Analytical Framework for Studying the Effects of User Participation in DSS Development

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Abstract- **Decision Support Systems (DSS) are mainly used for assisting users in analysis and decision-making. User participation is considered to be critical during the process of system development that typically consists of planning, analysis, design and implementation. Success or failure of implementation depends upon the activities carried-out in development phases. The activeness of user's participation during development phases is a contributing factor towards the success of DSS. We have studied participation of users during development phases at different levels. In addition, impact of user's participation on system implementation has also been measured via a scenario. Our work highlights importance of user participation during DSS development and considered it as a necessary element.**

I. INTRODUCTION

Numerous definitions for DSS exist. In general, a decision support system is an inter-active system that provides the user with easy access to decision models and data in order to support semi-structured and unstructured decision-making tasks [1]. DSS can be defined as a system used by decision-makers. These systems manage the complexity, competence and timeliness in decision making [2].

User participation is a significant factor in the system success. A lot of research has been done by different researchers in this regard. Previously user involvement was represented by the activities, actions and behaviors carried-out by the users in the process of system development. However, the later research found that it is user participation not user involvement [3]. User involvement is state of mind reflecting the importance and personal relevance of a system to the user [3]. Throughout this article the terms user involvement and user participation are interchangeably used.

The success or failure of DSS system depends upon various dimensions such as system quality, information quality, use, user satisfaction, individual impact and organizational impact [4]. Most often expected benefits from DSS system implementation are hard to realize [5]. Most of the researchers argued that DSS adoption depends directly upon the implementation phase and difficulties may arise if it lacks in this area of development [6]. However, apart from the gained popularity, success of DSS depends on many factors. We have seen many decision-support tools failed while they dealt with complex and unstructured problems [7]. Nevertheless, authors in [5] identified that the role of a user/actor serves as a major factor for system success. In particular, we found that user participation is a key factor that determines the success or failure of a DSS system. During development phases, active user participation resulted in system success while inactive participation leads to failure. User participation has been discussed by number of researchers. However level of user participation with respect to available tools and technologies, and its impact on system success or failure are yet to be discussed.

In this paper, we studied different levels/degrees (high, moderate and low) of participation during development phases. We have also measured the impact of user's participation on system implementation. Hence, we proposed a framework to overcome issues discussed earlier. To validate the proposed framework, a scenario has been discussed. In the scenario, user participation is measured at each phase with respect to available tools and technologies. System success is gauged in the context of ease of use, trust in system, sense of ownership, system adoption and user satisfaction.

II. LITERATURE REVIEW

User participation has been remained as a key aspect of DSS. Lot of research work has been done in this regard from last three decades. In 1984, Mann and Watson [1] presented contingency model for user participation in DSS development. This model is based on a three dimensional tentative model which was chosen from previous literature and validated with case studies. Case studies revealed that user participation depends upon the procedure adopted for development [1]. The proposed contingency model is the main strength of his work. The authors stated that proposed models require a link between information requirement and high level of user participation in DSS development [1]. However this work was limited to development phase only.

In 1988, Solis and Conway [8] consolidated previous research material related to DSS success. They recapitulated that different approaches exist for the measurement of MIS/DSS implementation's success. For example, normative approach, factor approach and process approach were focused. All these approaches concluded [8] that a successful implementation depends upon patterns of participation between users and developers. The authors limited the scope up to previous work only. Success factor table is given without justification or literature evidence. Moreover work is neither validated through experiments nor through cases studies.

Major contribution in the field of user participation is done by Barki and Hartwick [9]. In 1994, the authors [9] stated that participation can be measured in certain ways which users perform during system development process. However, the reliability of user participation and its subscales were ensured with validities [9]. Through participation users may be able to influence the design of new system in order to satisfy their needs. The feeling of ownership and better understanding of new system can be easily developed by involving users [9]. The work was validated by statistical techniques. All qualitative aspects are discussed in details however these were not measured in single or all phases of development life cycle.

After a couple of years, Turban [10] gave an overview of the factors that establish the link to success or failure of DSS. Different indicators exist to measure the successful implementation of DSS; user participation was regarded as one of the variables [10]. User participation with the degree of participation is defined [10] as an important determinant of implementation in the proposed model. Model includes eight stages/activities of DSS design where in termination stage users have to own the system, which will also prove their psychological ownership and commitment during DSS development [10]. The author focused more on consolidating previous works than innovating new ideas.

In 1997, Effects of user participation in system development were discussed by Hunton and Beeler [11]. The discussion includes a field experiment related to accounting systems in which users were given an opportunity to participate in developing software applications. Such experiments [11] reveal real situations leading to success of the systems. User participation is considered as an important factor for system success. If user believes that existing system is relevant and useful, they will participate in development activities [11].

Two years latter Newman et al. [12] conducted research in DSS with respect to success and failure in the field of agriculture sciences. Research shows [12] low adoption of DSS in agriculture because of no user participation during development, no ease of use, unknown end-users and user satisfaction [12]. A participatory approach was suggested.

In 2001, Hartwick and Barki [13] contributed in the same domain. Three dimensions were already identified as responsibility, user-IS relationship and hands-on activity but these do not provide accurate relationship. Therefore, communication was examined as a fourth dimension of user participation with the help of which user-analyst relation, and it is regarded as success for system [13]. In this way users described their needs and wants; finally they were engaged in development-related activities. Statistical techniques based upon a conceptual model, were applied to provide evidence for the proposed relationship [13]. The weakness however is on analyzing a few factors during factor analysis.

According to [14], DSS should be well designed and supportive in order to achieve high effectiveness. Thus, users are required to participate during design and specification of systems. It concluded that a poor model may be selected as a result of high user because they overlook technical issues. Similarly [14], users with high participation in system design demonstrated greater satisfaction than low user participation. In 2003, Kulhavy [15] presented a Developer's Perspective of a DSS. While designing DSS for industry processes, local modeling concepts were not applicable and were redefined to make it effective. Therefore, scope of DSS applications decision support workflow was being presented in the form of model. User participation and training were highly recommended [15]. The major drawback in this work was absence of validation, though non technical aspects were given attention whereas technical specifications were overlooked.

Three years later, it was presented that User Centeredness in user participation as one of the dimensions being identified in previous research work [16], which showed that user participation as an integral part of User Centered Design (UCD) and authors [16] emphasized on active user participation in the design practice. This is only possible for small projects, for larger projects they considered user representatives. Furthermore, for product development, user participation is consultative [16]. Empirical testing was provided as work is validated with previous literature only.

In the same year, Riedel et al. [17] highlighted that previous researchers focused on the relationship of user participation and perceived advantages. But there are lots of other factors as well. The proposed framework examined relationship between participation and performance in modeling processes. It was concluded [17] that involving users at every stage will increase complexity of overall project but it would result in good-quality customized products. Developers can work easily without user's participation. Major contribution of [17] is to link user participation and technology acceptance model.

In 2006, a case study in participatory decision support system development (AgClimate) was conducted [18]. Climate is dynamic and variable. To handle various risks, DSS can help to understand climate forecasts and understand the risks associated with alternative responses in order to obtain benefits from a forecast [18]. A prototype was developed with end-user participation. This participation resulted in the increased domain's knowledge, trusts in the system and also gained worth by meeting specific needs and interests of the users. It is [18] reported that validation is done through surveys but without details of adopted techniques.

During literature survey we found several limitations in the previous works. Our model intends to support missing features overlooked by others. For instance, [13] discussed limited factors during factor analysis. Our proposed model analyzes all mentioned factors. On the other hand, non-technical aspects are given more attention as compared to others [15]. We focused technical aspects by using different tools during several phases. Most of them analyzed various case studies of diverse organizations for validation [1], and a single case study is considered for a particular domain in our work. Validation parts in some works are absent [10][8], and the survey and questionnaires details are not there in [18][17].

We attempted to address these shortcomings in our proposed framework. Our model is composed of salient features as we focus on tools and technologies for integration of multiple dimensions, and observing their impacts.

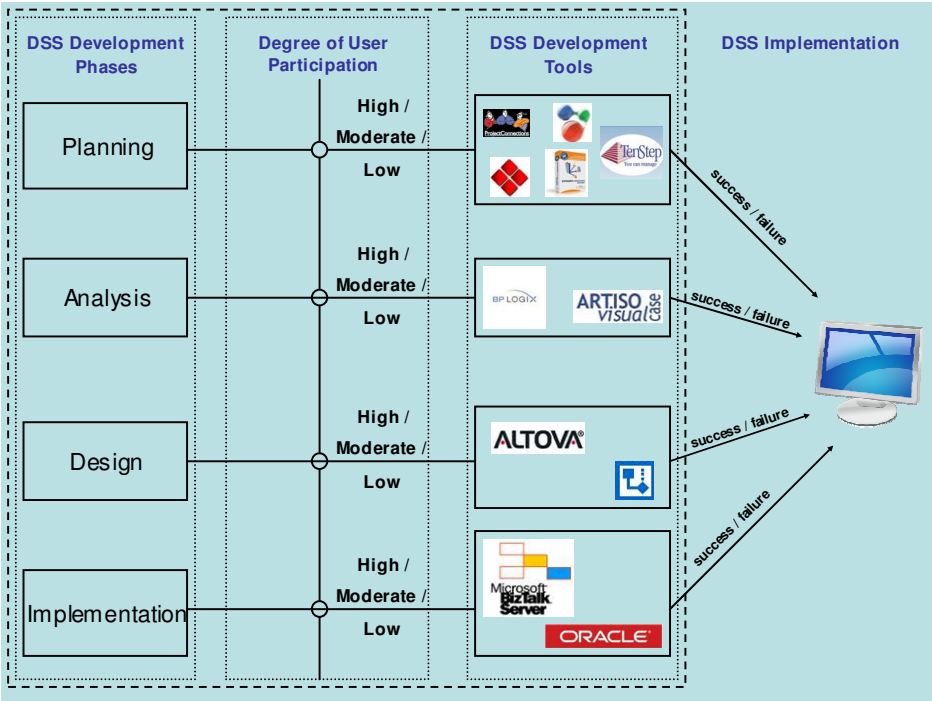

Fig. 1. Proposed analytical framework

III. PROPOSED FRAMEWORK

Based on literature review discussed in previous section, our experiences and hypothesis provide foundation for proposing a model to check and monitor impact of user participation during DSS development and its implementation. Success or failure of system implementation largely depends upon user participation. To investigate degree of user participation in system development and its impact on implementation, a conceptual model is proposed, as shown in Figure 1.

Proposed model consists of:

- DSS development phases.
- DSS development tools.
- Degree of user participation.
- Impact of user participation on DSS implementation.

Traditionally, DSS system development life cycle (SDLC) consists of four phases [19]. Phases include planning, analysis, design and implementation. In our proposed model phases are studied up to activities level.

Planning phase consists of several major activities such as; to identify business value, analyze feasibility, develop work plan, staffing project and maintaining control of overall project. In the same way analysis stage comprises of developing analysis strategy, determining business requirements, creating use cases, modeling of processes and data. Design is also one of the significant phases having many important features for the development of a system. It includes designing of physical system, architecture, interface, programs, databases and files. Implementation is considered to be the final stage in overall DSS development life cycle. It involves construction of system, installation, maintenance and its post implementation features

Tools and technologies are available for every phase of DSS development life cycle. Planning phase uses MyTimeBoxing, ProjectConnections, CriticalTools, SmartDraw, ConceptDraw and TenStep. Analysis is also carried out by means of several tools. Most frequently used tools are BP Logix and Artiso Visual Case Tool. For designing phase; Altova and MS Visio are used. However, implementation phase uses Oracle E-Business Suite, as just one of many options.

We target to study the degree of user participation during maximum activities of DSS development life cycle. Proposed conceptual model caters different levels of user participation as high, moderate and low during all phases/activities of DSS system development. High level of user participation is related to complete participation of users in development phase(s). Moderate level of participation is concerned with some level of reluctance from user's side and it is noticed that they are not completely participating in development activities. Finally in low level of participation, users are very much limited with respect to their participation. Whereas in some cases/activities, their interested is measured near to zero level.

Finally DSS implementation reveals the impact of user participation. It is measured that high level of user participation results in relatively high rate of system success. On the other hand, low level of user participation lead to failure of system, in most of the cases. However, moderate level of user participation borders between outcomes of success and failure of system implementations. Moreover it is also observed that high level of user participation at early stages of DSS development life cycle yield a significant probability of system success.

IV. VALIDATION

In Pakistan, a telecom company ABC (whose name is anonymous due to their privacy rules) is providing a wide range of services across the country. They include landline, cellular & Data Services. Data Services including DSL, dial-up, Web Hosting, Intranet, e-mail and video-conferencing.

In 2009, the company's management decided to have a DSS for making services plans or tariffs for Data Services. The requirements were given to a Software Company XYZ for the development of DSS. For designing tariffs, the following departments of the organization play respective roles:

1. Regularity Affairs Department
2. Data Services Operational Department
3. Billing Department.
4. Finance & Revenue Department.

The development of DSS system was started in second quarter of 2009. The Software Company was mainly consulting with the Regularity Affairs department, considering the major stakeholders of the domain. The purpose of the consultation was to prepare deliverables of planning phase, which includes System Request, Feasibility Study and Project Plan.

In the planning phase that embraces identifying business value, analyzing feasibility and developing work plan, the Regularity Affairs department was consulted. For the other sub-phases that cover staff project and control & direct project, no consultation was made. During the planning phase, the following planning tools were used: MyTimeBoxing, ProjectConnections, CriticalTools, SmartDraw and TenStep.

Successful deliverables of first phase of SDLC met the deadline and fulfilled the initial requirements specified in planning phase. Referring to our proposed model, the level of user participation was high in the planning phase and it contributed to certain success. Here, we interpret the success in terms of ownership as discussed in [10][9][11]. High level of user participation during this phase developed a sense of ownership in the system which will not only lead to adoption of the system but user's trust in system will also be cultivated.

In Analysis phase; analyzing problem and gathering information, initially almost all stakeholders were taken on board. But later, everyone in the telecom company was avoiding the developers and started pushing the ball in the court of other departments. In analysis sub-phases information they gathered from users and their own experiences.

During analysis the following tools were used to prepare the deliverables (System Proposal, Requirement Definition and Process Modeling): BP Logix and Artiso Visual Case tool.

According to Software Engineering practices, analysis phase is very important for gathering detailed user requirement from all the stakeholders. In this case of developing DSS for the Telecom Company, this step was taken lightly. Most of the stakeholders were not committed in full priority, minimum participation was offered by end-users. Since detailed information was not sufficiently gathered in analysis phase, the DSS was not developed as per desired up to the full specifications.

In terms of our proposed model, it is evident that that poor user participation or non-participation caused not only failure of analysis phase but also failure of whole system at the end. With low participation level, system will not fulfill the requirements of the user and affects also system adoption [12].

Design is the third phase of SDLC, which includes typically Physical System design, Architecture design, Interface and Databases design. Normally lay users are not consulted in designing phase. However developers tried to ensure the design of user-application interfaces captures users' requirements and met with full satisfaction. Tools used in this phase are Altova and MS Visio.

It produces deliverables such as, Alternative Matrix System Specification, Architecture Report, Hardware and Software Specification, Interface Design, Physical Process model, Program Design, Database & File Specification, Physical Data Modeling.

By our proposed model, this situation seems to be a success for the designing phase as users have actively participated and were satisfied with the output. Here, we are interpreting the success in terms of ease-of-use as feedbacked [10][9]. High level of user participation; developed trust in the system which will lead to user satisfaction [10][9][8] as well.

Implementation is the final phase of DSS SDLC. The core of this phase is delivery and technical support of the completed system. Oracle E-Business Suite was used in this phase.

User participation is not considered to be an important element for this phase. Literature also supported that user participation has least significant impact of success or failure on the implementation phase. Hence user participation in this phase has a neutral impact over the overall success or failure of the system.

When we applied our proposed model on the above case study, it resulted in the failure of the system. The major reason of this failure was the low user participation in analysis phase. The Software Company was unable to capture the needs and essences for the intended system. Hence it is shown that high level of user participation is required in almost all phases of SDLC especially in analysis phase, where detailed specifications are needed to be gathered. The complete Analytical Framework for Validation is shown in Figure 2.

V. CONCLUSION

There are several factors which are critical to success of DSS implementation. User participation plays a vital role in this regard. Technology selection in DSS development phases is also crucial. Here we proposed a framework which highlights level of user participation with respect to available tools & technologies and its impact on system success or failure.

Proposed framework is based on DSS development phases and latest tools and technologies, to monitor the level of user participation in DSS development and its impact on implementation. System success is measured in the context of ease of use, trust in system, sense of ownership, system adoption and user satisfaction. For future work, we have set dimensions of user's involvement to check its relations to user's participation and the impact on system success.

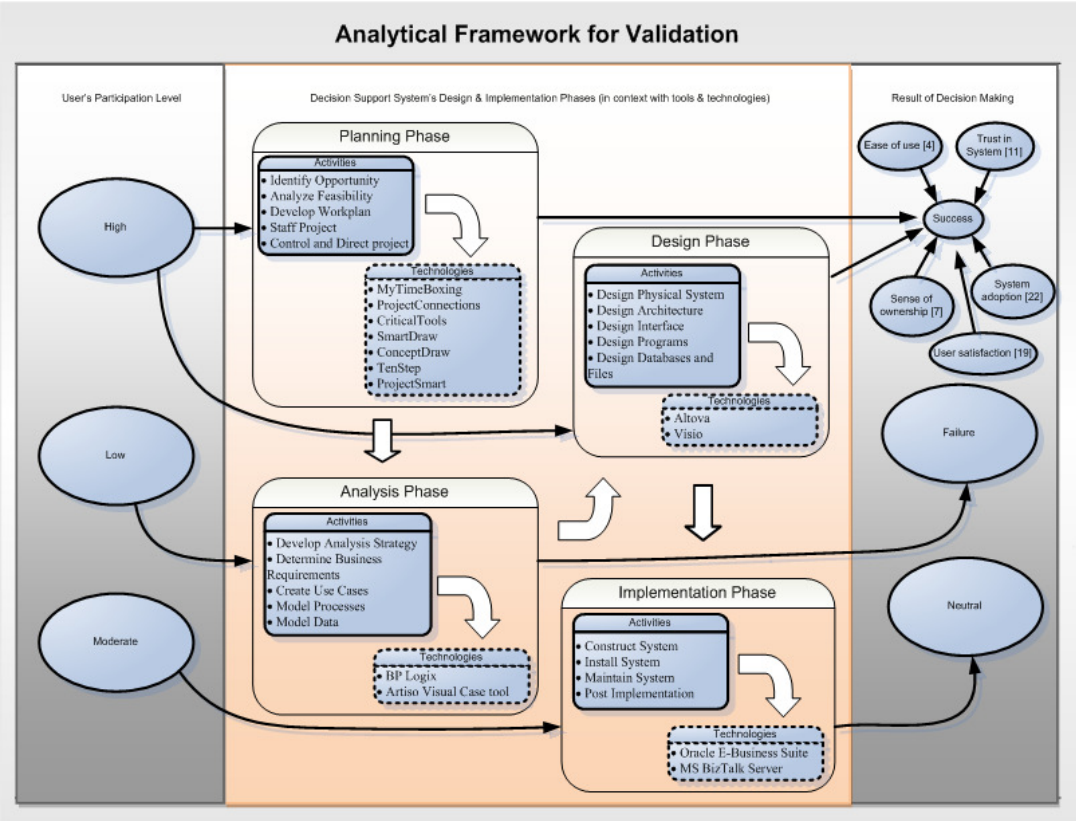

Fig. 2. Analytical framework for validation

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Table 1. Literature overview

Author(s)	Scope of Research	Validation Approach	Focus/key points
Mann and Watson (1984)	Development phase	Case study based	• Relationship observed between tool/technology verses user participations.
Solis and Conway (1988)	Limited phases	Literature based	• A successful implementation depends upon patterns of participation between users and developers.
Barki and Hartwick (1994)	During and after implementation phase	Questionnaire + factor analysis	• Impact of user participation during and after system implementation is discussed.
Turban (1996)	Complete Development Life Cycle	Questionnaire + Survey based	• Impact of user participation on DSS success.
Hunton and Beeler (1997)	Complete Development Life Cycle	Statistical	• If user believes that existing system is useful, they will participate in development activities.
Newman1 et al. (1999)	Development phase	Case study based	• Reasons behind low adoption of DSS verses user participation during development.
Hartwick and Barki (2001)	Complete Development Life Cycle	Statistical	• System success while considering communication as important part.
Kulhavy (2003)	Complete Development Life Cycle	Statistical	• Relationship between user and developer is examined.
J. Iivari and N. Iivari (2006)	Design phase	Literature based	• User participation is examined with respect to user centeredness.
Riedel et al. (2006)	Implementation and development phases	Survey based	• User's participation verse model complexity.
Breuer et al. (2007)	Design and implementation phases	Survey based	• Impacts of user's participation on specific objectives are observed.