based acceptance factors available. The aim of this study is to bridge the gap in fragmented views on BI acceptance, and explore the subject of BI acceptance by manufacturing sector.

5. A BRIEF EXPLANATION OF TAM, ECT AND TTF

These models (TAM, ECT and TTF) are selected attributed to their explanatory capability in justifying variances of usability in comparison to existing technology acceptance theories and models, which could lead in producing an effective model for technology acceptance concerning online platforms [14, 17]. ECT model is useful in achieving the success of implementing information system among the users. This is because the satisfaction of users in learning the system is useful in measuring the factor of continuance intention [18]. TAM is useful in assessing general activity-based systems that could explain technology acceptance effectively [19]. While TTF is useful in evaluating the degree that a technology will assist individuals based on their task requirements, with the functions of the technology incorporated in it [20]. The technology functions must be acceptable by the users in performing their tasks.

Technology Acceptance Model (TAM) pioneered by Davis *et al.* (1989) has been the most extensively utilized, and the earliest model in investigating technology acceptance. It was built using Theory of Reasoned Action (TRA) model. TRA justifies and envisages behavioral actions of users in certain environments. It theorizes the behavioral actions of an individual which are influenced by the intent on

carrying them out. This conjecture is applicable to TAM as well. TAM justifies the influence of predictors on the use of users' intention to utilize a technology-equipped system which predicts either rejection or acceptance of the technology via real behavioral actions. The goal of TAM is to justify the factors leading to acceptance or rejection of the technological system. In the work of Chooprayoon *et al.* (2007), TAM was utilized in their investigation to justify external factors that impact the personal belief of individuals including intentions and attitudes [21]. Figure 1 depicts the TAM model.

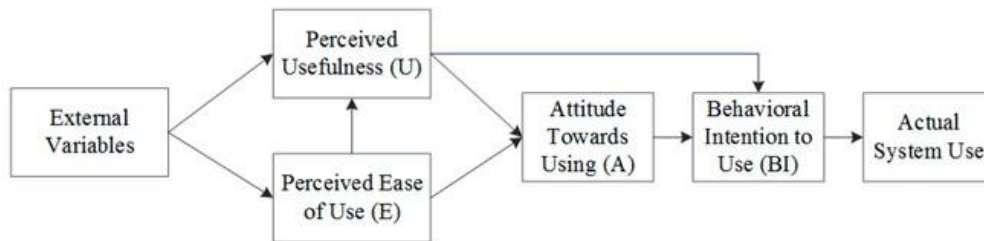


Figure 1. Theoretical acceptance model (TAM) [12]

In 1980, researchers developed ECT in marketing domain, which was designed in justifying repurchasing intention and satisfaction of customers [14]. ECT model is shown in Figure 2. It has been extended widely in studies encompassing policy studies, social psychology, and sociology. Under ECT, Cheung *et al.* (2005) postulated that satisfaction in purchasing is shaped by perceived performance and expectation [22]. As aforementioned, marketing domain is focused by ECT [23, 24, 14], concerning customers' behavioral actions after performing merchandise transaction, in addition to their satisfaction surrounding services provided. Recently, ECT has been utilized in information system's continuance intention studies. ECT was brought into information system studies by Bhattacharjee (2001), due to similarity exhibited in information system continuance when compared with repurchasing products in business transactions is shown in Figure 3 [25].

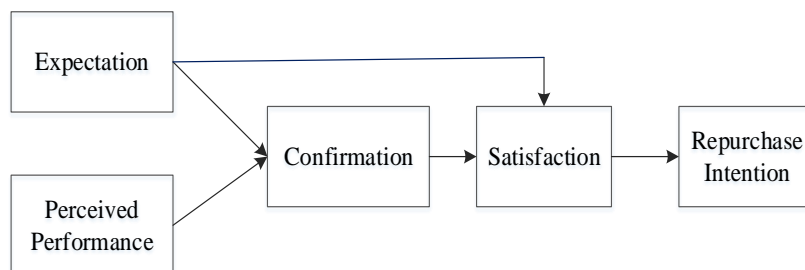


Figure 2. Expectation–confirmation theory (ECT) [14]

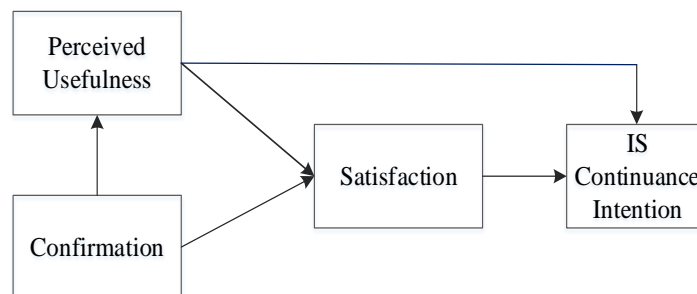


Figure 3. IS continuance model [25]

Figure 4 shows the general model of TTF. Formulated by Goodhue & Thompson (1995), the theory implies that the performance benefits will be gained when the features of technology match with the requirements of the tasks that must be performed [16], [26]. The performance benefits can be attained either by the individual including higher levels such as group, team and organization. This theory seems to suit the BI acceptance in manufacturing as the employees in manufacturing organizations are in need of a computer tool to assist them to execute their job tasks faster [27]. The study conducted by Yusof (2018) also indicated that the nature of manufacturing sector is in fast and dynamic environment, where a fast and quick decision is needed by the managers that can be obtained through fast execution of job tasks [2].

The application of elements of the TTF model can be seen in many research areas since 1995. Various domains have tested the elements in the TTF like transport and insurance, software development, managerial decision-making, e-learning, university library and social networking platform [28]. The usage of TTF in evaluating BI acceptance in manufacturing is yet to be investigated. One of the elements in TTF that is seen suitable to adapt in evaluating user acceptance towards BI is the tool functionality that is incorporated in the BI system. The tool function that exists in BI system is visual graphical display of data [4]. This is in line with a study conducted by Noor *et al.* 2017 who stated that to increase users' understanding towards a computer system, it is essential to include graphics in it [29]. The study also implied that the visual quality aspects of a computer system is very important. By adding the strengths of TTF with TAM and ECT will produce an integrated model that is useful for this study.

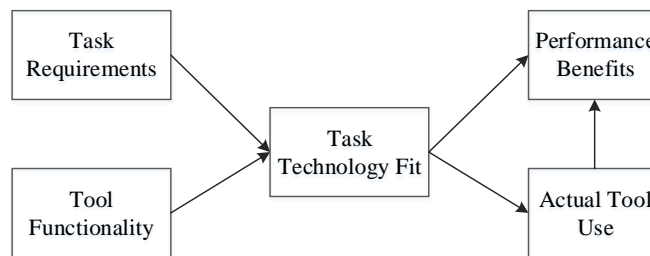


Figure 4. Task technology fit (TTF) general model [16]

6. THE PROPOSED MODEL

With the theoretical background of the TAM, ECT and TTF models, BI system and research motivation being discussed, this research proposes a model that recognizes various factors that attributed to the acceptance of BI system. The TAM, ECT and TTF models are incorporated into the proposed model. The model presumed that the acceptance of BI system is influenced by the continuance intention of users. Figure 5 shows the proposed model with the relationships among the constructs.

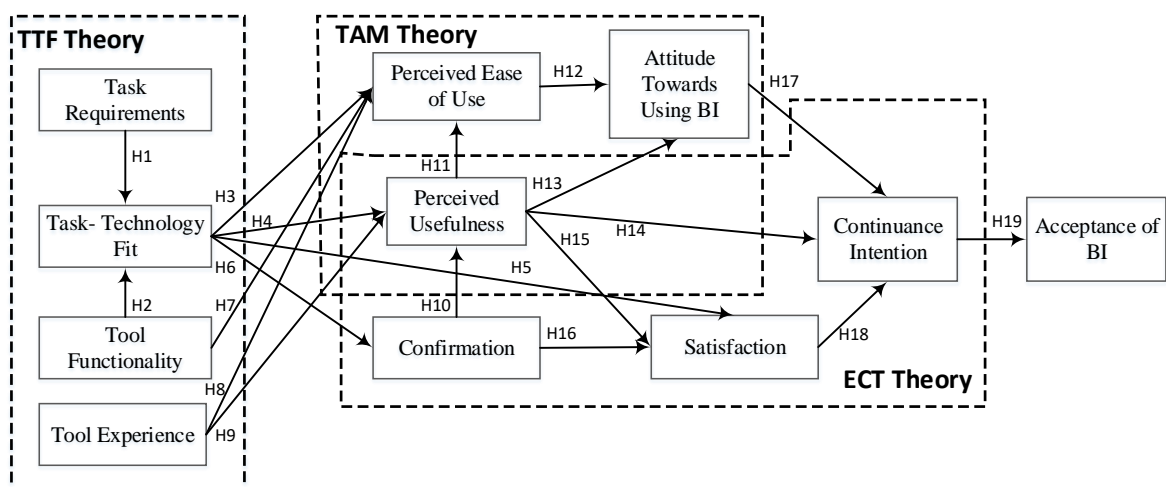


Figure 5. The proposed model

Based on the proposed model, the following hypotheses will be formulated:

- H1: There is a positive impact between task requirements and task-technology fit of BI
- H2: There is a positive impact between tool functionality and task-technology fit of BI
- H3: There is a positive impact between task-technology fit and perceived ease of use of BI
- H4: There is a positive impact between task-technology fit and perceived usefulness of BI
- H5: There is a positive impact between task-technology fit and satisfaction of BI
- H6: There is a positive impact between task-technology fit and confirmation of BI
- H7: There is a positive impact between tool functionality and perceived ease of use of BI
- H8: There is a positive impact between tool experience and perceived ease of use of BI
- H9: There is a positive impact between tool experience and perceived usefulness of BI
- H10: There is a positive impact between confirmation and perceived usefulness of BI
- H11: There is a positive impact between perceived usefulness and perceived ease of use of BI
- H12: There is a positive impact between perceived ease of use and attitude towards using BI
- H13: There is a positive impact between perceived usefulness and attitude towards using BI
- H14: There is a positive impact between perceived usefulness and continuance intention to use BI
- H15: There is a positive impact between perceived usefulness and satisfaction of BI
- H16: There is a positive impact between confirmation and satisfaction of BI
- H17: There is a positive impact between attitude toward using BI and continuance intention to use BI
- H18: There is a positive impact between satisfaction and continuance intention to use BI
- H19: There is a positive impact between continuance intention to use BI and acceptance of BI

7. RESEARCH METHOD

In order to test the hypotheses formulated in the previous section, a quantitative survey will be conducted that is targeting the workers population in manufacturing sector, particularly the Malaysian manufacturing companies. Subsequent sections will discuss about the questionnaire development, data collection and data analysis.

7.1. Questionnaire Development

To test the theoretical model, there will be three sections in the questionnaire. The first section will use to collect the respondents' personal demographic data in the manufacturing company. The second section includes the usage of BI in the manufacturing company, while the third section consists of questions that measures the constructs in the research model.

7.2. Data Collection

The data collection phase is very crucial as it gathers fresh and primary information that contributes to greater understanding towards the research [30]. Knowledge proliferation can be obtained upon getting the feedback from the respondents. The target participants of this study will be the workers in Malaysian manufacturing companies who have experience in using BI system. The list of potential manufacturing companies exist in Malaysia will be studied. Subsequently, questionnaires will be distributed to the participants and their feedback will be gathered. The targetted sample size will be around 100 to 300 respondents. This is aligned with the study by many researchers who suggested that if we are to employ parametric tests, 30 to 500 subjects is the necessary sample size. However, the numbers are not applicable for non-parametric tests [31, 32]. The 30-500 subjects are also applicable for the random sampling techniques in selecting a sample.

7.3. Data Analysis

Initial stage of data analysis will involve data screening as we need to remove the unusable data including outliers. The data screening process will be performed by using IBM Statistic Version 21. The next stage will follow the data analysis done by Wu & Chen (2016) that was adopted from Anderson & Gerbing (1988) [33, 34]. Firstly, the fitness and the construct validity of the proposed model will be examined. The process will involve assessing reliability, convergent validity and discriminant validity. Secondly, the structural model will be scrutinized to study the relationships between the theoretical constructs, in terms of their strength and direction. Here, the Structural Equation Modeling (SEM) will be used together with IBM SPSS AMOS Version 23.

8. EXPECTED RESULTS

The data from the quantitative survey among the workers in manufacturing companies in Malaysia who use BI will be collected and analyzed. The data analysis is expected to provide a strong support and ground for all the 19 hypotheses formulated from the proposed model. The constructs generated are hoping to explain the factors influencing the users' attitude and acceptance towards using BI. The identified factors are expected to result in positive relationships among each other in accordance with the hypotheses formulated. Finally, the overall results are expected to show that integrating the TAM, ECT and TTF models can determine the factors leading to the continuance usage of BI that leads to the acceptance of using BI in manufacturing.

9. CONCLUSION

The lack of research on the acceptance of BI in manufacturing motivates the research to study on the understanding of the factors that influence the acceptance of BI in manufacturing sector. A new model that integrates the TAM, ECT and TTF for BI system's acceptance in manufacturing industry is developed. The idea in the model presumed that based on the constructs, several factors will contribute to the continuance usage of BI system that leads to the user acceptance of BI. To test the model, a quantitative survey will be conducted to target respondents through questionnaires that contain measurable variables for respective constructs. The next move will embark on the distribution of questionnaires to targeted respondents who are the staffs of the manufacturing companies that use BI. Analysis will be done to the data collected, as stated in section 6.3 Data Analysis. The model will be tested using SEM. The results of the analysis is hoping to suggest that selected factors in the model are positively related towards the continuance usability of BI system in manufacturing which eventually leads to the acceptance of BI system.



The contribution of the model proposed in this study does not only aim to provide valuable insights towards the existing literatures but also to assist researchers to have a better view points on users' attitude and behavior in using BI system. Other than that, the factors for the acceptance of BI are hoping to guide future initiatives by industrial practitioners to develop and distribute BI to the manufacturing market.




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