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Internet of Things and its impact on Business Analytics

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ABSTRACT
Objectives:TostudytheImpactofIoTdataonBusinessAnalytics.**Methods/StatisticalAnalysis**:Anexploratoryresearchto study the Impact of IoT data on Business Analytics was conducted. Through the Literature review process, variouspreliminary information on IoT and Business Analytics including the Advanced Analytics was gathered. Research papers,Journals, Internet Sites and books were used to collate the relevant content on the subject. Analysis of all the relevantexampleswasdone.Thegapsintheareaofresearchwereidentifiedtoarriveattheproblemstatementanditsimpacton Organizations.**Findings:**Worldismovingveryrapidlytowardstheindustry4.0,whetherthemostimpactfulpositionin almost all the areas would be of IoT (Internet of Things). Profoundly IoT allows the connection between people andthingsatanypointandanygivenplacewithdevicesthatcantransmitdataoverthenetwork.Thus,theSmartenvironmentevolveswhichconsistsofSmartdevicestransmittingtherealtimedataoverSmartnetworks.BusinessDecisionMakingisfacilitatedwithagreateraccuracywithrealtimedatatransmittedcoupledwiththerelevantinformation.IoTandBusinessAnalyticsbasedonIoTdataisgainingalotofsignificanceandimportanceinlargerorganizations.Rightdecisionmakingattherighttimeandattherightplaceisthekeytosuccessfulbusinessesintoday'sdynamicenvironment.**Application:**Therealtimeanalyticsbecomesarealitywith IoTdatatransmittedovertheInternetandconsumedbytheBusinessAnalytics.UseofPastdataistoanalyzeandidentifythehiddentrendssothatfuturepredictabilityisbuilt.Currentdatahelpsvalidatetherelevancyof theBusinessAnalyticsModel.Italsohelpsintakingsomecoursecorrectionsasandwhenrequired.
Keywords: Advanced Analytics,Big Data,Business Analytics,Industry4.0., Internet of Things

I. INTRODUCTION

The most important and pivotal role in an economy isplayed by the Industries. The industries fundamentallyare a combination of People, Processes and Technology,which synchronize together for a definitive output. EverSince the beginning of Industrialization, the leaps thattechnology has taken has led to Paradigm, shifts namedasIndustrialRevolutions[1].

The Industry 1.0 was formed way-back in 1784, whichcomprisedofMachinesdrivenbySteamandWater.Industry 2.0 born around 1870 depended heavily on production of goods by mass production techniques usingelectrical as the source of energy. In the year 1969, theIndustrial Revolution took the Industry to the next stepof development where Information Technology (IT) wasin practice for replicating and reproducing production atamuchfasterratecalledasAutomation.Theadvanceddigitization with the combination of Internet technologiesandfutureorientedtechnologiesinthefieldofsmartobjectsresultedinanewParadigmshift.Finally,theeraofCyber Physical Systems arrived where the advancementoftheIndustrialrevolutionistermedasIndustry4.0.Thevision of the future contains modular, but efficient sys-tems where individual products will be produced with abatchsizeofonemaintainingtheeconomicconditionsofmassproduction[1].

Internet,byvirtueofitsubiquitouspresenceandimpact on all business and technology aspects, has com-manded an irrefutable presence in our lives. Internet hasgrown substantially in the last 5 decades starting from amicro network and to a macro global network servingbillions of users. This tremendous evolution in the pastfew years connected billions of things globally[2]. Amongother influences, the most recent one is of Internet ofThings (IoT). In[3], define IoT as "a network of dedicatedphysical objects (things) that contain embedded technologytosenseorinteractwiththeirinternalstateorthe external environment". In[4]define "IoT as connectingintelligent physical entities (sensors, devices, machines,assets, and products) to each other, to internet

services,andtoapplications".WiththeadventofIoT,thephysicalworld can now be connected to the all the systems withInternet. Things/devices, which were supposed to servecertain utilitarian purposes, can now actively participateinanecosystemcomprisedofotherthings/devices.Whiledoingso,things/devicescandeliverevenhighervalu estotheir intended recipients by virtue of their participationas active components/constituents of IoT. In[5]states that,the "Internet of Things" allows people and things to beconnected Anytime, Anywhere, with anything and any-one,ideallyusinganypath/networkandanyservice.

In[6]argue that the "IoT is a development of the pre-viousnotionsofubiquitouscomputing,pervasivecomputing and ambient intelligence". In[7]define "IoT asa system of interrelated computing devices, mechanicaland digital machines, objects, animals or people that areprovidedwithidentifiersandtheabilitytotransferdataover a network without requiring human-to-human orhuman-to-computer interaction". IoT is fundamentallythecriticalevaluationoftheinternetwheremachine–to –machinelearningcanbeachieved[8].

Forces from both sides of the Technology landscapesuchaspullandpushactedanddrovetheIoTanditsnextsteps. The push force was treating IoT as a new platformwherethepresentandfutureInformationandpassing of this information were applied. In contrast to technol-ogy pull forces where the existing areas of our economy,society and life are analyzed for the benefits by the widespreaddeploymentofIoT.

IoT, fundamentally, has grabbed the attention fromboththeprovidersaswellastheusersbecauseofitsabilityto connect devices, people and goods over a global net-work.Eachentityinthe IoT landscapeisallottedauniqueidentifier and the idea is to gather live data from each ofthem through the network. Live data can help organiza-tions in deriving useful and interesting trends based onadvancedanalyticsmodels.Thisprocessofchurningandmessagingmassivedataapplyingadvancedanalyticstechniq ues to unearth unseen patterns and possible cor-relationsarenamedasBigDataAnalytics[9].

Big Data is characterized by three main components,Variety,VelocityandVolume.Itisnowrapidlyexpandinginallsciencesandengineeringdomains,including physi-cal, biological and biomedical sciences. Until now big datawas largely made of transactional data generated manu-ally,whichusedtobestoredinrelationaldatabases.Withmore number of IoT networks deployed in the world, thebalancewillshiftfundamentallytowardslargevolumesofsensordata,whichisgeneratedbytheseuniquelycodifiedco nnected devices[10]. IoT makes a shift in the domain ofBigDatamanagement.Itbringsinasignificantrevolutionin the conventional solutions by intelligently connecteddevices, people, processes and things via sensors[11]. Themost fundamental issue faced by the Big Data applica-tions is churning of voluminous data, adding relevantinformationtoconvertthesameintoknowledgefordeci-sion-making[12]. The churning of data applying advanceanalytics techniques done for the Business key perfor-mance indicator variables to derive and predict BusinessDecisionsistermedasBusinessAnalytics.

A very interesting scenario has been brought to lightwhere a combination of electrical and mechanical partsbehavesintelligentlycombininghardware,software,con-trolsensors,datastorageandconnectivityovertheglobalnetwork. Opportunities of increasing productivity andreducing marginal costs at the same time turns into real-ity for organization as IoT allows sharing big data flowsamongmoderncompanies[13].

II. CURRENT STATE OF KNOWLEDGE

Advancedanalyticsisageneralterm,whichsimplymeansapplyingvariousadvancedanalytictechniquesto data adding relevant information and converting thesametoknowledgewhichcaneitherbeusestofindoutanswersofcurrentquestionsorsolvethemassist-ing decision making. It is not a technology in and ofitself, but rather, groups of tools that combine with oneanother to gain information, analyze that information,andpredictoutcomesoftheproblemsolutionsresult-ingintoaccurateandquickdecisionmaking[14]."Dataintegration and data mining are the basis for advancedanalytics"[15].Advancedanalyticsdrivendataanalysesallow enterprises to have a complete or "360 degrees"viewoftheiroperationsandcustomers.Dataanalyt-icsisanessentialresearchtopicintheIoTdomainthathasattractedmanydifferentresearchareassuchasstatistics,machine learninganddatamining.Theinsightthattheygainfromsuchanalysesisusedtodirect,optimize,andautomatetheirdecisi on-makingand build a knowledge base for future[16]. It results insuccessfulachievementofavarietyofspecificorga-nizationalgoalswiththehelpofthemodelsbuiltinthesystem.AdvancedAnalyticswhenappliedinthecontextofBusiness KeyPerformanceIndicatorsandthe decision- making depends on the data collected iscalled as Business Analytics. Business analytics systemscreatevalueandprovidecompetitiveadvantagefororganizations.In[17]statesthattheBAsystemsinvolvetheuseo

fadvancedstatisticalanalysistechniquesinmodeling, simulation, forecasting and data mining. BAsystems need embedded within the business processesandroutinesoforganizations.
"AclosepartnershipbetweentheBusinessAnalytics (BA) group and the Business is vital"[18]. Insights provided bytheBAgroupmustaligntothebusinessstrategiesandfocusareasthatcontributetothebusinessvalue.Businessvaluesofferstooneormoresegments of the customers and its network of partnerswho contribute to the profits and the revenue streams[19].An overview of how a business operates is termed asBusiness Model. The need of the hour is to figure outmechanisms that can tightly couple and embed BA systems within the business. If the role of BA is perceivedasatechnicalaspect,itcanhampertheunderstandingofthe richroleaBAmayplaywithinacompany.It is a very specific Business role of assisting BusinessunderstandingandhelpingDecision-makingthroughpredictivemodels[20].
The fundamental understanding of Internet of Thingsanditsroleinchangingtheapproachofunderstanding the Business Process Management fundamentally fromoutside and within the firm is becoming Vital in theleading Managerial Literature and a lot is spoken aboutthesame[21].Theneedtoscrutinizetheemergingideason IoT is largely felt[07]. IoT and its application in the realworld are a very niche and emerging field of research.Figure 1 depicts the envisaged growth of IoT until theyear2020[22].

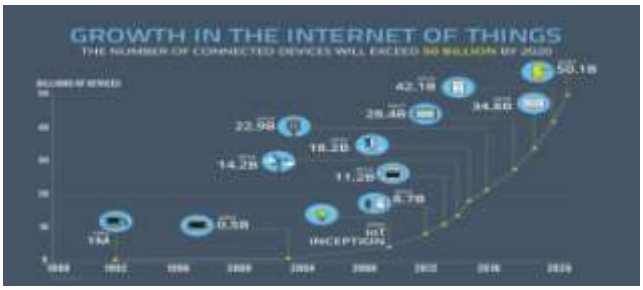

Figure1. GrowthinIoT.

ItisenvisagedandproveninsomecasesthatIoTcan actually reduce complexities and help create SmartEnvironments.In[23]statedthatapreliminaryresearchin applying/using IoT to ensure its inclusion in specificenvironments is missing and it has yet to make big in-roads.
The investigation and a thorough examination of therole of IoT in Business Process Management is yet to beexplored.Theconversionofinformationintoknowledgeisthenextleap,wherethedefinitionofknowledgeis"information combined with experience, context, interpretation and reflection". The Insights gained and the interpretation from theknowledgefortakingsensiblebusinessdecisionshugely depend upon the quality of knowledge possessedby an individual. For the Insights to be relevant to theexisting Business strategies and goals of a focused orga-nization, it is equally important to look at the existinglive data along with the past data for comparison. Whilelargelythepastdatawouldbeusedtogenerateusefulandmeaningful trends, the current month data would give animmediateinsighttotherelevancyofthecorrelationsandhelpquickdecision-making[24].Gatheringofrealtimedatathrough the smart sensing devices that is unpredictableand taking Business Strategy and goal-aligned decisionsisapromisingfieldofIoTAnalyticapplication[25].Thereisno black box or straight- forward answer to the questionof which the data to be evaluated to arrive at a correctBusinessdecision-makingmodel.Thestudyundertakes thetasktobuildtheDecisionMakingModelusingBusinessAnalyticsonthedatagatheredfromIoTdevices(Big Data) to help achieve the business objectives and inturntheorganizationalgoals.

III. POSSIBLE LOSSES/DAMAGES TO ORGANIZATIONS DUE TO THE LIMITATIONS

An Enterprise is designed to handle enormous data typesused for Decision Making at different point in time. Realtime data collected at source aids quick decision mak-ing at source. This objective can be achieved only whentherequirementsofthedecisionpointersisspeltoutand parameters are frozen on the basis of which decisioncanbetakeninadynamicanddistributedenviron-ment. Closed loop decision making requires gatheringthevaluesofthevariables.Dataacquisitionindicatesthe collection of data, which is transmitted by the smartsensors and other measuring equipment's. Data acquisi-tion includes different ways such as Manual capture andrecording. Electronic gathering of data with the help

ofsensorsetc.isdefinedasDataacquisition[26].Thesesensorsand data collection equipment become an integral part oftheIoTeco-systemtransmittingdatatothevariablesovernet.
Someveryimportantquotedstatementsthatempha-
sizethebenefitsofconsumingbigdataandBusinessAnalyticsforanorganization[27].In[28]statedthatiforgani-zationshavetoleverageontheopportunitiescreatedbythedatagathered,BusinessAnalyticsisthewayforward.Anotheri nterestingreportingmadeby[29]statedthatthehighperformingorganizationsweretakinginformeddecisionsbasedondat aanalysisatdoublethepaceofalowperformingorganization.BigDataAnalyticsisplay-inganimportantroleintransformingthelandscapeintoacompetitiveoneresultinginimprovementoftheorgani-zationalperformance,whichcannotbeundermined.In[30]hadsightedmanysuccessfulexamplesofexploringandbuildin gManagerialstrategiesdependentontheexten-siveuseofdataandanalyticsandtheirpotentialtoexploit.Without the complete eco-system being built, BusinessAnalyticsalonewillbeinsufficienttocreatetheBusinessValue.Theeco-systemincludestheresourceallocationandorchestrationalongwiththenecessaryinvestmentstobuildthesamewiththeI oTframeworkandusageof
thesame.

Figure2. UsageofIoTData.

Figure 2 depicts the difference between usage andnon-usageofIOTData[31]
As shown in Figure 3, Industries will not be able toreapthebenefitsofAdvancedAnalytics.Itwouldcripplethe organizations if the data required for the quick andaccurate decision-making is not provisioned because oftheabsenceoftheIoTinfrastructure.Itwillnotonlyaffectdecision - making, but would also bring in opacity in theorganization's vision towards the future and will lead toaSpeculativeHorizoninfluencingtheBusinessModel[31].

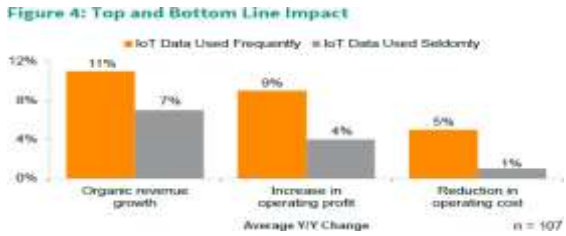

Figure3. ImpactofIoTDataonToplineandBottomLineofCompanies.

IV. CONCLUSIONS

With the world moving towards Industry 4.0, IoT hasgainedaprominentpositionandhascontinuedtoexpandits horizons in all domains. IoT fundamentally allowspeople and things to connect anytime, anywhere throughdevices which can transmit data with anything over anynetwork.TheSmartenvironmentthusevolvedwhichconsistsofSmartdevicestransmittingthedataoverSmart networks. As mentioned earlier the data transmit-tedcoupledwiththerelevantinformationisconvertedto knowledge, which can be used in Business DecisionMaking.CurrentlywhileIoTisevolving,BusinessAnalytics too has equally caught an eye from large orga-nizations.Rightdecisionmakingattherighttimeandattherightplaceisthekeytosuccessfulbusinessesin

today's dynamic environment. With IoT data, the possi-bilities of online business analytics increase rapidly. PastdataisfedintheBusinessAnalyticsmodelstoidentifythehidden trends and envisage the future, while the currentdata helps to validate the relevancy of the Model. Thisalso helps business in taking some course corrections ifrequired. Study of current state of knowledge reveals theinsufficiencyofinformationorevidenceoftheamalgama-tion of IoT data with Business Analytics. This can revealmanyemergingresearchdirectionsinsomeveryspecificandspecializeddomainssuchasmanufacturingetc.

V. LIMITATIONS

InternetofThingsanditscontributiontoBusinessAnalyticsarethemajorhighlightsifthispaper.Theattempt is also to understand Big data and how it isstitched in the Business Analytics Scheme of Things.While IoT conceptually is clarified the other importantperipherals of IoT such as Architecture & Dependencies,ChallengesinImplementation,Robustness,Openness,Privacy, Security etc. are not covered. Advanced Analyticsand its linkage to Business Analytics are depicted with-out getting into the Business Intelligence domain i.e. theVisualizationpieceoftheAnalyticsportfolio.

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